EUROPEAN COMMISSION
European Climate, Infrastructure and Environment Executive Agency

Director

GRANT AGREEMENT

NUMBER 101036723 — ARV

This **Agreement** ('the Agreement') is **between** the following parties:

on the one part,

the **European Climate, Infrastructure and Environment Executive Agency (CINEA)** ('the Agency'), under the powers delegated by the European Commission ('the Commission'), represented for the purposes of signature of this Agreement by Head of Department - Horizon Europe, European Climate, Infrastructure and Environment Executive Agency, Green research and innovation, Patrik KOLAR,

and

on the other part,

1. 'the coordinator':

NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU (NTNU), established in HOGSKOLERINGEN 1, TRONDHEIM 7491, Norway, VAT number: NO974767880MVA, represented for the purposes of signing the Agreement by Project Legal Signatory, Tor GRANDE

and the following other beneficiaries, if they sign their 'Accession Form' (see Annex 3 and Article 56):

2. **CONSEIL DES ARCHITECTES D'EUROPE (ACE)**, established in RUE PAUL EMILE JANSON 29, BRUXELLES 1050, Belgium, VAT number: BE0464884970,

3. **CESKE VYSOKE UCENI TECHNICKE V PRAZE (CVUT)**, established in JUGOSLAVSKYCH PARTYZANU 1580/3, PRAHA 160 00, Czech Republic, VAT number: CZ68407700,

4. **DANMARKS TEKNISKE UNIVERSITET (DTU)**, established in ANKER ENGELUNDSVEJ 1 BYGNING 101 A, KGS LYNGBY 2800, Denmark, VAT number: DK30060946,

5. **DANFOSS A/S (DANFOSS A/S)**, established in Nordborgvej 81, NORDBORG 6430, Denmark, VAT number: DK20165715,

6. **ENFOR AS (ENFOR)**, established in LYNGSO ALLE 3, HORSHOLM 2970, Denmark, VAT number: DK29421633,

7. **PROJECT ZERO A/S (PROJECTZERO)**, established in Alsion 2, Sonderborg 6400, Denmark, VAT number: DK29215642,

8. **ACCADEMIA EUROPEA DI BOLZANO (EURAC)**, established in VIALE DRUSO 1, BOLZANO 39100, Italy, VAT number: IT01659400210,

9. **SINTEF AS (SINTEF)**, established in STRINDVEGEN 4, TRONDHEIM 7034, Norway, VAT number: NO919303808MVA,

10. **AYUNTAMENT DE PALMA DE MALLORCA (PALMA)**, established in PLAZA DE CORT 1, PALMA DE MALLORCA 07001, Spain, VAT number: ESP0704000I,

11. **INSTITUTO BALEAR DE LA VIVIENDA (IBAVI)**, established in CALLE MANUEL AZANA 9 BAJOS, PALMA DE MALLORCA 07006, Spain, VAT number: ESQ5750001I,

12. **FUNDACIO INSTITUT DE RECERCA DE L'ENERGIA DE CATALUNYA (IREC)**, established in C/ JARDINS DE LES DONES DE NEGRE 1, SANT ADRIA DE BESOS 08930, Spain, VAT number: ESG64946387,

13. **METROVACESA, SA (MET)**, established in C QUINTANAVIDES 13 PARQUE EMPRESARIAL VIA NORTE ED 1 PLANTA 1, MADRID 28050, Spain, VAT number: ESA87471264,

14. **Stichting Hogeschool Utrecht (UAS Utrecht)**, established in PADUALAAN 99, UTRECHT 3584 CH, Netherlands, VAT number: NL806163185B01,

15. **COMITE EUROPEEN DE COORDINATION DE L'HABITAT SOCIAL AISBL (HOUSING EUROPE)**, established in SQUARE DE MEEUS 18, BRUXELLES 1050, Belgium, VAT number: BE0473324762,

16. **BURO DE HAAN INFORMATIE TECHNOLOGIE BV (Buro de Haan)**, established in ACHTHOEVENWEG 34, STAPHORST 7951 SK, Netherlands, VAT number: NL857548773B01,

17. **CENTER DANMARK DRIFT APS (Center Denmark)**, established in VENDERSGADE 74, FREDERICIA 7000, Denmark, VAT number: DK40868399,

18. **SONDERBORG ANDELSBOLIGFORENING (SAB)**, established in BYGTOFTEN 2, SONDERBORG 6400, Denmark, VAT number: DK45569810,

19. **GREEN DIGITAL FINANCE ALLIANCE (GDFA)**, established in CHEMIN DES ANEMONES 11-13, CHATELAINE 1219, Switzerland, VAT number: CHE496481826TVA,

20. **STICHTING BO-EX 91 (BOEX)**, established in JAN CORNELISZ MAYLAAN 18, UTRECHT 3526GV, Netherlands, VAT number: NL800519085B01,

21. **RC PANELS BV (Rc Panels B.V.)**, established in CONSTRUCTIEWEG 1, LEMELERVELD 8152 GA, Netherlands, VAT number: NL856857270B01,

22. **UNIVERSITEIT UTRECHT (UU)**, established in HEIDELBERGLAAN 8, UTRECHT 3584 CS, Netherlands, VAT number: NL001798650B01,

23. **GEMEENTE UTRECHT (CITY OF UTRECHT)**, established in STADSPLATEAU 1, UTRECHT 3521 AZ, Netherlands, VAT number: NL002220647B01,

24. **BOS INSTALLATIEWERKEN BV (BOSGROEP)**, established in TENNESSEEDREEF 17, UTRECHT 3565 CK, Netherlands, VAT number: NL801071197B01,

25. **IWELL BV (iwell)**, established in ATOOMWEG 7-9, UTRECHT 3542 AA, Netherlands, VAT number: NL856333268B01,

26. **ME X ARCHITECTS BV (MEX)**, established in SPOORLAAN 18, BILTHOVEN 3721 PB, Netherlands, VAT number: NL809748253B01,

27. **STICHTING MITROS (Mitros)**, established in KONINGIN WILHELMINALAAN 9, UTRECHT 3527 LA, Netherlands,

28. **STATUTARNI MESTO KARVINA (KARV)**, established in FRYSTATSKA 72 1, KARVINA FRYSTAT 733 24, Czech Republic, VAT number: CZ00297534,

29. **DOLOMITI ENERGIA RINNOVABILI SOCIETA A RESPONSABILITA' LIMITATA (DOL)**, established in VIA FERSINA 23, TRENTO 38123, Italy, VAT number: IT01840970220,

30. **DISTRETTO TECNOLOGICO TRENTINO SCARL (DTTN)**, established in PIAZZA MANIFATTURA 1, ROVERETO 38068, Italy, VAT number: IT01990440222,

31. **UNIVERSITA DEGLI STUDI DI TRENTO (UNITN)**, established in VIA CALEPINA 14, TRENTO 38122, Italy, VAT number: IT00340520220,

32. **POLITECNICO DI TORINO (POLITO)**, established in CORSO DUCA DEGLI ABRUZZI 24, TORINO 10129, Italy, VAT number: IT00518460019,

33. **OSLO KOMMUNE (OBF)**, established in RADHUSET, OSLO 0037, Norway, VAT number: NO958935420MVA,

34. **NANO POWER AS (NANO)**, established in TISKARSKA 599/12, PRAHA 108 00, Czech Republic, VAT number: CZ01719041,

35. **SISTEMES AVANCATS D ENERGIA SOLAR TERMICA SCCL (AIGUASOL SAEST)**, established in CALLE ROGER DE LLURIA 29 3R 2E, BARCELONA 08009, Spain, VAT number: ESF62787692,

Unless otherwise specified, references to ‘beneficiary’ or ‘beneficiaries’ include the coordinator.

The parties referred to above have agreed to enter into the Agreement under the terms and conditions below.

By signing the Agreement or the Accession Form, the beneficiaries accept the grant and agree to implement it under their own responsibility and in accordance with the Agreement, with all the obligations and conditions it sets out.

The Agreement is composed of:

Terms and Conditions

Annex 1 Description of the action

Annex 2 Estimated budget for the action

2a Additional information on the estimated budget

Annex 3 Accession Forms

Annex 4 Model for the financial statements

Annex 5 Model for the certificate on the financial statements

Annex 6 Model for the certificate on the methodology

TERMS AND CONDITIONS

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This Agreement sets out the rights and obligations and the terms and conditions applicable to the grant awarded to the beneficiaries for implementing the action set out in Chapter 2.

CHAPTER 2 ACTION

ARTICLE 2 — ACTION TO BE IMPLEMENTED

The grant is awarded for the action entitled '**Climate Positive Circular Communities**' — '**ARV**' **('action')**, as described in Annex 1.

ARTICLE 3 — DURATION AND STARTING DATE OF THE ACTION

The duration of the action will be **48 months** as of 1 January 2022 ('**starting date of the action**').

ARTICLE 4 — ESTIMATED BUDGET AND BUDGET TRANSFERS

4.1 Estimated budget

The '**estimated budget**' for the action is set out in Annex 2.

It contains the estimated eligible costs and the forms of costs, broken down by beneficiary (and linked third party) and budget category (see Articles 5, 6, and 14).

4.2 Budget transfers

The estimated budget breakdown indicated in Annex 2 may be adjusted — without an amendment (see Article 55) — by transfers of amounts between beneficiaries, budget categories and/or forms of costs set out in Annex 2, if the action is implemented as described in Annex 1.

However, the beneficiaries may not add costs relating to subcontracts not provided for in Annex 1, unless such additional subcontracts are approved by an amendment or in accordance with Article 13.

CHAPTER 3 GRANT

ARTICLE 5 — GRANT AMOUNT, FORM OF GRANT, REIMBURSEMENT RATES AND FORMS OF COSTS

5.1 Maximum grant amount

The '**maximum grant amount**' is **EUR 19 998 408.55** (nineteen million nine hundred and ninety eight thousand four hundred and eight EURO and fifty five eurocents).

5.2 Form of grant, reimbursement rates and forms of costs

The grant reimburses **100% of the eligible costs of the beneficiaries that are non-profit legal entities and 70% of the eligible costs of the beneficiaries and the affiliated entities that are profit legal entities** (see Article 6) (‘**reimbursement of eligible costs grant**’) (see Annex 2).

The estimated eligible costs of the action are EUR **21 316 651.63** (twenty one million three hundred and sixteen thousand six hundred and fifty one EURO and sixty three eurocents).

Eligible costs (see Article 6) must be declared under the following forms ('**forms of costs**'):

(a) for **direct personnel costs**:

- as actually incurred costs (‘**actual costs**’) or
- on the basis of an amount per unit calculated by the beneficiary in accordance with its usual cost accounting practices (‘**unit costs**’).

Personnel **costs for SME owners** or **beneficiaries that are natural persons** not receiving a salary (see Article 6.2, Points A.4 and A.5) must be declared on the basis of the amount per unit set out in Annex 2a (**unit costs**);

(b) for **direct costs for subcontracting**: as actually incurred costs (**actual costs**);

(c) for **direct costs of providing financial support to third parties**: not applicable;

(d) for **other direct costs**:

- for costs of internally invoiced goods and services: on the basis of an amount per unit calculated by the beneficiary in accordance with its usual cost accounting practices (‘**unit costs**’);
- for all other costs: as actually incurred costs (**actual costs**);

(e) for **indirect costs**: on the basis of a flat-rate applied as set out in Article 6.2, Point E (‘**flat-rate costs**’);

(f) **specific cost category(ies):** not applicable.

5.3 Final grant amount — Calculation

The ‘**final grant amount**’ depends on the actual extent to which the action is implemented in accordance with the Agreement’s terms and conditions.

This amount is calculated by the Agency — when the payment of the balance is made (see Article 21.4) — in the following steps:

Step 1 — Application of the reimbursement rates to the eligible costs

Step 2 — Limit to the maximum grant amount

Step 3 — Reduction due to the no-profit rule

Step 4 — Reduction due to substantial errors, irregularities or fraud or serious breach of obligations

5.3.1 Step 1 — Application of the reimbursement rates to the eligible costs

The reimbursement rate(s) (see Article 5.2) are applied to the eligible costs (actual costs, unit costs and flat-rate costs; see Article 6) declared by the beneficiaries and linked third parties (see Article 20) and approved by the Agency (see Article 21).

5.3.2 Step 2 — Limit to the maximum grant amount

If the amount obtained following Step 1 is higher than the maximum grant amount set out in Article 5.1, it will be limited to the latter.

5.3.3 Step 3 — Reduction due to the no-profit rule

The grant must not produce a profit.

'**Profit**' means the surplus of the amount obtained following Steps 1 and 2 plus the action's total receipts, over the action's total eligible costs.

The '**action's total eligible costs**' are the consolidated total eligible costs approved by the Agency.

The '**action's total receipts**' are the consolidated total receipts generated during its duration (see Article 3).

The following are considered **receipts**:

(a) income generated by the action; if the income is generated from selling equipment or other assets purchased under the Agreement, the receipt is up to the amount declared as eligible under the Agreement;

(b) financial contributions given by third parties to the beneficiary or to a linked third party specifically to be used for the action, and

(c) in-kind contributions provided by third parties free of charge and specifically to be used for the action, if they have been declared as eligible costs.

The following are however not considered receipts:

(a) income generated by exploiting the action's results (see Article 28);

(b) financial contributions by third parties, if they may be used to cover costs other than the eligible costs (see Article 6);

(c) financial contributions by third parties with no obligation to repay any amount unused at the end of the period set out in Article 3.

If there is a profit, it will be deducted from the amount obtained following Steps 1 and 2.

5.3.4 Step 4 — Reduction due to substantial errors, irregularities or fraud or serious breach of obligations — Reduced grant amount — Calculation

If the grant is reduced (see Article 43), the Agency will calculate the reduced grant amount by deducting the amount of the reduction (calculated in proportion to the seriousness of the errors,

irregularities or fraud or breach of obligations, in accordance with Article 43.2) from the maximum grant amount set out in Article 5.1.

The final grant amount will be the lower of the following two:

- the amount obtained following Steps 1 to 3 or
- the reduced grant amount following Step 4.

5.4 Revised final grant amount — Calculation

If — after the payment of the balance (in particular, after checks, reviews, audits or investigations; see Article 22) — the Agency rejects costs (see Article 42) or reduces the grant (see Article 43), it will calculate the '**revised final grant amount**' for the beneficiary concerned by the findings.

This amount is calculated by the Agency on the basis of the findings, as follows:

- in case of **rejection of costs**: by applying the reimbursement rate to the revised eligible costs approved by the Agency for the beneficiary concerned;
- in case of **reduction of the grant**: by calculating the concerned beneficiary's share in the grant amount reduced in proportion to the seriousness of the errors, irregularities or fraud or breach of obligations (see Article 43.2).

In case of **rejection of costs and reduction of the grant**, the revised final grant amount for the beneficiary concerned will be the lower of the two amounts above.

ARTICLE 6 — ELIGIBLE AND INELIGIBLE COSTS

6.1 General conditions for costs to be eligible

'**Eligible costs**' are costs that meet the following criteria:

(a) for **actual costs**:

(i) they must be actually incurred by the beneficiary;

(ii) they must be incurred in the period set out in Article 3, with the exception of costs relating to the submission of the periodic report for the last reporting period and the final report (see Article 20);

(iii) they must be indicated in the estimated budget set out in Annex 2;

(iv) they must be incurred in connection with the action as described in Annex 1 and necessary for its implementation;

(v) they must be identifiable and verifiable, in particular recorded in the beneficiary's accounts in accordance with the accounting standards applicable in the country where the beneficiary is established and with the beneficiary's usual cost accounting practices;

(vi) they must comply with the applicable national law on taxes, labour and social security, and

(vii) they must be reasonable, justified and must comply with the principle of sound financial management, in particular regarding economy and efficiency;

(b) for **unit costs**:

(i) they must be calculated as follows:

{amounts per unit set out in Annex 2a or calculated by the beneficiary in accordance with its usual cost accounting practices (see Article 6.2, Point A and Article 6.2.D.5)

multiplied by

the number of actual units};

(ii) the number of actual units must comply with the following conditions:

- the units must be actually used or produced in the period set out in Article 3;
- the units must be necessary for implementing the action or produced by it, and
- the number of units must be identifiable and verifiable, in particular supported by records and documentation (see Article 18);

(c) for **flat-rate costs**:

(i) they must be calculated by applying the flat-rate set out in Annex 2, and

(ii) the costs (actual costs or unit costs) to which the flat-rate is applied must comply with the conditions for eligibility set out in this Article.

6.2 Specific conditions for costs to be eligible

Costs are eligible if they comply with the general conditions (see above) and the specific conditions set out below for each of the following budget categories:

A. direct personnel costs;
B. direct costs of subcontracting;
C. not applicable;
D. other direct costs;
E. indirect costs;
F. not applicable.

'Direct costs' are costs that are directly linked to the action implementation and can therefore be attributed to it directly. They must not include any indirect costs (see Point E below).

'Indirect costs' are costs that are not directly linked to the action implementation and therefore cannot be attributed directly to it.

A. Direct personnel costs

<u>Types of eligible personnel costs</u>

A.1 Personnel costs are eligible, if they are related to personnel working for the beneficiary under an employment contract (or equivalent appointing act) and assigned to the action ('**costs for employees (or equivalent)**'). They must be limited to salaries (including during parental leave), social security contributions, taxes and other costs included in the **remuneration**, if they arise from national law or the employment contract (or equivalent appointing act).

Beneficiaries that are non-profit legal entities[1] may also declare as personnel costs **additional remuneration** for personnel assigned to the action (including payments on the basis of supplementary contracts regardless of their nature), if:

(a) it is part of the beneficiary's usual remuneration practices and is paid in a consistent manner whenever the same kind of work or expertise is required;

(b) the criteria used to calculate the supplementary payments are objective and generally applied by the beneficiary, regardless of the source of funding used.

'Additional remuneration' means any part of the remuneration which exceeds what the person would be paid for time worked in projects funded by national schemes.

Additional remuneration for personnel assigned to the action is eligible up to the following amount:

(a) if the person works full time and exclusively on the action during the full year: up to EUR 8 000;

(b) if the person works exclusively on the action but not full-time or not for the full year: up to the corresponding pro-rata amount of EUR 8 000, or

(c) if the person does not work exclusively on the action: up to a pro-rata amount calculated as follows:

{{EUR 8 000

divided by

the number of annual productive hours (see below)},

multiplied by

the number of hours that the person has worked on the action during the year}.

A.2 The **costs for natural persons working under a direct contract** with the beneficiary other than an employment contract are eligible personnel costs, if:

(a) the person works under conditions similar to those of an employee (in particular regarding the way the work is organised, the tasks that are performed and the premises where they are performed);

(b) the result of the work carried out belongs to the beneficiary (unless exceptionally agreed otherwise), and

[1] For the definition, see Article 2.1(14) of the Rules for Participation Regulation No 1290/2013: '**non-profit legal entity**' means a legal entity which by its legal form is non-profit-making or which has a legal or statutory obligation not to distribute profits to its shareholders or individual members.

(c) the costs are not significantly different from those for personnel performing similar tasks under an employment contract with the beneficiary.

A.3 The **costs of personnel seconded by a third party against payment** are eligible personnel costs, if the conditions in Article 11.1 are met.

A.4 **Costs of owners** of beneficiaries that are small and medium-sized enterprises ('**SME owners**') who are working on the action and who do not receive a salary are eligible personnel costs, if they correspond to the amount per unit set out in Annex 2a multiplied by the number of actual hours worked on the action.

A.5 **Costs of 'beneficiaries that are natural persons'** not receiving a salary are eligible personnel costs, if they correspond to the amount per unit set out in Annex 2a multiplied by the number of actual hours worked on the action.

Calculation

Personnel costs must be calculated by the beneficiaries as follows:

{{hourly rate

multiplied by

the number of actual hours worked on the action},

plus

for non-profit legal entities: additional remuneration to personnel assigned to the action under the conditions set out above (Point A.1)}.

The number of actual hours declared for a person must be identifiable and verifiable (see Article 18).

The total number of hours declared in EU or Euratom grants, for a person for a year, cannot be higher than the annual productive hours used for the calculations of the hourly rate. Therefore, the maximum number of hours that can be declared for the grant are:

{number of annual productive hours for the year (see below)

minus

total number of hours declared by the beneficiary, for that person in that year, for other EU or Euratom grants}.

The '**hourly rate**' is one of the following:

(a) for personnel costs declared as **actual costs** (i.e. budget categories A.1, A.2, A.3): the hourly rate is calculated *per full financial year*, as follows:

{actual annual personnel costs (excluding additional remuneration) for the person

divided by

number of annual productive hours}.

using the personnel costs and the number of productive hours for each full financial year covered by the reporting period concerned. If a financial year is not closed at the end of the

reporting period, the beneficiaries must use the hourly rate of the last closed financial year available.

For the 'number of annual productive hours', the beneficiaries may choose one of the following:

(i) 'fixed number of hours': 1 720 hours for persons working full time (or corresponding pro-rata for persons not working full time);

(ii) 'individual annual productive hours': the total number of hours worked by the person in the year for the beneficiary, calculated as follows:

{annual workable hours of the person (according to the employment contract, applicable collective labour agreement or national law)

plus

overtime worked

minus

absences (such as sick leave and special leave)}.

'Annual workable hours' means the period during which the personnel must be working, at the employer's disposal and carrying out his/her activity or duties under the employment contract, applicable collective labour agreement or national working time legislation.

If the contract (or applicable collective labour agreement or national working time legislation) does not allow to determine the annual workable hours, this option cannot be used;

(iii) 'standard annual productive hours': the 'standard number of annual hours' generally applied by the beneficiary for its personnel in accordance with its usual cost accounting practices. This number must be at least 90% of the 'standard annual workable hours'.

If there is no applicable reference for the standard annual workable hours, this option cannot be used.

For all options, the actual time spent on **parental leave** by a person assigned to the action may be deducted from the number of annual productive hours.

As an alternative, beneficiaries may calculate the hourly rate *per month*, as follows:

{actual monthly personnel cost (excluding additional remuneration) for the person

divided by

{number of annual productive hours / 12}}

using the personnel costs for each month and (one twelfth of) the annual productive hours calculated according to either option (i) or (iii) above, i.e.:

- fixed number of hours or
- standard annual productive hours.

Time spent on **parental leave** may not be deducted when calculating the hourly rate per month. However, beneficiaries may declare personnel costs incurred in periods of parental leave in proportion to the time the person worked on the action in that financial year.

If parts of a basic remuneration are generated over a period longer than a month, the beneficiaries may include only the share which is generated in the month (irrespective of the amount actually paid for that month).

Each beneficiary must use only one option (per full financial year or per month) for each full financial year;

(b) for personnel costs declared on the basis of **unit costs** (i.e. budget categories A.1, A.2, A.4, A.5): the hourly rate is one of the following:

(i) for SME owners or beneficiaries that are natural persons: the hourly rate set out in Annex 2a (see Points A.4 and A.5 above), or

(ii) for personnel costs declared on the basis of the beneficiary's usual cost accounting practices: the hourly rate calculated by the beneficiary in accordance with its usual cost accounting practices, if:

- the cost accounting practices used are applied in a consistent manner, based on objective criteria, regardless of the source of funding;

- the hourly rate is calculated using the actual personnel costs recorded in the beneficiary's accounts, excluding any ineligible cost or costs included in other budget categories.

  The actual personnel costs may be adjusted by the beneficiary on the basis of budgeted or estimated elements. Those elements must be relevant for calculating the personnel costs, reasonable and correspond to objective and verifiable information;

and

- the hourly rate is calculated using the number of annual productive hours (see above).

B. Direct costs of subcontracting (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are eligible if the conditions in Article 13.1.1 are met.

C. Direct costs of providing financial support to third parties

Not applicable

D. Other direct costs

D.1 **Travel costs and related subsistence allowances** (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are eligible if they are in line with the beneficiary's usual practices on travel.

D.2 The **depreciation costs of equipment, infrastructure or other assets** (new or second-hand) as recorded in the beneficiary's accounts are eligible, if they were purchased in accordance with

Article 10.1.1 and written off in accordance with international accounting standards and the beneficiary's usual accounting practices.

The **costs of renting or leasing** equipment, infrastructure or other assets (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are also eligible, if they do not exceed the depreciation costs of similar equipment, infrastructure or assets and do not include any financing fees.

The costs of equipment, infrastructure or other assets **contributed in-kind against payment** are eligible, if they do not exceed the depreciation costs of similar equipment, infrastructure or assets, do not include any financing fees and if the conditions in Article 11.1 are met.

The only portion of the costs that will be taken into account is that which corresponds to the duration of the action and rate of actual use for the purposes of the action.

D.3 **Costs of other goods and services** (including related duties, taxes and charges such as non-deductible value added tax (VAT) paid by the beneficiary) are eligible, if they are:

(a) purchased specifically for the action and in accordance with Article 10.1.1 or

(b) contributed in kind against payment and in accordance with Article 11.1.

Such goods and services include, for instance, consumables and supplies, dissemination (including open access), protection of results, certificates on the financial statements (if they are required by the Agreement), certificates on the methodology, translations and publications.

D.4 **Capitalised and operating costs of 'large research infrastructure'**[2] directly used for the action are eligible, if:

(a) the value of the large research infrastructure represents at least 75% of the total fixed assets (at historical value in its last closed balance sheet before the date of the signature of the Agreement or as determined on the basis of the rental and leasing costs of the research infrastructure[3]);

(b) the beneficiary's methodology for declaring the costs for large research infrastructure has been positively assessed by the Commission ('**ex-ante assessment**');

(c) the beneficiary declares as direct eligible costs only the portion which corresponds to the duration of the action and the rate of actual use for the purposes of the action, and

(d) they comply with the conditions as further detailed in the annotations to the H2020 grant agreements.

[2] '**Large research infrastructure**' means research infrastructure of a total value of at least EUR 20 million, for a beneficiary, calculated as the sum of historical asset values of each individual research infrastructure of that beneficiary, as they appear in its last closed balance sheet before the date of the signature of the Agreement or as determined on the basis of the rental and leasing costs of the research infrastructure.

[3] For the definition, see Article 2(6) of the H2020 Framework Programme Regulation No 1291/2013: '**Research infrastructure**' are facilities, resources and services that are used by the research communities to conduct research and foster innovation in their fields. Where relevant, they may be used beyond research, e.g. for education or public services. They include: major scientific equipment (or sets of instruments); knowledge-based resources such as collections, archives or scientific data; e-infrastructures such as data and computing systems and communication networks; and any other infrastructure of a unique nature essential to achieve excellence in research and innovation. Such infrastructures may be 'single-sited', 'virtual' or 'distributed'.

D.5 **Costs of internally invoiced goods and services** directly used for the action are eligible, if:

(a) they are declared on the basis of a unit cost calculated in accordance with the beneficiary's usual cost accounting practices;

(b) the cost accounting practices used are applied in a consistent manner, based on objective criteria, regardless of the source of funding;

(c) the unit cost is calculated using the actual costs for the good or service recorded in the beneficiary's accounts, excluding any ineligible cost or costs included in other budget categories.

The actual costs may be adjusted by the beneficiary on the basis of budgeted or estimated elements. Those elements must be relevant for calculating the costs, reasonable and correspond to objective and verifiable information;

(d) the unit cost excludes any costs of items which are not directly linked to the production of the invoiced goods or service.

'Internally invoiced goods and services' means goods or services which are provided by the beneficiary directly for the action and which the beneficiary values on the basis of its usual cost accounting practices.

E. Indirect costs

Indirect costs are eligible if they are declared on the basis of the flat-rate of 25% of the eligible direct costs (see Article 5.2 and Points A to D above), from which are excluded:

(a) costs of subcontracting and

(b) costs of in-kind contributions provided by third parties which are not used on the beneficiary's premises;

(c) not applicable;

(d) not applicable.

Beneficiaries receiving an operating grant[4] financed by the EU or Euratom budget cannot declare indirect costs for the period covered by the operating grant, unless they can demonstrate that the operating grant does not cover any costs of the action.

F. Specific cost category(ies)

Not applicable

6.3 Conditions for costs of linked third parties to be eligible

[4] For the definition, see Article 121(1)(b) of Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002 ('**Financial Regulation No 966/2012**')(OJ L 218, 26.10.2012, p.1): '**operating grant**' means direct financial contribution, by way of donation, from the budget in order to finance the functioning of a body which pursues an aim of general EU interest or has an objective forming part of and supporting an EU policy.

Costs incurred by linked third parties are eligible if they fulfil — *mutatis mutandis* — the general and specific conditions for eligibility set out in this Article (Article 6.1 and 6.2) and Article 14.1.1.

6.4 Conditions for in-kind contributions provided by third parties free of charge to be eligible

In-kind contributions provided free of charge are eligible direct costs (for the beneficiary or linked third party), if the costs incurred by the third party fulfil — *mutatis mutandis* — the general and specific conditions for eligibility set out in this Article (Article 6.1 and 6.2) and Article 12.1.

6.5 Ineligible costs

'**Ineligible costs**' are:

(a) costs that do not comply with the conditions set out above (Article 6.1 to 6.4), in particular:

(i) costs related to return on capital;

(ii) debt and debt service charges;

(iii) provisions for future losses or debts;

(iv) interest owed;

(v) doubtful debts;

(vi) currency exchange losses;

(vii) bank costs charged by the beneficiary's bank for transfers from the Agency;

(viii) excessive or reckless expenditure;

(ix) deductible VAT;

(x) costs incurred during suspension of the implementation of the action (see Article 49);

(b) costs declared under another EU or Euratom grant (including grants awarded by a Member State and financed by the EU or Euratom budget and grants awarded by bodies other than the Agency for the purpose of implementing the EU or Euratom budget); in particular, indirect costs if the beneficiary is already receiving an operating grant financed by the EU or Euratom budget in the same period, unless it can demonstrate that the operating grant does not cover any costs of the action.

6.6 Consequences of declaration of ineligible costs

Declared costs that are ineligible will be rejected (see Article 42).

This may also lead to any of the other measures described in Chapter 6.

CHAPTER 4 RIGHTS AND OBLIGATIONS OF THE PARTIES

SECTION 1 RIGHTS AND OBLIGATIONS RELATED TO IMPLEMENTING THE ACTION

ARTICLE 7 — GENERAL OBLIGATION TO PROPERLY IMPLEMENT THE ACTION

7.1 General obligation to properly implement the action

The beneficiaries must implement the action as described in Annex 1 and in compliance with the provisions of the Agreement and all legal obligations under applicable EU, international and national law.

7.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 8 — RESOURCES TO IMPLEMENT THE ACTION — THIRD PARTIES INVOLVED IN THE ACTION

The beneficiaries must have the appropriate resources to implement the action.

If it is necessary to implement the action, the beneficiaries may:

- purchase goods, works and services (see Article 10);
- use in-kind contributions provided by third parties against payment (see Article 11);
- use in-kind contributions provided by third parties free of charge (see Article 12);
- call upon subcontractors to implement action tasks described in Annex 1 (see Article 13);
- call upon linked third parties to implement action tasks described in Annex 1 (see Article 14);
- call upon international partners to implement action tasks described in Annex 1 (see Article 14a).

In these cases, the beneficiaries retain sole responsibility towards the Agency and the other beneficiaries for implementing the action.

ARTICLE 9 — IMPLEMENTATION OF ACTION TASKS BY BENEFICIARIES NOT RECEIVING EU FUNDING

Not applicable

ARTICLE 10 — PURCHASE OF GOODS, WORKS OR SERVICES

10.1 Rules for purchasing goods, works or services

10.1.1 If necessary to implement the action, the beneficiaries may purchase goods, works or services.

The beneficiaries must make such purchases ensuring the best value for money or, if appropriate, the lowest price. In doing so, they must avoid any conflict of interests (see Article 35).

The beneficiaries must ensure that the Agency, the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards their contractors.

10.1.2 Beneficiaries that are 'contracting authorities' within the meaning of Directive 2004/18/EC[5] (or 2014/24/EU[6]) or 'contracting entities' within the meaning of Directive 2004/17/EC[7] (or 2014/25/EU[8]) must comply with the applicable national law on public procurement.

10.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under Article 10.1.1, the costs related to the contract concerned will be ineligible (see Article 6) and will be rejected (see Article 42).

If a beneficiary breaches any of its obligations under Article 10.1.2, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 11 — USE OF IN-KIND CONTRIBUTIONS PROVIDED BY THIRD PARTIES AGAINST PAYMENT

11.1 Rules for the use of in-kind contributions against payment

If necessary to implement the action, the beneficiaries may use in-kind contributions provided by third parties against payment.

The beneficiaries may declare costs related to the payment of in-kind contributions as eligible (see Article 6.1 and 6.2), up to the third parties' costs for the seconded persons, contributed equipment, infrastructure or other assets or other contributed goods and services.

The third parties and their contributions must be set out in Annex 1. The Agency may however approve in-kind contributions not set out in Annex 1 without amendment (see Article 55), if:

- they are specifically justified in the periodic technical report and
- their use does not entail changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

The beneficiaries must ensure that the Agency, the Commission, the European Court of Auditors

[5] Directive 2004/18/EC of the European Parliament and of the Council of 31 March 2004 on the coordination of procedures for the award of public work contracts, public supply contracts and public service contracts (OJ L 134, 30.04.2004, p. 114).

[6] Directive 2014/24/EU of the European Parliament and of the Council of 26 February 2014 on public procurement and repealing Directive 2004/18/EC. (OJ L 94, 28.03.2014, p. 65).

[7] Directive 2004/17/EC of the European Parliament and of the Council of 31 March 2004 coordinating the procurement procedures of entities operating in the water, energy, transport and postal services sectors (OJ L 134, 30.04.2004, p. 1)

[8] Directive 2014/25/EU of the European Parliament and of the Council of 26 February 2014 on procurement by entities operating in the water, energy, transport and postal services sectors and repealing Directive 2004/17/EC (OJ L 94, 28.03.2014, p. 243).

(ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards the third parties.

11.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the costs related to the payment of the in-kind contribution will be ineligible (see Article 6) and will be rejected (see Article 42).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 12 — USE OF IN-KIND CONTRIBUTIONS PROVIDED BY THIRD PARTIES FREE OF CHARGE

12.1 Rules for the use of in-kind contributions free of charge

If necessary to implement the action, the beneficiaries may use in-kind contributions provided by third parties free of charge.

The beneficiaries may declare costs incurred by the third parties for the seconded persons, contributed equipment, infrastructure or other assets or other contributed goods and services as eligible in accordance with Article 6.4.

The third parties and their contributions must be set out in Annex 1. The Agency may however approve in-kind contributions not set out in Annex 1 without amendment (see Article 55), if:

- they are specifically justified in the periodic technical report and
- their use does not entail changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

The beneficiaries must ensure that the Agency, the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards the third parties.

12.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the costs incurred by the third parties related to the in-kind contribution will be ineligible (see Article 6) and will be rejected (see Article 42).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 13 — IMPLEMENTATION OF ACTION TASKS BY SUBCONTRACTORS

13.1 Rules for subcontracting action tasks

13.1.1 If necessary to implement the action, the beneficiaries may award subcontracts covering the implementation of certain action tasks described in Annex 1.

Subcontracting may cover only a limited part of the action.

The beneficiaries must award the subcontracts ensuring the best value for money or, if appropriate, the lowest price. In doing so, they must avoid any conflict of interests (see Article 35).

The tasks to be implemented and the estimated cost for each subcontract must be set out in Annex 1 and the total estimated costs of subcontracting per beneficiary must be set out in Annex 2. The Agency may however approve subcontracts not set out in Annex 1 and 2 without amendment (see Article 55), if:

- they are specifically justified in the periodic technical report and
- they do not entail changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

The beneficiaries must ensure that the Agency, the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards their subcontractors.

13.1.2 The beneficiaries must ensure that their obligations under Articles 35, 36, 38 and 46 also apply to the subcontractors.

Beneficiaries that are 'contracting authorities' within the meaning of Directive 2004/18/EC (or 2014/24/EU) or 'contracting entities' within the meaning of Directive 2004/17/EC (or 2014/25/EU) must comply with the applicable national law on public procurement.

13.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under Article 13.1.1, the costs related to the subcontract concerned will be ineligible (see Article 6) and will be rejected (see Article 42).

If a beneficiary breaches any of its obligations under Article 13.1.2, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 14 — IMPLEMENTATION OF ACTION TASKS BY LINKED THIRD PARTIES

14.1 Rules for calling upon linked third parties to implement part of the action

14.1.1 The following **affiliated entities**[10] and **third parties with a legal link to a beneficiary**[11] ('**linked third parties**') may implement the action tasks attributed to them in Annex 1:

[10] For the definition see Article 2.1(2) Rules for Participation Regulation No 1290/2013: '**affiliated entity**' means any legal entity that is:
- under the direct or indirect control of a participant, or
- under the same direct or indirect control as the participant, or
- directly or indirectly controlling a participant.

'Control' may take any of the following forms:
(a) the direct or indirect holding of more than 50% of the nominal value of the issued share capital in the legal entity concerned, or of a majority of the voting rights of the shareholders or associates of that entity;
(b) the direct or indirect holding, in fact or in law, of decision-making powers in the legal entity concerned.

However the following relationships between legal entities shall not in themselves be deemed to constitute controlling relationships:
(a) the same public investment corporation, institutional investor or venture-capital company has a direct or indirect holding of more than 50% of the nominal value of the issued share capital or a majority of voting rights of the shareholders or associates;
(b) the legal entities concerned are owned or supervised by the same public body.

- ARMALAM SRL (Armalam), affiliated or linked to DTTN
- X-LAM DOLOMITI SRL (X-LAM DOLOMITI), affiliated or linked to DTTN
- FANTI LEGNAMI SRL (FANTI LEGNAMI), affiliated or linked to DTTN

The linked third parties may declare as eligible the costs they incur for implementing the action tasks in accordance with Article 6.3.

The beneficiaries must ensure that the Agency, the Commission, the European Court of Auditors (ECA) and the European Anti-Fraud Office (OLAF) can exercise their rights under Articles 22 and 23 also towards their linked third parties.

14.1.2 The beneficiaries must ensure that their obligations under Articles 18, 20, 35, 36 and 38 also apply to their linked third parties.

14.2 Consequences of non-compliance

If any obligation under Article 14.1.1 is breached, the costs of the linked third party will be ineligible (see Article 6) and will be rejected (see Article 42).

If any obligation under Article 14.1.2 is breached, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 14a — IMPLEMENTATION OF ACTION TASKS BY INTERNATIONAL PARTNERS

Not applicable

ARTICLE 15 — FINANCIAL SUPPORT TO THIRD PARTIES

15.1 Rules for providing financial support to third parties

Not applicable

15.2 Financial support in the form of prizes

Not applicable

15.3 Consequences of non-compliance

Not applicable

ARTICLE 16 — PROVISION OF TRANS-NATIONAL OR VIRTUAL ACCESS TO RESEARCH INFRASTRUCTURE

16.1 Rules for providing trans-national access to research infrastructure

[11] '**Third party with a legal link to a beneficiary**' is any legal entity which has a legal link to the beneficiary implying collaboration that is not limited to the action.

Not applicable

16.2 Rules for providing virtual access to research infrastructure

Not applicable

16.3 Consequences of non-compliance

Not applicable

SECTION 2 RIGHTS AND OBLIGATIONS RELATED TO THE GRANT ADMINISTRATION

ARTICLE 17 — GENERAL OBLIGATION TO INFORM

17.1 General obligation to provide information upon request

The beneficiaries must provide — during implementation of the action or afterwards and in accordance with Article 41.2 — any information requested in order to verify eligibility of the costs, proper implementation of the action and compliance with any other obligation under the Agreement.

17.2 Obligation to keep information up to date and to inform about events and circumstances likely to affect the Agreement

Each beneficiary must keep information stored in the Participant Portal Beneficiary Register (via the electronic exchange system; see Article 52) up to date, in particular, its name, address, legal representatives, legal form and organisation type.

Each beneficiary must immediately inform the coordinator — which must immediately inform the Agency and the other beneficiaries — of any of the following:

(a) **events** which are likely to affect significantly or delay the implementation of the action or the EU's financial interests, in particular:

  (i) changes in its legal, financial, technical, organisational or ownership situation or those of its linked third parties and

  (ii) changes in the name, address, legal form, organisation type of its linked third parties;

(b) **circumstances** affecting:

  (i) the decision to award the grant or

  (ii) compliance with requirements under the Agreement.

17.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 18 — KEEPING RECORDS — SUPPORTING DOCUMENTATION

18.1 Obligation to keep records and other supporting documentation

The beneficiaries must — for a period of five years after the payment of the balance — keep records and other supporting documentation in order to prove the proper implementation of the action and the costs they declare as eligible.

They must make them available upon request (see Article 17) or in the context of checks, reviews, audits or investigations (see Article 22).

If there are on-going checks, reviews, audits, investigations, litigation or other pursuits of claims under the Agreement (including the extension of findings; see Article 22), the beneficiaries must keep the records and other supporting documentation until the end of these procedures.

The beneficiaries must keep the original documents. Digital and digitalised documents are considered originals if they are authorised by the applicable national law. The Agency may accept non-original documents if it considers that they offer a comparable level of assurance.

18.1.1 Records and other supporting documentation on the scientific and technical implementation

The beneficiaries must keep records and other supporting documentation on scientific and technical implementation of the action in line with the accepted standards in the respective field.

18.1.2 Records and other documentation to support the costs declared

The beneficiaries must keep the records and documentation supporting the costs declared, in particular the following:

(a) for **actual costs**: adequate records and other supporting documentation to prove the costs declared, such as contracts, subcontracts, invoices and accounting records. In addition, the beneficiaries' usual cost accounting practices and internal control procedures must enable direct reconciliation between the amounts declared, the amounts recorded in their accounts and the amounts stated in the supporting documentation;

(b) for **unit costs**: adequate records and other supporting documentation to prove the number of units declared. Beneficiaries do not need to identify the actual eligible costs covered or to keep or provide supporting documentation (such as accounting statements) to prove the amount per unit.

In addition, **for unit costs calculated in accordance with the beneficiary's usual cost accounting practices**, the beneficiaries must keep adequate records and documentation to prove that the cost accounting practices used comply with the conditions set out in Article 6.2.

The beneficiaries and linked third parties may submit to the Commission, for approval, a certificate (drawn up in accordance with Annex 6) stating that their usual cost accounting practices comply with these conditions (‘**certificate on the methodology**’). If the certificate is approved, costs declared in line with this methodology will not be challenged subsequently, unless the beneficiaries have concealed information for the purpose of the approval.

(c) for **flat-rate costs**: adequate records and other supporting documentation to prove the eligibility

of the costs to which the flat-rate is applied. The beneficiaries do not need to identify the costs covered or provide supporting documentation (such as accounting statements) to prove the amount declared at a flat-rate.

In addition, for **personnel costs** (declared as actual costs or on the basis of unit costs), the beneficiaries must keep **time records** for the number of hours declared. The time records must be in writing and approved by the persons working on the action and their supervisors, at least monthly. In the absence of reliable time records of the hours worked on the action, the Agency may accept alternative evidence supporting the number of hours declared, if it considers that it offers an adequate level of assurance.

As an exception, for **persons working exclusively on the action**, there is no need to keep time records, if the beneficiary signs a **declaration** confirming that the persons concerned have worked exclusively on the action.

For costs declared by linked third parties (see Article 14), it is the beneficiary that must keep the originals of the financial statements and the certificates on the financial statements of the linked third parties.

18.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, costs insufficiently substantiated will be ineligible (see Article 6) and will be rejected (see Article 42), and the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 19 — SUBMISSION OF DELIVERABLES

19.1 Obligation to submit deliverables

The coordinator must submit the '**deliverables**' identified in Annex 1, in accordance with the timing and conditions set out in it.

19.2 Consequences of non-compliance

If the coordinator breaches any of its obligations under this Article, the Agency may apply any of the measures described in Chapter 6.

ARTICLE 20 — REPORTING — PAYMENT REQUESTS

20.1 Obligation to submit reports

The coordinator must submit to the Agency (see Article 52) the technical and financial reports set out in this Article. These reports include requests for payment and must be drawn up using the forms and templates provided in the electronic exchange system (see Article 52).

20.2 Reporting periods

The action is divided into the following '**reporting periods**':

- RP1: from month 1 to month 18
- RP2: from month 19 to month 36
- RP3: from month 37 to month 48

20.3 Periodic reports — Requests for interim payments

The coordinator must submit a periodic report within 60 days following the end of each reporting period.

The **periodic report** must include the following:

(a) a '**periodic technical report**' containing:

(i) an **explanation of the work carried out** by the beneficiaries;

(ii) an **overview of the progress** towards the objectives of the action, including milestones and deliverables identified in Annex 1.

This report must include explanations justifying the differences between work expected to be carried out in accordance with Annex 1 and that actually carried out.

The report must detail the exploitation and dissemination of the results and — if required in Annex 1 — an updated '**plan for the exploitation and dissemination of the results**'.

The report must indicate the communication activities;

(iii) a **summary** for publication by the Agency;

(iv) the answers to the '**questionnaire**', covering issues related to the action implementation and the economic and societal impact, notably in the context of the Horizon 2020 key performance indicators and the Horizon 2020 monitoring requirements;

(b) a '**periodic financial report**' containing:

(i) an '**individual financial statement**' (see Annex 4) from each beneficiary and from each linked third party, for the reporting period concerned.

The individual financial statement must detail the eligible costs (actual costs, unit costs and flat-rate costs; see Article 6) for each budget category (see Annex 2).

The beneficiaries and linked third parties must declare all eligible costs, even if — for actual costs, unit costs and flat-rate costs — they exceed the amounts indicated in the estimated budget (see Annex 2). Amounts which are not declared in the individual financial statement will not be taken into account by the Agency.

If an individual financial statement is not submitted for a reporting period, it may be included in the periodic financial report for the next reporting period.

The individual financial statements of the last reporting period must also detail the **receipts of the action** (see Article 5.3.3).

Each beneficiary and each linked third party must **certify** that:

- the information provided is full, reliable and true;
- the costs declared are eligible (see Article 6);
- the costs can be substantiated by adequate records and supporting documentation (see Article 18) that will be produced upon request (see Article 17) or in the context of checks, reviews, audits and investigations (see Article 22), and
- for the last reporting period: that all the receipts have been declared (see Article 5.3.3);

(ii) an **explanation of the use of resources** and the information on subcontracting (see Article 13) and in-kind contributions provided by third parties (see Articles 11 and 12) from each beneficiary and from each linked third party, for the reporting period concerned;

(iii) not applicable;

(iv) a '**periodic summary financial statement**', created automatically by the electronic exchange system, consolidating the individual financial statements for the reporting period concerned and including — except for the last reporting period — the **request for interim payment**.

20.4 Final report — Request for payment of the balance

In addition to the periodic report for the last reporting period, the coordinator must submit the final report within 60 days following the end of the last reporting period.

The **final report** must include the following:

(a) a '**final technical report**' with a **summary** for publication containing:

(i) an overview of the results and their exploitation and dissemination;

(ii) the conclusions on the action, and

(iii) the socio-economic impact of the action;

(b) a '**final financial report**' containing:

(i) a '**final summary financial statement**', created automatically by the electronic exchange system, consolidating the individual financial statements for all reporting periods and including the **request for payment of the balance** and

(ii) a '**certificate on the financial statements**' (drawn up in accordance with Annex 5) for each beneficiary and for each linked third party, if it requests a total contribution of EUR 325 000 or more, as reimbursement of actual costs and unit costs calculated on the basis of its usual cost accounting practices (see Article 5.2 and Article 6.2).

20.5 Information on cumulative expenditure incurred

Not applicable

20.6 Currency for financial statements and conversion into euro

Financial statements must be drafted in euro.

Beneficiaries and linked third parties with accounting established in a currency other than the euro must convert the costs recorded in their accounts into euro, at the average of the daily exchange rates published in the C series of the *Official Journal of the European Union*, calculated over the corresponding reporting period.

If no daily euro exchange rate is published in the *Official Journal of the European Union* for the currency in question, they must be converted at the average of the monthly accounting rates published on the Commission's website, calculated over the corresponding reporting period.

Beneficiaries and linked third parties with accounting established in euro must convert costs incurred in another currency into euro according to their usual accounting practices.

20.7 Language of reports

All reports (technical and financial reports, including financial statements) must be submitted in the language of the Agreement.

20.8 Consequences of non-compliance

If the reports submitted do not comply with this Article, the Agency may suspend the payment deadline (see Article 47) and apply any of the other measures described in Chapter 6.

If the coordinator breaches its obligation to submit the reports and if it fails to comply with this obligation within 30 days following a written reminder, the Agency may terminate the Agreement (see Article 50) or apply any of the other measures described in Chapter 6.

ARTICLE 21 — PAYMENTS AND PAYMENT ARRANGEMENTS

21.1 Payments to be made

The following payments will be made to the coordinator:

- one **pre-financing payment**;
- one or more **interim payments**, on the basis of the request(s) for interim payment (see Article 20), and
- one **payment of the balance**, on the basis of the request for payment of the balance (see Article 20).

21.2 Pre-financing payment — Amount — Amount retained for the Guarantee Fund

The aim of the pre-financing is to provide the beneficiaries with a float.

It remains the property of the EU until the payment of the balance.

The amount of the pre-financing payment will be EUR **10 665 817.89** (ten million six hundred and sixty five thousand eight hundred and seventeen EURO and eighty nine eurocents).

The Agency will — except if Article 48 applies — make the pre-financing payment to the coordinator within 30 days, either from the entry into force of the Agreement (see Article 58) or from 10 days before the starting date of the action (see Article 3), whichever is the latest.

An amount of EUR **999 920.43** (nine hundred and ninety nine thousand nine hundred and twenty EURO and forty three eurocents), corresponding to 5% of the maximum grant amount (see Article 5.1), is retained by the Agency from the pre-financing payment and transferred into the '**Guarantee Fund**'.

21.3 Interim payments — Amount — Calculation

Interim payments reimburse the eligible costs incurred for the implementation of the action during the corresponding reporting periods.

The Agency will pay to the coordinator the amount due as interim payment within 90 days from receiving the periodic report (see Article 20.3), except if Articles 47 or 48 apply.

Payment is subject to the approval of the periodic report. Its approval does not imply recognition of the compliance, authenticity, completeness or correctness of its content.

The **amount due as interim payment** is calculated by the Agency in the following steps:

Step 1 — Application of the reimbursement rates

Step 2 — Limit to 90% of the maximum grant amount

21.3.1 Step 1 — Application of the reimbursement rates

The reimbursement rate(s) (see Article 5.2) are applied to the eligible costs (actual costs, unit costs and flat-rate costs; see Article 6) declared by the beneficiaries and the linked third parties (see Article 20) and approved by the Agency (see above) for the concerned reporting period.

21.3.2 Step 2 — Limit to 90% of the maximum grant amount

The total amount of pre-financing and interim payments must not exceed 90% of the maximum grant amount set out in Article 5.1. The maximum amount for the interim payment will be calculated as follows:

{90% of the maximum grant amount (see Article 5.1)

minus

{pre-financing and previous interim payments}}.

21.4 Payment of the balance — Amount — Calculation — Release of the amount retained for the Guarantee Fund

The payment of the balance reimburses the remaining part of the eligible costs incurred by the beneficiaries for the implementation of the action.

If the total amount of earlier payments is greater than the final grant amount (see Article 5.3), the payment of the balance takes the form of a recovery (see Article 44).

If the total amount of earlier payments is lower than the final grant amount, the Agency will pay the balance within 90 days from receiving the final report (see Article 20.4), except if Articles 47 or 48 apply.

Payment is subject to the approval of the final report. Its approval does not imply recognition of the compliance, authenticity, completeness or correctness of its content.

The **amount due as the balance** is calculated by the Agency by deducting the total amount of pre-financing and interim payments (if any) already made, from the final grant amount determined in accordance with Article 5.3:

{final grant amount (see Article 5.3)

minus

{pre-financing and interim payments (if any) made}}.

At the payment of the balance, the amount retained for the Guarantee Fund (see above) will be released and:

- if the balance is positive: the amount released will be paid in full to the coordinator together with the amount due as the balance;
- if the balance is negative (payment of the balance taking the form of recovery): it will be deducted from the amount released (see Article 44.1.2). If the resulting amount:
  - is positive, it will be paid to the coordinator
  - is negative, it will be recovered.

The amount to be paid may however be offset — without the beneficiaries' consent — against any other amount owed by a beneficiary to the Agency, the Commission or another executive agency (under the EU or Euratom budget), up to the maximum EU contribution indicated, for that beneficiary, in the estimated budget (see Annex 2).

21.5 Notification of amounts due

When making payments, the Agency will formally notify to the coordinator the amount due, specifying whether it concerns an interim payment or the payment of the balance.

For the payment of the balance, the notification will also specify the final grant amount.

In the case of reduction of the grant or recovery of undue amounts, the notification will be preceded by the contradictory procedure set out in Articles 43 and 44.

21.6 Currency for payments

The Agency will make all payments in euro.

21.7 Payments to the coordinator — Distribution to the beneficiaries

Payments will be made to the coordinator.

Payments to the coordinator will discharge the Agency from its payment obligation.

The coordinator must distribute the payments between the beneficiaries without unjustified delay.

Pre-financing may however be distributed only:

(a) if the minimum number of beneficiaries set out in the call for proposals has acceded to the Agreement (see Article 56) and

(b) to beneficiaries that have acceded to the Agreement (see Article 56).

21.8 Bank account for payments

All payments will be made to the following bank account:

Name of bank: DNB BANK ASA
Full name of the account holder: NORGES TEKNISK NATURVITENSKAPELIGEUNIVERSITET NTNU
IBAN code: NO8174500447293

21.9 Costs of payment transfers

The cost of the payment transfers is borne as follows:

- the Agency bears the cost of transfers charged by its bank;
- the beneficiary bears the cost of transfers charged by its bank;
- the party causing a repetition of a transfer bears all costs of the repeated transfer.

21.10 Date of payment

Payments by the Agency are considered to have been carried out on the date when they are debited to its account.

21.11 Consequences of non-compliance

21.11.1 If the Agency does not pay within the payment deadlines (see above), the beneficiaries are entitled to **late-payment interest** at the rate applied by the European Central Bank (ECB) for its main refinancing operations in euros ('reference rate'), plus three and a half points. The reference rate is the rate in force on the first day of the month in which the payment deadline expires, as published in the C series of the *Official Journal of the European Union*.

If the late-payment interest is lower than or equal to EUR 200, it will be paid to the coordinator only upon request submitted within two months of receiving the late payment.

Late-payment interest is not due if all beneficiaries are EU Member States (including regional and local government authorities or other public bodies acting on behalf of a Member State for the purpose of this Agreement).

Suspension of the payment deadline or payments (see Articles 47 and 48) will not be considered as late payment.

Late-payment interest covers the period running from the day following the due date for payment (see above), up to and including the date of payment.

Late-payment interest is not considered for the purposes of calculating the final grant amount.

21.11.2 If the coordinator breaches any of its obligations under this Article, the grant may be reduced (see Article 43) and the Agreement or the participation of the coordinator may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 22 — CHECKS, REVIEWS, AUDITS AND INVESTIGATIONS — EXTENSION OF FINDINGS

22.1 Checks, reviews and audits by the Agency and the Commission

22.1.1 Right to carry out checks

The Agency or the Commission will — during the implementation of the action or afterwards — check the proper implementation of the action and compliance with the obligations under the Agreement, including assessing deliverables and reports.

For this purpose the Agency or the Commission may be assisted by external persons or bodies.

The Agency or the Commission may also request additional information in accordance with Article 17. The Agency or the Commission may request beneficiaries to provide such information to it directly.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

22.1.2 Right to carry out reviews

The Agency or the Commission may — during the implementation of the action or afterwards — carry out reviews on the proper implementation of the action (including assessment of deliverables and reports), compliance with the obligations under the Agreement and continued scientific or technological relevance of the action.

Reviews may be started up to two years after the payment of the balance. They will be formally notified to the coordinator or beneficiary concerned and will be considered to have started on the date of the formal notification.

If the review is carried out on a third party (see Articles 10 to 16), the beneficiary concerned must inform the third party.

The Agency or the Commission may carry out reviews directly (using its own staff) or indirectly (using external persons or bodies appointed to do so). It will inform the coordinator or beneficiary concerned of the identity of the external persons or bodies. They have the right to object to the appointment on grounds of commercial confidentiality.

The coordinator or beneficiary concerned must provide — within the deadline requested — any information and data in addition to deliverables and reports already submitted (including information

on the use of resources). The Agency or the Commission may request beneficiaries to provide such information to it directly.

The coordinator or beneficiary concerned may be requested to participate in meetings, including with external experts.

For **on-the-spot** reviews, the beneficiaries must allow access to their sites and premises, including to external persons or bodies, and must ensure that information requested is readily available.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

On the basis of the review findings, a '**review report**' will be drawn up.

The Agency or the Commission will formally notify the review report to the coordinator or beneficiary concerned, which has 30 days to formally notify observations ('**contradictory review procedure**').

Reviews (including review reports) are in the language of the Agreement.

22.1.3 Right to carry out audits

The Agency or the Commission may — during the implementation of the action or afterwards — carry out audits on the proper implementation of the action and compliance with the obligations under the Agreement.

Audits may be started up to two years after the payment of the balance. They will be formally notified to the coordinator or beneficiary concerned and will be considered to have started on the date of the formal notification.

If the audit is carried out on a third party (see Articles 10 to 16), the beneficiary concerned must inform the third party.

The Agency or the Commission may carry out audits directly (using its own staff) or indirectly (using external persons or bodies appointed to do so). It will inform the coordinator or beneficiary concerned of the identity of the external persons or bodies. They have the right to object to the appointment on grounds of commercial confidentiality.

The coordinator or beneficiary concerned must provide — within the deadline requested — any information (including complete accounts, individual salary statements or other personal data) to verify compliance with the Agreement. The Agency or the Commission may request beneficiaries to provide such information to it directly.

For **on-the-spot** audits, the beneficiaries must allow access to their sites and premises, including to external persons or bodies, and must ensure that information requested is readily available.

Information provided must be accurate, precise and complete and in the format requested, including electronic format.

On the basis of the audit findings, a '**draft audit report**' will be drawn up.

The Agency or the Commission will formally notify the draft audit report to the coordinator or beneficiary concerned, which has 30 days to formally notify observations ('**contradictory audit procedure**'). This period may be extended by the Agency or the Commission in justified cases.

The '**final audit report**' will take into account observations by the coordinator or beneficiary concerned. The report will be formally notified to it.

Audits (including audit reports) are in the language of the Agreement.

The Agency or the Commission may also access the beneficiaries' statutory records for the periodical assessment of unit costs or flat-rate amounts.

22.2 Investigations by the European Anti-Fraud Office (OLAF)

Under Regulations No 883/2013[16] and No 2185/96[17] (and in accordance with their provisions and procedures), the European Anti-Fraud Office (OLAF) may — at any moment during implementation of the action or afterwards — carry out investigations, including on-the-spot checks and inspections, to establish whether there has been fraud, corruption or any other illegal activity affecting the financial interests of the EU.

22.3 Checks and audits by the European Court of Auditors (ECA)

Under Article 287 of the Treaty on the Functioning of the European Union (TFEU) and Article 161 of the Financial Regulation No 966/2012[18], the European Court of Auditors (ECA) may — at any moment during implementation of the action or afterwards — carry out audits.

The ECA has the right of access for the purpose of checks and audits.

22.4 Checks, reviews, audits and investigations for international organisations

Not applicable

22.5 Consequences of findings in checks, reviews, audits and investigations — Extension of findings

22.5.1 Findings in this grant

Findings in checks, reviews, audits or investigations carried out in the context of this grant may lead to the rejection of ineligible costs (see Article 42), reduction of the grant (see Article 43), recovery of undue amounts (see Article 44) or to any of the other measures described in Chapter 6.

Rejection of costs or reduction of the grant after the payment of the balance will lead to a revised final grant amount (see Article 5.4).

Findings in checks, reviews, audits or investigations may lead to a request for amendment for the modification of Annex 1 (see Article 55).

[16] Regulation (EU, Euratom) No 883/2013 of the European Parliament and of the Council of 11 September 2013 concerning investigations conducted by the European Anti-Fraud Office (OLAF) and repealing Regulation (EC) No 1073/1999 of the European Parliament and of the Council and Council Regulation (Euratom) No 1074/1999 (OJ L 248, 18.09.2013, p. 1).

[17] Council Regulation (Euratom, EC) No 2185/1996 of 11 November 1996 concerning on-the-spot checks and inspections carried out by the Commission in order to protect the European Communities' financial interests against fraud and other irregularities (OJ L 292, 15.11.1996, p. 2).

[18] Regulation (EU, Euratom) No 966/2012 of the European Parliament and of the Council of 25 October 2012 on the financial rules applicable to the general budget of the Union and repealing Council Regulation (EC, Euratom) No 1605/2002 (OJ L 298, 26.10.2012, p. 1).

Checks, reviews, audits or investigations that find systemic or recurrent errors, irregularities, fraud or breach of obligations may also lead to consequences in other EU or Euratom grants awarded under similar conditions ('**extension of findings from this grant to other grants**').

Moreover, findings arising from an OLAF investigation may lead to criminal prosecution under national law.

22.5.2 Findings in other grants

The Agency or the Commission may extend findings from other grants to this grant ('**extension of findings from other grants to this grant**'), if:

(a) the beneficiary concerned is found, in other EU or Euratom grants awarded under similar conditions, to have committed systemic or recurrent errors, irregularities, fraud or breach of obligations that have a material impact on this grant and

(b) those findings are formally notified to the beneficiary concerned — together with the list of grants affected by the findings — no later than two years after the payment of the balance of this grant.

The extension of findings may lead to the rejection of costs (see Article 42), reduction of the grant (see Article 43), recovery of undue amounts (see Article 44), suspension of payments (see Article 48), suspension of the action implementation (see Article 49) or termination (see Article 50).

22.5.3 Procedure

The Agency or the Commission will formally notify the beneficiary concerned the systemic or recurrent errors and its intention to extend these audit findings, together with the list of grants affected.

22.5.3.1 If the findings concern **eligibility of costs**: the formal notification will include:

(a) an invitation to submit observations on the list of grants affected by the findings;

(b) the request to submit **revised financial statements** for all grants affected;

(c) the **correction rate for extrapolation** established by the Agency or the Commission on the basis of the systemic or recurrent errors, to calculate the amounts to be rejected if the beneficiary concerned:

(i) considers that the submission of revised financial statements is not possible or practicable or

(ii) does not submit revised financial statements.

The beneficiary concerned has 90 days from receiving notification to submit observations, revised financial statements or to propose a duly substantiated **alternative correction method**. This period may be extended by the Agency or the Commission in justified cases.

The Agency or the Commission may then start a rejection procedure in accordance with Article 42, on the basis of:

- the revised financial statements, if approved;

- the proposed alternative correction method, if accepted

or

- the initially notified correction rate for extrapolation, if it does not receive any observations or revised financial statements, does not accept the observations or the proposed alternative correction method or does not approve the revised financial statements.

22.5.3.2 If the findings concern **substantial errors**, **irregularities or fraud** or **serious breach of obligations**: the formal notification will include:

(a) an invitation to submit observations on the list of grants affected by the findings and

(b) the flat-rate the Agency or the Commission intends to apply according to the principle of proportionality.

The beneficiary concerned has 90 days from receiving notification to submit observations or to propose a duly substantiated alternative flat-rate.

The Agency or the Commission may then start a reduction procedure in accordance with Article 43, on the basis of:

- the proposed alternative flat-rate, if accepted

or

- the initially notified flat-rate, if it does not receive any observations or does not accept the observations or the proposed alternative flat-rate.

22.6 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, any insufficiently substantiated costs will be ineligible (see Article 6) and will be rejected (see Article 42).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 23 — EVALUATION OF THE IMPACT OF THE ACTION

23.1 Right to evaluate the impact of the action

The Agency or the Commission may carry out interim and final evaluations of the impact of the action measured against the objective of the EU programme.

Evaluations may be started during implementation of the action and up to five years after the payment of the balance. The evaluation is considered to start on the date of the formal notification to the coordinator or beneficiaries.

The Agency or the Commission may make these evaluations directly (using its own staff) or indirectly (using external bodies or persons it has authorised to do so).

The coordinator or beneficiaries must provide any information relevant to evaluate the impact of the action, including information in electronic format.

23.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the Agency may apply the measures described in Chapter 6.

SECTION 3 RIGHTS AND OBLIGATIONS RELATED TO BACKGROUND AND RESULTS

SUBSECTION 1 GENERAL

ARTICLE 23a — MANAGEMENT OF INTELLECTUAL PROPERTY

23a.1 Obligation to take measures to implement the Commission Recommendation on the management of intellectual property in knowledge transfer activities

Beneficiaries that are universities or other public research organisations must take measures to implement the principles set out in Points 1 and 2 of the Code of Practice annexed to the Commission Recommendation on the management of intellectual property in knowledge transfer activities[19].

This does not change the obligations set out in Subsections 2 and 3 of this Section.

The beneficiaries must ensure that researchers and third parties involved in the action are aware of them.

23a.2 Consequences of non-compliance

If a beneficiary breaches its obligations under this Article, the Agency may apply any of the measures described in Chapter 6.

SUBSECTION 2 RIGHTS AND OBLIGATIONS RELATED TO BACKGROUND

ARTICLE 24 — AGREEMENT ON BACKGROUND

24.1 Agreement on background

The beneficiaries must identify and agree (in writing) on the background for the action ('**agreement on background**').

'**Background**' means any data, know-how or information — whatever its form or nature (tangible or intangible), including any rights such as intellectual property rights — that:

(a) is held by the beneficiaries before they acceded to the Agreement, and

(b) is needed to implement the action or exploit the results.

24.2 Consequences of non-compliance

[19] Commission Recommendation C(2008) 1329 of 10.4.2008 on the management of intellectual property in knowledge transfer activities and the Code of Practice for universities and other public research institutions attached to this recommendation.

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 25 — ACCESS RIGHTS TO BACKGROUND

25.1 Exercise of access rights — Waiving of access rights — No sub-licensing

To exercise access rights, this must first be requested in writing ('**request for access**').

'**Access rights**' means rights to use results or background under the terms and conditions laid down in this Agreement.

Waivers of access rights are not valid unless in writing.

Unless agreed otherwise, access rights do not include the right to sub-license.

25.2 Access rights for other beneficiaries, for implementing their own tasks under the action

The beneficiaries must give each other access — on a royalty-free basis — to background needed to implement their own tasks under the action, unless the beneficiary that holds the background has — before acceding to the Agreement —:

(a) informed the other beneficiaries that access to its background is subject to legal restrictions or limits, including those imposed by the rights of third parties (including personnel), or

(b) agreed with the other beneficiaries that access would not be on a royalty-free basis.

25.3 Access rights for other beneficiaries, for exploiting their own results

The beneficiaries must give each other access — under fair and reasonable conditions — to background needed for exploiting their own results, unless the beneficiary that holds the background has — before acceding to the Agreement — informed the other beneficiaries that access to its background is subject to legal restrictions or limits, including those imposed by the rights of third parties (including personnel).

'**Fair and reasonable conditions**' means appropriate conditions, including possible financial terms or royalty-free conditions, taking into account the specific circumstances of the request for access, for example the actual or potential value of the results or background to which access is requested and/or the scope, duration or other characteristics of the exploitation envisaged.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

25.4 Access rights for affiliated entities

Unless otherwise agreed in the consortium agreement, access to background must also be given — under fair and reasonable conditions (see above; Article 25.3) and unless it is subject to legal restrictions or limits, including those imposed by the rights of third parties (including personnel) —

to affiliated entities[20] established in an EU Member State or '**associated country**'[21], if this is needed to exploit the results generated by the beneficiaries to which they are affiliated.

Unless agreed otherwise (see above; Article 25.1), the affiliated entity concerned must make the request directly to the beneficiary that holds the background.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

25.5 Access rights for third parties

Not applicable

25.6 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

SUBSECTION 3 RIGHTS AND OBLIGATIONS RELATED TO RESULTS

ARTICLE 26 — OWNERSHIP OF RESULTS

26.1 Ownership by the beneficiary that generates the results

Results are owned by the beneficiary that generates them.

'**Results**' means any (tangible or intangible) output of the action such as data, knowledge or information — whatever its form or nature, whether it can be protected or not — that is generated in the action, as well as any rights attached to it, including intellectual property rights.

26.2 Joint ownership by several beneficiaries

Two or more beneficiaries own results jointly if:

(a) they have jointly generated them and

(b) it is not possible to:

(i) establish the respective contribution of each beneficiary, or

(ii) separate them for the purpose of applying for, obtaining or maintaining their protection (see Article 27).

[20] For the definition, see 'affiliated entity' footnote (Article 14.1).

[21] For the definition, see Article 2.1(3) of the Rules for Participation Regulation No 1290/2013: '**associated country**' means a third country which is party to an international agreement with the Union, as identified in Article 7 of Horizon 2020 Framework Programme Regulation No 1291/2013. Article 7 sets out the conditions for association of non-EU countries to Horizon 2020.

The joint owners must agree (in writing) on the allocation and terms of exercise of their joint ownership ('**joint ownership agreement**'), to ensure compliance with their obligations under this Agreement.

Unless otherwise agreed in the joint ownership agreement, each joint owner may grant non-exclusive licences to third parties to exploit jointly-owned results (without any right to sub-license), if the other joint owners are given:

(a) at least 45 days advance notice and

(b) fair and reasonable compensation.

Once the results have been generated, joint owners may agree (in writing) to apply another regime than joint ownership (such as, for instance, transfer to a single owner (see Article 30) with access rights for the others).

26.3 Rights of third parties (including personnel)

If third parties (including personnel) may claim rights to the results, the beneficiary concerned must ensure that it complies with its obligations under the Agreement.

If a third party generates results, the beneficiary concerned must obtain all necessary rights (transfer, licences or other) from the third party, in order to be able to respect its obligations as if those results were generated by the beneficiary itself.

If obtaining the rights is impossible, the beneficiary must refrain from using the third party to generate the results.

26.4 Agency ownership, to protect results

26.4.1 The Agency may — with the consent of the beneficiary concerned — assume ownership of results to protect them, if a beneficiary intends — up to four years after the period set out in Article 3 — to disseminate its results without protecting them, except in any of the following cases:

(a) the lack of protection is because protecting the results is not possible, reasonable or justified (given the circumstances);

(b) the lack of protection is because there is a lack of potential for commercial or industrial exploitation, or

(c) the beneficiary intends to transfer the results to another beneficiary or third party established in an EU Member State or associated country, which will protect them.

Before the results are disseminated and unless any of the cases above under Points (a), (b) or (c) applies, the beneficiary must formally notify the Agency and at the same time inform it of any reasons for refusing consent. The beneficiary may refuse consent only if it can show that its legitimate interests would suffer significant harm.

If the Agency decides to assume ownership, it will formally notify the beneficiary concerned within 45 days of receiving notification.

No dissemination relating to these results may take place before the end of this period or, if the Agency takes a positive decision, until it has taken the necessary steps to protect the results.

26.4.2 The Agency may — with the consent of the beneficiary concerned — assume ownership of results to protect them, if a beneficiary intends — up to four years after the period set out in Article 3 — to stop protecting them or not to seek an extension of protection, except in any of the following cases:

(a) the protection is stopped because of a lack of potential for commercial or industrial exploitation;

(b) an extension would not be justified given the circumstances.

A beneficiary that intends to stop protecting results or not seek an extension must — unless any of the cases above under Points (a) or (b) applies — formally notify the Agency at least 60 days before the protection lapses or its extension is no longer possible and at the same time inform it of any reasons for refusing consent. The beneficiary may refuse consent only if it can show that its legitimate interests would suffer significant harm.

If the Agency decides to assume ownership, it will formally notify the beneficiary concerned within 45 days of receiving notification.

26.5 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to the any of the other measures described in Chapter 6.

ARTICLE 27 — PROTECTION OF RESULTS — VISIBILITY OF EU FUNDING

27.1 Obligation to protect the results

Each beneficiary must examine the possibility of protecting its results and must adequately protect them — for an appropriate period and with appropriate territorial coverage — if:

(a) the results can reasonably be expected to be commercially or industrially exploited and

(b) protecting them is possible, reasonable and justified (given the circumstances).

When deciding on protection, the beneficiary must consider its own legitimate interests and the legitimate interests (especially commercial) of the other beneficiaries.

27.2 Agency ownership, to protect the results

If a beneficiary intends not to protect its results, to stop protecting them or not seek an extension of protection, the Agency may — under certain conditions (see Article 26.4) — assume ownership to ensure their (continued) protection.

27.3 Information on EU funding

Applications for protection of results (including patent applications) filed by or on behalf of a beneficiary must — unless the Agency requests or agrees otherwise or unless it is impossible — include the following:

"The project leading to this application has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036723".

27.4 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such a breach may also lead to any of the other measures described in Chapter 6.

ARTICLE 28 — EXPLOITATION OF RESULTS

28.1 Obligation to exploit the results

Each beneficiary must — up to four years after the period set out in Article 3 — take measures aiming to ensure '**exploitation**' of its results (either directly or indirectly, in particular through transfer or licensing; see Article 30) by:

(a) using them in further research activities (outside the action);

(b) developing, creating or marketing a product or process;

(c) creating and providing a service, or

(d) using them in standardisation activities.

This does not change the security obligations in Article 37, which still apply.

28.2 Results that could contribute to European or international standards — Information on EU funding

If results could reasonably be expected to contribute to European or international standards, the beneficiary concerned must — up to four years after the period set out in Article 3 — inform the Agency.

If results are incorporated in a standard, the beneficiary concerned must — unless the Agency requests or agrees otherwise or unless it is impossible — ask the standardisation body to include the following statement in (information related to) the standard:

> "Results incorporated in this standard received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036723".

28.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced in accordance with Article 43.

Such a breach may also lead to any of the other measures described in Chapter 6.

ARTICLE 29 — DISSEMINATION OF RESULTS — OPEN ACCESS — VISIBILITY OF EU FUNDING

29.1 Obligation to disseminate results

Unless it goes against their legitimate interests, each beneficiary must — as soon as possible —

'**disseminate**' its results by disclosing them to the public by appropriate means (other than those resulting from protecting or exploiting the results), including in scientific publications (in any medium).

This does not change the obligation to protect results in Article 27, the confidentiality obligations in Article 36, the security obligations in Article 37 or the obligations to protect personal data in Article 39, all of which still apply.

A beneficiary that intends to disseminate its results must give advance notice to the other beneficiaries of — unless agreed otherwise — at least 45 days, together with sufficient information on the results it will disseminate.

Any other beneficiary may object within — unless agreed otherwise — 30 days of receiving notification, if it can show that its legitimate interests in relation to the results or background would be significantly harmed. In such cases, the dissemination may not take place unless appropriate steps are taken to safeguard these legitimate interests.

If a beneficiary intends not to protect its results, it may — under certain conditions (see Article 26.4.1) — need to formally notify the Agency before dissemination takes place.

29.2 Open access to scientific publications

Each beneficiary must ensure open access (free of charge online access for any user) to all peer-reviewed scientific publications relating to its results.

In particular, it must:

(a) as soon as possible and at the latest on publication, deposit a machine-readable electronic copy of the published version or final peer-reviewed manuscript accepted for publication in a repository for scientific publications;

Moreover, the beneficiary must aim to deposit at the same time the research data needed to validate the results presented in the deposited scientific publications.

(b) ensure open access to the deposited publication — via the repository — at the latest:

(i) on publication, if an electronic version is available for free via the publisher, or

(ii) within six months of publication (twelve months for publications in the social sciences and humanities) in any other case.

(c) ensure open access — via the repository — to the bibliographic metadata that identify the deposited publication.

The bibliographic metadata must be in a standard format and must include all of the following:

- the terms "European Union (EU)" and "Horizon 2020";
- the name of the action, acronym and grant number;
- the publication date, and length of embargo period if applicable, and
- a persistent identifier.

29.3 Open access to research data

Regarding the digital research data generated in the action ('**data**'), the beneficiaries must:

(a) deposit in a research data repository and take measures to make it possible for third parties to access, mine, exploit, reproduce and disseminate — free of charge for any user — the following:

(i) the data, including associated metadata, needed to validate the results presented in scientific publications, as soon as possible;

(ii) not applicable;

(iii) other data, including associated metadata, as specified and within the deadlines laid down in the 'data management plan' (see Annex 1);

(b) provide information — via the repository — about tools and instruments at the disposal of the beneficiaries and necessary for validating the results (and — where possible — provide the tools and instruments themselves).

This does not change the obligation to protect results in Article 27, the confidentiality obligations in Article 36, the security obligations in Article 37 or the obligations to protect personal data in Article 39, all of which still apply.

As an exception, the beneficiaries do not have to ensure open access to specific parts of their research data under Point (a)(i) and (iii), if the achievement of the action's main objective (as described in Annex 1) would be jeopardised by making those specific parts of the research data openly accessible. In this case, the data management plan must contain the reasons for not giving access.

29.4 Information on EU funding — Obligation and right to use the EU emblem

Unless the Agency requests or agrees otherwise or unless it is impossible, any dissemination of results (in any form, including electronic) must:

(a) display the EU emblem and

(b) include the following text:

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036723".

When displayed together with another logo, the EU emblem must have appropriate prominence.

For the purposes of their obligations under this Article, the beneficiaries may use the EU emblem without first obtaining approval from the Agency.

This does not however give them the right to exclusive use.

Moreover, they may not appropriate the EU emblem or any similar trademark or logo, either by registration or by any other means.

29.5 Disclaimer excluding Agency responsibility

Any dissemination of results must indicate that it reflects only the author's view and that the Agency is not responsible for any use that may be made of the information it contains.

29.6 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such a breach may also lead to any of the other measures described in Chapter 6.

ARTICLE 30 — TRANSFER AND LICENSING OF RESULTS

30.1 Transfer of ownership

Each beneficiary may transfer ownership of its results.

It must however ensure that its obligations under Articles 26.2, 26.4, 27, 28, 29, 30 and 31 also apply to the new owner and that this owner has the obligation to pass them on in any subsequent transfer.

This does not change the security obligations in Article 37, which still apply.

Unless agreed otherwise (in writing) for specifically-identified third parties or unless impossible under applicable EU and national laws on mergers and acquisitions, a beneficiary that intends to transfer ownership of results must give at least 45 days advance notice (or less if agreed in writing) to the other beneficiaries that still have (or still may request) access rights to the results. This notification must include sufficient information on the new owner to enable any beneficiary concerned to assess the effects on its access rights.

Unless agreed otherwise (in writing) for specifically-identified third parties, any other beneficiary may object within 30 days of receiving notification (or less if agreed in writing), if it can show that the transfer would adversely affect its access rights. In this case, the transfer may not take place until agreement has been reached between the beneficiaries concerned.

30.2 Granting licenses

Each beneficiary may grant licences to its results (or otherwise give the right to exploit them), if:

(a) this does not impede the access rights under Article 31 and

(b) not applicable.

In addition to Points (a) and (b), exclusive licences for results may be granted only if all the other beneficiaries concerned have waived their access rights (see Article 31.1).

This does not change the dissemination obligations in Article 29 or security obligations in Article 37, which still apply.

30.3 Agency right to object to transfers or licensing

Not applicable

30.4 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such a breach may also lead to any of the other measures described in Chapter 6.

ARTICLE 31 — ACCESS RIGHTS TO RESULTS

31.1 Exercise of access rights — Waiving of access rights — No sub-licensing

The conditions set out in Article 25.1 apply.

The obligations set out in this Article do not change the security obligations in Article 37, which still apply.

31.2 Access rights for other beneficiaries, for implementing their own tasks under the action

The beneficiaries must give each other access — on a royalty-free basis — to results needed for implementing their own tasks under the action.

31.3 Access rights for other beneficiaries, for exploiting their own results

The beneficiaries must give each other — under fair and reasonable conditions (see Article 25.3) — access to results needed for exploiting their own results.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

31.4 Access rights of affiliated entities

Unless agreed otherwise in the consortium agreement, access to results must also be given — under fair and reasonable conditions (Article 25.3) — to affiliated entities established in an EU Member State or associated country, if this is needed for those entities to exploit the results generated by the beneficiaries to which they are affiliated.

Unless agreed otherwise (see above; Article 31.1), the affiliated entity concerned must make any such request directly to the beneficiary that owns the results.

Requests for access may be made — unless agreed otherwise — up to one year after the period set out in Article 3.

31.5 Access rights for the EU institutions, bodies, offices or agencies and EU Member States

The beneficiaries must give access to their results — on a royalty-free basis — to EU institutions, bodies, offices or agencies, for developing, implementing or monitoring EU policies or programmes.

Such access rights are limited to non-commercial and non-competitive use.

This does not change the right to use any material, document or information received from the beneficiaries for communication and publicising activities (see Article 38.2).

31.6 Access rights for third parties

Not applicable

31.7 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

SECTION 4 OTHER RIGHTS AND OBLIGATIONS

ARTICLE 32 — RECRUITMENT AND WORKING CONDITIONS FOR RESEARCHERS

32.1 Obligation to take measures to implement the European Charter for Researchers and Code of Conduct for the Recruitment of Researchers

The beneficiaries must take all measures to implement the principles set out in the Commission Recommendation on the European Charter for Researchers and the Code of Conduct for the Recruitment of Researchers[23], in particular regarding:

- working conditions;
- transparent recruitment processes based on merit, and
- career development.

The beneficiaries must ensure that researchers and third parties involved in the action are aware of them.

32.2 Consequences of non-compliance

If a beneficiary breaches its obligations under this Article, the Agency may apply any of the measures described in Chapter 6.

ARTICLE 33 — GENDER EQUALITY

33.1 Obligation to aim for gender equality

The beneficiaries must take all measures to promote equal opportunities between men and women in the implementation of the action. They must aim, to the extent possible, for a gender balance at all levels of personnel assigned to the action, including at supervisory and managerial level.

33.2 Consequences of non-compliance

If a beneficiary breaches its obligations under this Article, the Agency may apply any of the measures described in Chapter 6.

[23] Commission Recommendation 2005/251/EC of 11 March 2005 on the European Charter for Researchers and on a Code of Conduct for the Recruitment of Researchers (OJ L 75, 22.3.2005, p. 67).

ARTICLE 34 — ETHICS AND RESEARCH INTEGRITY

34.1 Obligation to comply with ethical and research integrity principles

The beneficiaries must carry out the action in compliance with:

(a) ethical principles (including the highest standards of research integrity)

and

(b) applicable international, EU and national law.

Funding will not be granted for activities carried out outside the EU if they are prohibited in all Member States or for activities which destroy human embryos (for example, for obtaining stem cells).

The beneficiaries must ensure that the activities under the action have an exclusive focus on civil applications.

The beneficiaries must ensure that the activities under the action do not:

(a) aim at human cloning for reproductive purposes;

(b) intend to modify the genetic heritage of human beings which could make such changes heritable (with the exception of research relating to cancer treatment of the gonads, which may be financed), or

(c) intend to create human embryos solely for the purpose of research or for the purpose of stem cell procurement, including by means of somatic cell nuclear transfer.

In addition, the beneficiaries must respect the fundamental principle of research integrity — as set out, for instance, in the European Code of Conduct for Research Integrity[24].

This implies compliance with the following fundamental principles:

- **reliability** in ensuring the quality of research reflected in the design, the methodology, the analysis and the use of resources;

- **honesty** in developing, undertaking, reviewing, reporting and communicating research in a transparent, fair and unbiased way;

- **respect** for colleagues, research participants, society, ecosystems, cultural heritage and the environment;

- **accountability** for the research from idea to publication, for its management and organisation, for training, supervision and mentoring, and for its wider impacts

and means that beneficiaries must ensure that persons carrying out research tasks follow the good research practices and refrain from the research integrity violations described in this Code.

[24] European Code of Conduct for Research Integrity of ALLEA (All European Academies) http://ec.europa.eu/research/participants/data/ref/h2020/other/hi/h2020-ethics_code-of-conduct_en.pdf

This does not change the other obligations under this Agreement or obligations under applicable international, EU or national law, all of which still apply.

34.2 Activities raising ethical issues

Activities raising ethical issues must comply with the '**ethics requirements**' set out as deliverables in Annex 1.

Before the beginning of an activity raising an ethical issue, each beneficiary must have obtained:

(a) any ethics committee opinion required under national law and

(b) any notification or authorisation for activities raising ethical issues required under national and/or European law

needed for implementing the action tasks in question.

The documents must be kept on file and be submitted upon request by the coordinator to the Agency (see Article 52). If they are not in English, they must be submitted together with an English summary, which shows that the action tasks in question are covered and includes the conclusions of the committee or authority concerned (if available).

34.3 Activities involving human embryos or human embryonic stem cells

Activities involving research on human embryos or human embryonic stem cells may be carried out, in addition to Article 34.1, only if:

- they are set out in Annex 1 or
- the coordinator has obtained explicit approval (in writing) from the Agency (see Article 52).

34.4 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43) and the Agreement or participation of the beneficiary may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 35 — CONFLICT OF INTERESTS

35.1 Obligation to avoid a conflict of interests

The beneficiaries must take all measures to prevent any situation where the impartial and objective implementation of the action is compromised for reasons involving economic interest, political or national affinity, family or emotional ties or any other shared interest ('**conflict of interests**').

They must formally notify to the Agency without delay any situation constituting or likely to lead to a conflict of interests and immediately take all the necessary steps to rectify this situation.

The Agency may verify that the measures taken are appropriate and may require additional measures to be taken by a specified deadline.

35.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43) and the Agreement or participation of the beneficiary may be terminated (see Article 50).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 36 — CONFIDENTIALITY

36.1 General obligation to maintain confidentiality

During implementation of the action and for four years after the period set out in Article 3, the parties must keep confidential any data, documents or other material (in any form) that is identified as confidential at the time it is disclosed ('**confidential information**').

If a beneficiary requests, the Agency may agree to keep such information confidential for an additional period beyond the initial four years.

If information has been identified as confidential only orally, it will be considered to be confidential only if this is confirmed in writing within 15 days of the oral disclosure.

Unless otherwise agreed between the parties, they may use confidential information only to implement the Agreement.

The beneficiaries may disclose confidential information to their personnel or third parties involved in the action only if they:

(a) need to know to implement the Agreement and

(b) are bound by an obligation of confidentiality.

This does not change the security obligations in Article 37, which still apply.

The Agency may disclose confidential information to its staff, other EU institutions and bodies. It may disclose confidential information to third parties, if:

(a) this is necessary to implement the Agreement or safeguard the EU's financial interests and

(b) the recipients of the information are bound by an obligation of confidentiality.

Under the conditions set out in Article 4 of the Rules for Participation Regulation No 1290/2013[25], the Commission must moreover make available information on the results to other EU institutions, bodies, offices or agencies as well as Member States or associated countries.

The confidentiality obligations no longer apply if:

(a) the disclosing party agrees to release the other party;

[25] Regulation (EU) No 1290/2013 of the European Parliament and of the Council of 11 December 2013 laying down the rules for participation and dissemination in "Horizon 2020 - the Framework Programme for Research and Innovation (2014-2020)" (OJ L 347, 20.12.2013 p.81).

(b) the information was already known by the recipient or is given to him without obligation of confidentiality by a third party that was not bound by any obligation of confidentiality;

(c) the recipient proves that the information was developed without the use of confidential information;

(d) the information becomes generally and publicly available, without breaching any confidentiality obligation, or

(e) the disclosure of the information is required by EU or national law.

36.2 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 37 — SECURITY-RELATED OBLIGATIONS

37.1 Results with a security recommendation

Not applicable

37.2 Classified information

Not applicable

37.3 Activities involving dual-use goods or dangerous materials and substances

Not applicable

37.4 Consequences of non-compliance

Not applicable

ARTICLE 38 — PROMOTING THE ACTION — VISIBILITY OF EU FUNDING

38.1 Communication activities by beneficiaries

38.1.1 Obligation to promote the action and its results

The beneficiaries must promote the action and its results, by providing targeted information to multiple audiences (including the media and the public) in a strategic and effective manner.

This does not change the dissemination obligations in Article 29, the confidentiality obligations in Article 36 or the security obligations in Article 37, all of which still apply.

Before engaging in a communication activity expected to have a major media impact, the beneficiaries must inform the Agency (see Article 52).

38.1.2 Information on EU funding — Obligation and right to use the EU emblem

Unless the Agency requests or agrees otherwise or unless it is impossible, any communication activity related to the action (including in electronic form, via social media, etc.) and any infrastructure, equipment and major results funded by the grant must:

(a) display the EU emblem and

(b) include the following text:

For communication activities:

"This project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036723".

For infrastructure, equipment and major results:

"This *[infrastructure][equipment][insert type of result]* is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 101036723".

When displayed together with another logo, the EU emblem must have appropriate prominence.

For the purposes of their obligations under this Article, the beneficiaries may use the EU emblem without first obtaining approval from the Agency.

This does not, however, give them the right to exclusive use.

Moreover, they may not appropriate the EU emblem or any similar trademark or logo, either by registration or by any other means.

38.1.3 Disclaimer excluding Agency and Commission responsibility

Any communication activity related to the action must indicate that it reflects only the author's view and that the Agency and the Commission are not responsible for any use that may be made of the information it contains.

38.2 Communication activities by the Agency and the Commission

38.2.1 Right to use beneficiaries' materials, documents or information

The Agency and the Commission may use, for its communication and publicising activities, information relating to the action, documents notably summaries for publication and public deliverables as well as any other material, such as pictures or audio-visual material received from any beneficiary (including in electronic form).

This does not change the confidentiality obligations in Article 36 and the security obligations in Article 37, all of which still apply.

If the Agency's or the Commission's use of these materials, documents or information would risk compromising legitimate interests, the beneficiary concerned may request the Agency or the Commission not to use it (see Article 52).

The right to use a beneficiary's materials, documents and information includes:

(a) **use for its own purposes** (in particular, making them available to persons working for the Agency, the Commission or any other EU institution, body, office or agency or body or

institutions in EU Member States; and copying or reproducing them in whole or in part, in unlimited numbers);

(b) **distribution to the public** (in particular, publication as hard copies and in electronic or digital format, publication on the internet, as a downloadable or non-downloadable file, broadcasting by any channel, public display or presentation, communicating through press information services, or inclusion in widely accessible databases or indexes);

(c) **editing or redrafting** for communication and publicising activities (including shortening, summarising, inserting other elements (such as meta-data, legends, other graphic, visual, audio or text elements), extracting parts (e.g. audio or video files), dividing into parts, use in a compilation);

(d) translation;

(e) giving **access in response to individual requests** under Regulation No 1049/2001[27], without the right to reproduce or exploit;

(f) **storage** in paper, electronic or other form;

(g) **archiving**, in line with applicable document-management rules, and

(h) the right to authorise **third parties** to act on its behalf or sub-license the modes of use set out in Points (b), (c), (d) and (f) to third parties if needed for the communication and publicising activities of the Agency or the Commission.

If the right of use is subject to rights of a third party (including personnel of the beneficiary), the beneficiary must ensure that it complies with its obligations under this Agreement (in particular, by obtaining the necessary approval from the third parties concerned).

Where applicable (and if provided by the beneficiaries), the Agency or the Commission will insert the following information:

> "© – [year] – [name of the copyright owner]. All rights reserved. Licensed to the European Climate, Infrastructure and Environment Executive Agency (CINEA) and the European Union (EU) under conditions."

38.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under this Article, the grant may be reduced (see Article 43).

Such breaches may also lead to any of the other measures described in Chapter 6.

ARTICLE 39 — PROCESSING OF PERSONAL DATA

39.1 Processing of personal data by the Agency and the Commission

Any personal data under the Agreement will be processed by the Agency or the Commission under

[27] Regulation (EC) No 1049/2001 of the European Parliament and of the Council of 30 May 2001 regarding public access to European Parliament, Council and Commission documents, OJ L 145, 31.5.2001, p. 43.

Regulation No 45/2001[28] and according to the 'notifications of the processing operations' to the Data Protection Officer (DPO) of the Agency or the Commission (publicly accessible in the DPO register).

Such data will be processed by the '**data controller**' of the Agency or the Commission for the purposes of implementing, managing and monitoring the Agreement or protecting the financial interests of the EU or Euratom (including checks, reviews, audits and investigations; see Article 22).

The persons whose personal data are processed have the right to access and correct their own personal data. For this purpose, they must send any queries about the processing of their personal data to the data controller, via the contact point indicated in the privacy statement(s) that are published on the Agency and the Commission websites.

They also have the right to have recourse at any time to the European Data Protection Supervisor (EDPS).

39.2 Processing of personal data by the beneficiaries

The beneficiaries must process personal data under the Agreement in compliance with applicable EU and national law on data protection (including authorisations or notification requirements).

The beneficiaries may grant their personnel access only to data that is strictly necessary for implementing, managing and monitoring the Agreement.

The beneficiaries must inform the personnel whose personal data are collected and processed by the Agency or the Commission. For this purpose, they must provide them with the privacy statement(s) (see above), before transmitting their data to the Agency or the Commission.

39.3 Consequences of non-compliance

If a beneficiary breaches any of its obligations under Article 39.2, the Agency may apply any of the measures described in Chapter 6.

ARTICLE 40 — ASSIGNMENTS OF CLAIMS FOR PAYMENT AGAINST THE AGENCY

The beneficiaries may not assign any of their claims for payment against the Agency to any third party, except if approved by the Agency on the basis of a reasoned, written request by the coordinator (on behalf of the beneficiary concerned).

If the Agency has not accepted the assignment or the terms of it are not observed, the assignment will have no effect on it.

In no circumstances will an assignment release the beneficiaries from their obligations towards the Agency.

[28] Regulation (EC) No 45/2001 of the European Parliament and of the Council of 18 December 2000 on the protection of individuals with regard to the processing of personal data by the Community institutions and bodies and on the free movement of such data (OJ L 8, 12.01.2001, p. 1).

CHAPTER 5 DIVISION OF BENEFICIARIES' ROLES AND RESPONSIBILITIES — RELATIONSHIP WITH COMPLEMENTARY BENEFICIARIES — RELATIONSHIP WITH PARTNERS OF A JOINT ACTION

ARTICLE 41 — DIVISION OF BENEFICIARIES' ROLES AND RESPONSIBILITIES — RELATIONSHIP WITH COMPLEMENTARY BENEFICIARIES — RELATIONSHIP WITH PARTNERS OF A JOINT ACTION

41.1 Roles and responsibility towards the Agency

The beneficiaries have full responsibility for implementing the action and complying with the Agreement.

The beneficiaries are jointly and severally liable for the **technical implementation** of the action as described in Annex 1. If a beneficiary fails to implement its part of the action, the other beneficiaries become responsible for implementing this part (without being entitled to any additional EU funding for doing so), unless the Agency expressly relieves them of this obligation.

The **financial responsibility** of each beneficiary is governed by Article 44.

41.2 Internal division of roles and responsibilities

The internal roles and responsibilities of the beneficiaries are divided as follows:

(a) Each **beneficiary** must:

(i) keep information stored in the Participant Portal Beneficiary Register (via the electronic exchange system) up to date (see Article 17);

(ii) inform the coordinator immediately of any events or circumstances likely to affect significantly or delay the implementation of the action (see Article 17);

(iii) submit to the coordinator in good time:

- individual financial statements for itself and its linked third parties and, if required, certificates on the financial statements (see Article 20);
- the data needed to draw up the technical reports (see Article 20);
- ethics committee opinions and notifications or authorisations for activities raising ethical issues (see Article 34);
- any other documents or information required by the Agency or the Commission under the Agreement, unless the Agreement requires the beneficiary to submit this information directly to the Agency or the Commission.

(b) The **coordinator** must:

(i) monitor that the action is implemented properly (see Article 7);

(ii) act as the intermediary for all communications between the beneficiaries and the Agency

(in particular, providing the Agency with the information described in Article 17), unless the Agreement specifies otherwise;

(iii) request and review any documents or information required by the Agency and verify their completeness and correctness before passing them on to the Agency;

(iv) submit the deliverables and reports to the Agency (see Articles 19 and 20);

(v) ensure that all payments are made to the other beneficiaries without unjustified delay (see Article 21);

(vi) inform the Agency of the amounts paid to each beneficiary, when required under the Agreement (see Articles 44 and 50) or requested by the Agency.

The coordinator may not delegate or subcontract the above-mentioned tasks to any other beneficiary or third party (including linked third parties).

41.3 Internal arrangements between beneficiaries — Consortium agreement

The beneficiaries must have internal arrangements regarding their operation and co-ordination to ensure that the action is implemented properly. These internal arrangements must be set out in a written '**consortium agreement**' between the beneficiaries, which may cover:

- internal organisation of the consortium;
- management of access to the electronic exchange system;
- distribution of EU funding;
- additional rules on rights and obligations related to background and results (including whether access rights remain or not, if a beneficiary is in breach of its obligations) (see Section 3 of Chapter 4);
- settlement of internal disputes;
- liability, indemnification and confidentiality arrangements between the beneficiaries.

The consortium agreement must not contain any provision contrary to the Agreement.

41.4 Relationship with complementary beneficiaries — Collaboration agreement

Not applicable

41.5 Relationship with partners of a joint action — Coordination agreement

Not applicable

CHAPTER 6 REJECTION OF COSTS — REDUCTION OF THE GRANT — RECOVERY — SANCTIONS — DAMAGES — SUSPENSION — TERMINATION — FORCE MAJEURE

SECTION 1 REJECTION OF COSTS — REDUCTION OF THE GRANT — RECOVERY — SANCTIONS

ARTICLE 42 — REJECTION OF INELIGIBLE COSTS

42.1 Conditions

The Agency will — after **termination of the participation of a beneficiary**, at the time of an **interim payment**, **at the payment of the balance** or **afterwards** — reject any costs which are ineligible (see Article 6), in particular following checks, reviews, audits or investigations (see Article 22).

The rejection may also be based on the **extension of findings from other grants to this grant** (see Article 22.5.2).

42.2 Ineligible costs to be rejected — Calculation — Procedure

Ineligible costs will be rejected in full.

If the rejection of costs does not lead to a recovery (see Article 44), the Agency will formally notify the coordinator or beneficiary concerned of the rejection of costs, the amounts and the reasons why (if applicable, together with the notification of amounts due; see Article 21.5). The coordinator or beneficiary concerned may — within 30 days of receiving notification — formally notify the Agency of its disagreement and the reasons why.

If the rejection of costs leads to a recovery, the Agency will follow the contradictory procedure with pre-information letter set out in Article 44.

42.3 Effects

If the Agency rejects costs at the time of an **interim payment** or **the payment of the balance**, it will deduct them from the total eligible costs declared, for the action, in the periodic or final summary financial statement (see Articles 20.3 and 20.4). It will then calculate the interim payment or payment of the balance as set out in Articles 21.3 or 21.4.

If the Agency rejects costs **after termination of the participation of a beneficiary**, it will deduct them from the costs declared by the beneficiary in the termination report and include the rejection in the calculation after termination (see Article 50.2 and 50.3).

If the Agency — **after an interim payment but before the payment of the balance** — rejects costs declared in a periodic summary financial statement, it will deduct them from the total eligible costs declared, for the action, in the next periodic summary financial statement or in the final summary financial statement. It will then calculate the interim payment or payment of the balance as set out in Articles 21.3 or 21.4.

If the Agency rejects costs **after the payment of the balance**, it will deduct the amount rejected from the total eligible costs declared, by the beneficiary, in the final summary financial statement. It will then calculate the revised final grant amount as set out in Article 5.4.

ARTICLE 43 — REDUCTION OF THE GRANT

43.1 Conditions

The Agency may — **after termination of the participation of a beneficiary**, **at the payment of the balance** or **afterwards** — reduce the grant amount (see Article 5.1), if :

(a) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed:

(i) substantial errors, irregularities or fraud or

(ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles) or

(b) a beneficiary (or a natural person who has the power to represent or take decision on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2).

43.2 Amount to be reduced — Calculation — Procedure

The amount of the reduction will be proportionate to the seriousness of the errors, irregularities or fraud or breach of obligations.

Before reduction of the grant, the Agency will formally notify a '**pre-information letter**' to the coordinator or beneficiary concerned:

- informing it of its intention to reduce the grant, the amount it intends to reduce and the reasons why and

- inviting it to submit observations within 30 days of receiving notification.

If the Agency does not receive any observations or decides to pursue reduction despite the observations it has received, it will formally notify **confirmation** of the reduction (if applicable, together with the notification of amounts due; see Article 21).

43.3 Effects

If the Agency reduces the grant **after termination of the participation of a beneficiary**, it will calculate the reduced grant amount for that beneficiary and then determine the amount due to that beneficiary (see Article 50.2 and 50.3).

If the Agency reduces the grant **at the payment of the balance**, it will calculate the reduced grant amount for the action and then determine the amount due as payment of the balance (see Articles 5.3.4 and 21.4).

If the Agency reduces the grant **after the payment of the balance**, it will calculate the revised final grant amount for the beneficiary concerned (see Article 5.4). If the revised final grant amount for the beneficiary concerned is lower than its share of the final grant amount, the Agency will recover the difference (see Article 44).

ARTICLE 44 — RECOVERY OF UNDUE AMOUNTS

44.1 Amount to be recovered — Calculation — Procedure

The Agency will — after **termination of the participation of a beneficiary, at the payment of the balance** or **afterwards** — claim back any amount that was paid, but is not due under the Agreement.

Each beneficiary's financial responsibility in case of recovery is limited to its own debt (including undue amounts paid by the Agency for costs declared by its linked third parties), except for the amount retained for the Guarantee Fund (see Article 21.4).

44.1.1 Recovery after termination of a beneficiary's participation

If recovery takes place after termination of a beneficiary's participation (including the coordinator), the Agency will claim back the undue amount from the beneficiary concerned, by formally notifying it a debit note (see Article 50.2 and 50.3). This note will specify the amount to be recovered, the terms and the date for payment.

If payment is not made by the date specified in the debit note, the Agency or the Commission will **recover** the amount:

(a) by '**offsetting**' it — without the beneficiary's consent — against any amounts owed to the beneficiary concerned by the Agency, the Commission or another executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU's financial interests, the Agency or the Commission may offset before the payment date specified in the debit note;

(b) not applicable;

(c) by **taking legal action** (see Article 57) or by **adopting an enforceable decision** under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial Regulation No 966/2012.

If payment is not made by the date specified in the debit note, the amount to be recovered (see above) will be increased by **late-payment interest** at the rate set out in Article 21.11, from the day following the payment date in the debit note, up to and including the date the Agency or the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC[29] applies.

44.1.2 Recovery at payment of the balance

If the payment of the balance takes the form of a recovery (see Article 21.4), the Agency will formally notify a '**pre-information letter**' to the coordinator:

- informing it of its intention to recover, the amount due as the balance and the reasons why;

[29] Directive 2007/64/EC of the European Parliament and of the Council of 13 November 2007 on payment services in the internal market amending Directives 97/7/EC, 2002/65/EC, 2005/60/EC and 2006/48/EC and repealing Directive 97/5/EC (OJ L 319, 05.12.2007, p. 1).

- specifying that it intends to deduct the amount to be recovered from the amount retained for the Guarantee Fund;

- requesting the coordinator to submit a report on the distribution of payments to the beneficiaries within 30 days of receiving notification, and

- inviting the coordinator to submit observations within 30 days of receiving notification.

If no observations are submitted or the Agency decides to pursue recovery despite the observations it has received, it will **confirm recovery** (together with the notification of amounts due; see Article 21.5) and:

- pay the difference between the amount to be recovered and the amount retained for the Guarantee Fund, **if the difference is positive** or

- formally notify to the coordinator a **debit note** for the difference between the amount to be recovered and the amount retained for the Guarantee Fund, **if the difference is negative**. This note will also specify the terms and the date for payment.

If the coordinator does not repay the Agency by the date in the debit note and has not submitted the report on the distribution of payments: the Agency or the Commission will **recover** the amount set out in the debit note from the coordinator (see below).

If the coordinator does not repay the Agency by the date in the debit note, but has submitted the report on the distribution of payments: the Agency will:

(a) identify the beneficiaries for which the amount calculated as follows is negative:

{{{beneficiary's costs declared in the final summary financial statement and approved by the Agency multiplied by the reimbursement rate set out in Article 5.2 for the beneficiary concerned

plus

its linked third parties' costs declared in the final summary financial statement and approved by the Agency multiplied by the reimbursement rate set out in Article 5.2 for each linked third party concerned}

divided by

the EU contribution for the action calculated according to Article 5.3.1}

multiplied by

the final grant amount (see Article 5.3)},

minus

{pre-financing and interim payments received by the beneficiary}}.

(b) formally notify to each beneficiary identified according to point (a) a **debit note** specifying the terms and date for payment. The amount of the debit note is calculated as follows:

{{amount calculated according to point (a) for the beneficiary concerned

divided by

the sum of the amounts calculated according to point (a) for all the beneficiaries identified according to point (a)}

multiplied by

the amount set out in the debit note formally notified to the coordinator}.

If payment is not made by the date specified in the debit note, the Agency or the Commission will **recover** the amount:

(a) by **offsetting** it — without the beneficiary's consent — against any amounts owed to the beneficiary concerned by the Agency, the Commission or another executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU's financial interests, the Agency or the Commission may offset before the payment date specified in the debit note;

(b) by **drawing on the Guarantee Fund**. The Agency or the Commission will formally notify the beneficiary concerned the debit note on behalf of the Guarantee Fund and recover the amount:

(i) not applicable;

(ii) by **taking legal action** (see Article 57) or by **adopting an enforceable decision** under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial Regulation No 966/2012.

If payment is not made by the date in the debit note, the amount to be recovered (see above) will be increased by **late-payment interest** at the rate set out in Article 21.11, from the day following the payment date in the debit note, up to and including the date the Agency or the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC applies.

44.1.3 Recovery of amounts after payment of the balance

If, for a beneficiary, the revised final grant amount (see Article 5.4) is lower than its share of the final grant amount, it must repay the difference to the Agency.

The beneficiary's share of the final grant amount is calculated as follows:

{{{beneficiary's costs declared in the final summary financial statement and approved by the Agency multiplied by the reimbursement rate set out in Article 5.2 for the beneficiary concerned

plus

its linked third parties' costs declared in the final summary financial statement and approved by the Agency multiplied by the reimbursement rate set out in Article 5.2 for each linked third party concerned}

divided by

the EU contribution for the action calculated according to Article 5.3.1}

multiplied by

the final grant amount (see Article 5.3)}.

If the coordinator has not distributed amounts received (see Article 21.7), the Agency will also recover these amounts.

The Agency will formally notify a **pre-information letter** to the beneficiary concerned:

- informing it of its intention to recover, the due amount and the reasons why and
- inviting it to submit observations within 30 days of receiving notification.

If no observations are submitted or the Agency decides to pursue recovery despite the observations it has received, it will **confirm** the amount to be recovered and formally notify to the beneficiary concerned a **debit note**. This note will also specify the terms and the date for payment.

If payment is not made by the date specified in the debit note, the Agency or the Commission will **recover** the amount:

(a) by **offsetting** it — without the beneficiary's consent — against any amounts owed to the beneficiary concerned by the Agency, the Commission or another executive agency (from the EU or Euratom budget).

In exceptional circumstances, to safeguard the EU's financial interests, the Agency or the Commission may offset before the payment date specified in the debit note;

(b) by **drawing on the Guarantee Fund**. The Agency or the Commission will formally notify the beneficiary concerned the debit note on behalf of the Guarantee Fund and recover the amount:

(i) not applicable;

(ii) by **taking legal action** (see Article 57) or by **adopting an enforceable decision** under Article 299 of the Treaty on the Functioning of the EU (TFEU) and Article 79(2) of the Financial Regulation No 966/2012.

If payment is not made by the date in the debit note, the amount to be recovered (see above) will be increased by **late-payment interest** at the rate set out in Article 21.11, from the day following the date for payment in the debit note, up to and including the date the Agency or the Commission receives full payment of the amount.

Partial payments will be first credited against expenses, charges and late-payment interest and then against the principal.

Bank charges incurred in the recovery process will be borne by the beneficiary, unless Directive 2007/64/EC applies.

ARTICLE 45 — ADMINISTRATIVE SANCTIONS

In addition to contractual measures, the Agency or the Commission may also adopt administrative sanctions under Articles 106 and 131(4) of the Financial Regulation No 966/2012 (i.e. exclusion from future procurement contracts, grants, prizes and expert contracts and/or financial penalties).

SECTION 2 LIABILITY FOR DAMAGES

ARTICLE 46 — LIABILITY FOR DAMAGES

46.1 Liability of the Agency

The Agency cannot be held liable for any damage caused to the beneficiaries or to third parties as a consequence of implementing the Agreement, including for gross negligence.

The Agency cannot be held liable for any damage caused by any of the beneficiaries or third parties involved in the action, as a consequence of implementing the Agreement.

46.2 Liability of the beneficiaries

Except in case of force majeure (see Article 51), the beneficiaries must compensate the Agency for any damage it sustains as a result of the implementation of the action or because the action was not implemented in full compliance with the Agreement.

SECTION 3 SUSPENSION AND TERMINATION

ARTICLE 47 — SUSPENSION OF PAYMENT DEADLINE

47.1 Conditions

The Agency may — at any moment — suspend the payment deadline (see Article 21.2 to 21.4) if a request for payment (see Article 20) cannot be approved because:

(a) it does not comply with the provisions of the Agreement (see Article 20);

(b) the technical or financial reports have not been submitted or are not complete or additional information is needed, or

(c) there is doubt about the eligibility of the costs declared in the financial statements and additional checks, reviews, audits or investigations are necessary.

47.2 Procedure

The Agency will formally notify the coordinator of the suspension and the reasons why.

The suspension will **take effect** the day notification is sent by the Agency (see Article 52).

If the conditions for suspending the payment deadline are no longer met, the suspension will be **lifted** — and the remaining period will resume.

If the suspension exceeds two months, the coordinator may request the Agency if the suspension will continue.

If the payment deadline has been suspended due to the non-compliance of the technical or financial reports (see Article 20) and the revised report or statement is not submitted or was submitted but is also rejected, the Agency may also terminate the Agreement or the participation of the beneficiary (see Article 50.3.1(l)).

ARTICLE 48 — SUSPENSION OF PAYMENTS

48.1 Conditions

The Agency may — at any moment — suspend payments, in whole or in part and interim payments or the payment of the balance for one or more beneficiaries, if:

(a) a beneficiary (or a natural person who has the power to represent or take decision on its behalf) has committed or is suspected of having committed:

(i) substantial errors, irregularities or fraud or

(ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles) or

(b) a beneficiary (or a natural person who has the power to represent or take decision on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2).

If payments are suspended for one or more beneficiaries, the Agency will make partial payment(s) for the part(s) not suspended. If suspension concerns the payment of the balance, — once suspension is lifted — the payment or the recovery of the amount(s) concerned will be considered the payment of the balance that closes the action.

48.2 Procedure

Before suspending payments, the Agency will formally notify the coordinator or beneficiary concerned:

- informing it of its intention to suspend payments and the reasons why and
- inviting it to submit observations within 30 days of receiving notification.

If the Agency does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify **confirmation** of the suspension. Otherwise, it will formally notify that the suspension procedure is not continued.

The suspension will **take effect** the day the confirmation notification is sent by the Agency.

If the conditions for resuming payments are met, the suspension will be **lifted**. The Agency will formally notify the coordinator or beneficiary concerned.

During the suspension, the periodic report(s) for all reporting periods except the last one (see Article 20.3), must not contain any individual financial statements from the beneficiary concerned and its linked third parties. The coordinator must include them in the next periodic report after the suspension is lifted or — if suspension is not lifted before the end of the action — in the last periodic report.

The beneficiaries may suspend implementation of the action (see Article 49.1) or terminate the Agreement or the participation of the beneficiary concerned (see Article 50.1 and 50.2).

ARTICLE 49 — SUSPENSION OF THE ACTION IMPLEMENTATION

49.1 Suspension of the action implementation, by the beneficiaries

49.1.1 Conditions

The beneficiaries may suspend implementation of the action or any part of it, if exceptional circumstances — in particular *force majeure* (see Article 51) — make implementation impossible or excessively difficult.

49.1.2 Procedure

The coordinator must immediately formally notify to the Agency the suspension (see Article 52), stating:

- the reasons why and
- the expected date of resumption.

The suspension will **take effect** the day this notification is received by the Agency.

Once circumstances allow for implementation to resume, the coordinator must immediately formally notify the Agency and request an **amendment** of the Agreement to set the date on which the action will be resumed, extend the duration of the action and make other changes necessary to adapt the action to the new situation (see Article 55) — unless the Agreement or the participation of a beneficiary has been terminated (see Article 50).

The suspension will be **lifted** with effect from the resumption date set out in the amendment. This date may be before the date on which the amendment enters into force.

Costs incurred during suspension of the action implementation are not eligible (see Article 6).

49.2 Suspension of the action implementation, by the Agency

49.2.1 Conditions

The Agency may suspend implementation of the action or any part of it, if:

(a) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed or is suspected of having committed:

  (i) substantial errors, irregularities or fraud or

  (ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles);

(b) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions —

systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2), or

(c) the action is suspected of having lost its scientific or technological relevance.

49.2.2 Procedure

Before suspending implementation of the action, the Agency will formally notify the coordinator or beneficiary concerned:

- informing it of its intention to suspend the implementation and the reasons why and
- inviting it to submit observations within 30 days of receiving notification.

If the Agency does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify **confirmation** of the suspension. Otherwise, it will formally notify that the procedure is not continued.

The suspension will **take effect** five days after confirmation notification is received (or on a later date specified in the notification).

It will be **lifted** if the conditions for resuming implementation of the action are met.

The coordinator or beneficiary concerned will be formally notified of the lifting and the Agreement will be **amended** to set the date on which the action will be resumed, extend the duration of the action and make other changes necessary to adapt the action to the new situation (see Article 55) — unless the Agreement has already been terminated (see Article 50).

The suspension will be lifted with effect from the resumption date set out in the amendment. This date may be before the date on which the amendment enters into force.

Costs incurred during suspension are not eligible (see Article 6).

The beneficiaries may not claim damages due to suspension by the Agency (see Article 46).

Suspension of the action implementation does not affect the Agency's right to terminate the Agreement or participation of a beneficiary (see Article 50), reduce the grant or recover amounts unduly paid (see Articles 43 and 44).

ARTICLE 50 — TERMINATION OF THE AGREEMENT OR OF THE PARTICIPATION OF ONE OR MORE BENEFICIARIES

50.1 Termination of the Agreement, by the beneficiaries

50.1.1 Conditions and procedure

The beneficiaries may terminate the Agreement.

The coordinator must formally notify termination to the Agency (see Article 52), stating:

- the reasons why and

- the date the termination will take effect. This date must be after the notification.

If no reasons are given or if the Agency considers the reasons do not justify termination, the Agreement will be considered to have been '**terminated improperly**'.

The termination will **take effect** on the day specified in the notification.

50.1.2 Effects

The coordinator must — within 60 days from when termination takes effect — submit:

(i) a periodic report (for the open reporting period until termination; see Article 20.3) and

(ii) the final report (see Article 20.4).

If the Agency does not receive the reports within the deadline (see above), only costs which are included in an approved periodic report will be taken into account.

The Agency will **calculate** the final grant amount (see Article 5.3) and the balance (see Article 21.4) on the basis of the reports submitted. Only costs incurred until termination are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

Improper termination may lead to a reduction of the grant (see Article 43).

After termination, the beneficiaries' obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38, 40, 42, 43 and 44) continue to apply.

50.2 Termination of the participation of one or more beneficiaries, by the beneficiaries

50.2.1 Conditions and procedure

The participation of one or more beneficiaries may be terminated by the coordinator, on request of the beneficiary concerned or on behalf of the other beneficiaries.

The coordinator must formally notify termination to the Agency (see Article 52) and inform the beneficiary concerned.

If the coordinator's participation is terminated without its agreement, the formal notification must be done by another beneficiary (acting on behalf of the other beneficiaries).

The notification must include:

- the reasons why;
- the opinion of the beneficiary concerned (or proof that this opinion has been requested in writing);
- the date the termination takes effect. This date must be after the notification, and
- a request for amendment (see Article 55), with a proposal for reallocation of the tasks and the estimated budget of the beneficiary concerned (see Annexes 1 and 2) and, if necessary, the addition of one or more new beneficiaries (see Article 56). If termination takes effect after the period set out in Article 3, no request for amendment must be included unless the beneficiary

concerned is the coordinator. In this case, the request for amendment must propose a new coordinator.

If this information is not given or if the Agency considers that the reasons do not justify termination, the participation will be considered to have been **terminated improperly**.

The termination will **take effect** on the day specified in the notification.

50.2.2 Effects

The coordinator must — within 30 days from when termination takes effect — submit:

(i) a report on the distribution of payments to the beneficiary concerned and

(ii) if termination takes effect during the period set out in Article 3, a '**termination report**' from the beneficiary concerned, for the open reporting period until termination, containing an overview of the progress of the work, an overview of the use of resources, the individual financial statement and, if applicable, the certificate on the financial statement (see Articles 20.3 and 20.4).

The information in the termination report must also be included in the periodic report for the next reporting period (see Article 20.3).

If the request for amendment is rejected by the Agency (because it calls into question the decision awarding the grant or breaches the principle of equal treatment of applicants), the Agreement may be terminated according to Article 50.3.1(c).

If the request for amendment is accepted by the Agency, the Agreement is **amended** to introduce the necessary changes (see Article 55).

The Agency will — on the basis of the periodic reports, the termination report and the report on the distribution of payments — **calculate** the amount which is due to the beneficiary and if the (pre-financing and interim) payments received by the beneficiary exceed this amount.

The **amount which is due** is calculated in the following steps:

Step 1 — Application of the reimbursement rate to the eligible costs

The grant amount for the beneficiary is calculated by applying the reimbursement rate(s) to the total eligible costs declared by the beneficiary and its linked third parties in the termination report and approved by the Agency.

Only costs incurred by the beneficiary concerned until termination takes effect are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

Step 2 — Reduction due to substantial errors, irregularities or fraud or serious breach of obligations

In case of a reduction (see Article 43), the Agency will calculate the reduced grant amount for the beneficiary by deducting the amount of the reduction (calculated in proportion to the seriousness of the errors, irregularities or fraud or breach

of obligations, in accordance with Article 43.2) from the grant amount for the beneficiary.

If the payments received **exceed the amounts due**:

- if termination takes effect during the period set out in Article 3 and the request for amendment is accepted, the beneficiary concerned must repay to the coordinator the amount unduly received. The Agency will formally notify the amount unduly received and request the beneficiary concerned to repay it to the coordinator within 30 days of receiving notification. If it does not repay the coordinator, the Agency will draw upon the Guarantee Fund to pay the coordinator and then notify a **debit note** on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);

- in all other cases, in particular if termination takes effect after the period set out in Article 3, the Agency will formally notify a **debit note** to the beneficiary concerned. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the Agency the amount due and the Agency will notify a debit note on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);

- if the beneficiary concerned is the former coordinator, it must repay the new coordinator according to the procedure above, unless:

  - termination takes effect after an interim payment and

  - the former coordinator has not distributed amounts received as pre-financing or interim payments (see Article 21.7).

  In this case, the Agency will formally notify a **debit note** to the former coordinator. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the Agency the amount due. The Agency will then pay the new coordinator and notify a debit note on behalf of the Guarantee Fund to the former coordinator (see Article 44).

If the payments received **do not exceed the amounts due**: amounts owed to the beneficiary concerned will be included in the next interim or final payment.

If the Agency does not receive the termination report within the deadline (see above), only costs included in an approved periodic report will be taken into account.

If the Agency does not receive the report on the distribution of payments within the deadline (see above), it will consider that:

- the coordinator did not distribute any payment to the beneficiary concerned and that

- the beneficiary concerned must not repay any amount to the coordinator.

Improper termination may lead to a reduction of the grant (see Article 43) or termination of the Agreement (see Article 50).

After termination, the concerned beneficiary's obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38, 40, 42, 43 and 44) continue to apply.

50.3 Termination of the Agreement or the participation of one or more beneficiaries, by the Agency

50.3.1 Conditions

The Agency may terminate the Agreement or the participation of one or more beneficiaries, if:

(a) one or more beneficiaries do not accede to the Agreement (see Article 56);

(b) a change to their legal, financial, technical, organisational or ownership situation (or those of its linked third parties) is likely to substantially affect or delay the implementation of the action or calls into question the decision to award the grant;

(c) following termination of participation for one or more beneficiaries (see above), the necessary changes to the Agreement would call into question the decision awarding the grant or breach the principle of equal treatment of applicants (see Article 55);

(d) implementation of the action is prevented by force majeure (see Article 51) or suspended by the coordinator (see Article 49.1) and either:

  (i) resumption is impossible, or

  (ii) the necessary changes to the Agreement would call into question the decision awarding the grant or breach the principle of equal treatment of applicants;

(e) a beneficiary is declared bankrupt, being wound up, having its affairs administered by the courts, has entered into an arrangement with creditors, has suspended business activities, or is subject to any other similar proceedings or procedures under national law;

(f) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has been found guilty of professional misconduct, proven by any means;

(g) a beneficiary does not comply with the applicable national law on taxes and social security;

(h) the action has lost scientific or technological relevance;

(i) not applicable;

(j) not applicable;

(k) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed fraud, corruption, or is involved in a criminal organisation, money laundering or any other illegal activity;

(l) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed:

  (i) substantial errors, irregularities or fraud or

  (ii) serious breach of obligations under the Agreement or during the award procedure (including improper implementation of the action, submission of false information, failure to provide required information, breach of ethical principles);

(m) a beneficiary (or a natural person who has the power to represent or take decisions on its behalf) has committed — in other EU or Euratom grants awarded to it under similar conditions — systemic or recurrent errors, irregularities, fraud or serious breach of obligations that have a material impact on this grant (**extension of findings from other grants to this grant**; see Article 22.5.2);

(n) despite a specific request by the Agency, a beneficiary does not request — through the coordinator — an amendment to the Agreement to end the participation of one of its linked third parties or international partners that is in one of the situations under points (e), (f), (g), (k), (l) or (m) and to reallocate its tasks.

50.3.2 Procedure

Before terminating the Agreement or participation of one or more beneficiaries, the Agency will formally notify the coordinator or beneficiary concerned:

- informing it of its intention to terminate and the reasons why and

- inviting it, within 30 days of receiving notification, to submit observations and — in case of Point (l.ii) above — to inform the Agency of the measures to ensure compliance with the obligations under the Agreement.

If the Agency does not receive observations or decides to pursue the procedure despite the observations it has received, it will formally notify to the coordinator or beneficiary concerned **confirmation** of the termination and the date it will take effect. Otherwise, it will formally notify that the procedure is not continued.

The termination will **take effect**:

- for terminations under Points (b), (c), (e), (g), (h), (j), (l.ii) and (n) above: on the day specified in the notification of the confirmation (see above);

- for terminations under Points (a), (d), (f), (i), (k), (l.i) and (m) above: on the day after the notification of the confirmation is received.

50.3.3 Effects

(a) for **termination of the Agreement**:

The coordinator must — within 60 days from when termination takes effect — submit:

(i) a periodic report (for the last open reporting period until termination; see Article 20.3) and

(ii) a final report (see Article 20.4).

If the Agreement is terminated for breach of the obligation to submit reports (see Articles 20.8 and 50.3.1(l)), the coordinator may not submit any reports after termination.

If the Agency does not receive the reports within the deadline (see above), only costs which are included in an approved periodic report will be taken into account.

The Agency will **calculate** the final grant amount (see Article 5.3) and the balance (see

Article 21.4) on the basis of the reports submitted. Only costs incurred until termination takes effect are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

This does not affect the Agency's right to reduce the grant (see Article 43) or to impose administrative sanctions (Article 45).

The beneficiaries may not claim damages due to termination by the Agency (see Article 46).

After termination, the beneficiaries' obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38, 40, 42, 43 and 44) continue to apply.

(b) for **termination of the participation of one or more beneficiaries**:

The coordinator must — within 60 days from when termination takes effect — submit:

(i) a report on the distribution of payments to the beneficiary concerned;

(ii) a request for amendment (see Article 55), with a proposal for reallocation of the tasks and estimated budget of the beneficiary concerned (see Annexes 1 and 2) and, if necessary, the addition of one or more new beneficiaries (see Article 56). If termination is notified after the period set out in Article 3, no request for amendment must be submitted unless the beneficiary concerned is the coordinator. In this case the request for amendment must propose a new coordinator, and

(iii) if termination takes effect during the period set out in Article 3, a **termination report** from the beneficiary concerned, for the open reporting period until termination, containing an overview of the progress of the work, an overview of the use of resources, the individual financial statement and, if applicable, the certificate on the financial statement (see Article 20).

The information in the termination report must also be included in the periodic report for the next reporting period (see Article 20.3).

If the request for amendment is rejected by the Agency (because it calls into question the decision awarding the grant or breaches the principle of equal treatment of applicants), the Agreement may be terminated according to Article 50.3.1(c).

If the request for amendment is accepted by the Agency, the Agreement is **amended** to introduce the necessary changes (see Article 55).

The Agency will — on the basis of the periodic reports, the termination report and the report on the distribution of payments — **calculate** the amount which is due to the beneficiary and if the (pre-financing and interim) payments received by the beneficiary exceed this amount.

The **amount which is due** is calculated in the following steps:

Step 1 — Application of the reimbursement rate to the eligible costs

The grant amount for the beneficiary is calculated by applying the reimbursement rate(s) to the total eligible costs declared by the beneficiary and its linked third parties in the termination report and approved by the Agency.

Only costs incurred by the beneficiary concerned until termination takes effect are eligible (see Article 6). Costs relating to contracts due for execution only after termination are not eligible.

Step 2 — Reduction due to substantial errors, irregularities or fraud or serious breach of obligations

In case of a reduction (see Article 43), the Agency will calculate the reduced grant amount for the beneficiary by deducting the amount of the reduction (calculated in proportion to the seriousness of the errors, irregularities or fraud or breach of obligations, in accordance with Article 43.2) from the grant amount for the beneficiary.

If the payments received **exceed the amounts due**:

- if termination takes effect during the period set out in Article 3 and the request for amendment is accepted, the beneficiary concerned must repay to the coordinator the amount unduly received. The Agency will formally notify the amount unduly received and request the beneficiary concerned to repay it to the coordinator within 30 days of receiving notification. If it does not repay the coordinator, the Agency will draw upon the Guarantee Fund to pay the coordinator and then notify a **debit note** on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);

- in all other cases, in particular if termination takes effect after the period set out in Article 3, the Agency will formally notify a **debit note** to the beneficiary concerned. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the Agency the amount due and the Agency will notify a debit note on behalf of the Guarantee Fund to the beneficiary concerned (see Article 44);

- if the beneficiary concerned is the former coordinator, it must repay the new coordinator according to the procedure above, unless:

  - termination takes effect after an interim payment and

  - the former coordinator has not distributed amounts received as pre-financing or interim payments (see Article 21.7).

  In this case, the Agency will formally notify a **debit note** to the former coordinator. If payment is not made by the date in the debit note, the Guarantee Fund will pay to the Agency the amount due. The Agency will then pay the new coordinator and notify a debit note on behalf of the Guarantee Fund to the former coordinator (see Article 44).

If the payments received **do not exceed the amounts due**: amounts owed to the beneficiary concerned will be included in the next interim or final payment.

If the Agency does not receive the termination report within the deadline (see above), only costs included in an approved periodic report will be taken into account.

If the Agency does not receive the report on the distribution of payments within the deadline (see above), it will consider that:

- the coordinator did not distribute any payment to the beneficiary concerned and that
- the beneficiary concerned must not repay any amount to the coordinator.

After termination, the concerned beneficiary's obligations (in particular Articles 20, 22, 23, Section 3 of Chapter 4, 36, 37, 38, 40, 42, 43 and 44) continue to apply.

SECTION 4 FORCE MAJEURE

ARTICLE 51 — FORCE MAJEURE

'Force majeure' means any situation or event that:

- prevents either party from fulfilling their obligations under the Agreement,
- was unforeseeable, exceptional situation and beyond the parties' control,
- was not due to error or negligence on their part (or on the part of third parties involved in the action), and
- proves to be inevitable in spite of exercising all due diligence.

The following cannot be invoked as force majeure:

- any default of a service, defect in equipment or material or delays in making them available, unless they stem directly from a relevant case of force majeure,
- labour disputes or strikes, or
- financial difficulties.

Any situation constituting force majeure must be formally notified to the other party without delay, stating the nature, likely duration and foreseeable effects.

The parties must immediately take all the necessary steps to limit any damage due to force majeure and do their best to resume implementation of the action as soon as possible.

The party prevented by force majeure from fulfilling its obligations under the Agreement cannot be considered in breach of them.

CHAPTER 7 FINAL PROVISIONS

ARTICLE 52 — COMMUNICATION BETWEEN THE PARTIES

52.1 Form and means of communication

Communication under the Agreement (information, requests, submissions, 'formal notifications', etc.) must:

- be made in writing and

- bear the number of the Agreement.

All communication must be made through the Participant Portal **electronic** exchange system and using the forms and templates provided there.

If — after the payment of the balance — the Agency finds that a formal notification was not accessed, a second formal notification will be made by registered post with proof of delivery ('formal notification on **paper**'). Deadlines will be calculated from the moment of the second notification.

Communications in the electronic exchange system must be made by persons authorised according to the Participant Portal Terms & Conditions. For naming the authorised persons, each beneficiary must have designated — before the signature of this Agreement — a 'legal entity appointed representative (LEAR)'. The role and tasks of the LEAR are stipulated in his/her appointment letter (see Participant Portal Terms & Conditions).

If the electronic exchange system is temporarily unavailable, instructions will be given on the Agency and Commission websites.

52.2 Date of communication

Communications are considered to have been made when they are sent by the sending party (i.e. on the date and time they are sent through the electronic exchange system).

Formal notifications through the **electronic** exchange system are considered to have been made when they are received by the receiving party (i.e. on the date and time of acceptance by the receiving party, as indicated by the time stamp). A formal notification that has not been accepted within 10 days after sending is considered to have been accepted.

Formal notifications **on paper** sent by **registered post** with proof of delivery (only after the payment of the balance) are considered to have been made on either:

- the delivery date registered by the postal service or
- the deadline for collection at the post office.

If the electronic exchange system is temporarily unavailable, the sending party cannot be considered in breach of its obligation to send a communication within a specified deadline.

52.3 Addresses for communication

The **electronic** exchange system must be accessed via the following URL:

https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/myarea/projects

The Agency will formally notify the coordinator and beneficiaries in advance any changes to this URL.

Formal notifications on paper (only after the payment of the balance) addressed **to the Agency** must be sent to the official mailing address indicated on the Agency's website.

Formal notifications on paper (only after the payment of the balance) addressed **to the beneficiaries** must be sent to their legal address as specified in the Participant Portal Beneficiary Register.

ARTICLE 53 — INTERPRETATION OF THE AGREEMENT

53.1 Precedence of the Terms and Conditions over the Annexes

The provisions in the Terms and Conditions of the Agreement take precedence over its Annexes.

Annex 2 takes precedence over Annex 1.

53.2 Privileges and immunities

Not applicable

ARTICLE 54 — CALCULATION OF PERIODS, DATES AND DEADLINES

In accordance with Regulation No 1182/71[30], periods expressed in days, months or years are calculated from the moment the triggering event occurs.

The day during which that event occurs is not considered as falling within the period.

ARTICLE 55 — AMENDMENTS TO THE AGREEMENT

55.1 Conditions

The Agreement may be amended, unless the amendment entails changes to the Agreement which would call into question the decision awarding the grant or breach the principle of equal treatment of applicants.

Amendments may be requested by any of the parties.

55.2 Procedure

The party requesting an amendment must submit a request for amendment signed in the electronic exchange system (see Article 52).

The coordinator submits and receives requests for amendment on behalf of the beneficiaries (see Annex 3).

If a change of coordinator is requested without its agreement, the submission must be done by another beneficiary (acting on behalf of the other beneficiaries).

The request for amendment must include:

- the reasons why;
- the appropriate supporting documents, and
- for a change of coordinator without its agreement: the opinion of the coordinator (or proof that this opinion has been requested in writing).

[30] Regulation (EEC, Euratom) No 1182/71 of the Council of 3 June 1971 determining the rules applicable to periods, dates and time-limits (OJ L 124, 8.6.1971, p. 1).

The Agency may request additional information.

If the party receiving the request agrees, it must sign the amendment in the electronic exchange system within 45 days of receiving notification (or any additional information the Agency has requested). If it does not agree, it must formally notify its disagreement within the same deadline. The deadline may be extended, if necessary for the assessment of the request. If no notification is received within the deadline, the request is considered to have been rejected.

An amendment **enters into force** on the day of the signature of the receiving party.

An amendment **takes effect** on the date agreed by the parties or, in the absence of such an agreement, on the date on which the amendment enters into force.

ARTICLE 56 — ACCESSION TO THE AGREEMENT

56.1 Accession of the beneficiaries mentioned in the Preamble

The other beneficiaries must accede to the Agreement by signing the Accession Form (see Annex 3) in the electronic exchange system (see Article 52) within 30 days after its entry into force (see Article 58).

They will assume the rights and obligations under the Agreement with effect from the date of its entry into force (see Article 58).

If a beneficiary does not accede to the Agreement within the above deadline, the coordinator must — within 30 days — request an amendment to make any changes necessary to ensure proper implementation of the action. This does not affect the Agency's right to terminate the Agreement (see Article 50).

56.2 Addition of new beneficiaries

In justified cases, the beneficiaries may request the addition of a new beneficiary.

For this purpose, the coordinator must submit a request for amendment in accordance with Article 55. It must include an Accession Form (see Annex 3) signed by the new beneficiary in the electronic exchange system (see Article 52).

New beneficiaries must assume the rights and obligations under the Agreement with effect from the date of their accession specified in the Accession Form (see Annex 3).

ARTICLE 57 — APPLICABLE LAW AND SETTLEMENT OF DISPUTES

57.1 Applicable law

The Agreement is governed by the applicable EU law, supplemented if necessary by the law of Belgium.

57.2 Dispute settlement

If a dispute concerning the interpretation, application or validity of the Agreement cannot be settled amicably, the General Court — or, on appeal, the Court of Justice of the European Union — has sole

jurisdiction. Such actions must be brought under Article 272 of the Treaty on the Functioning of the EU (TFEU).

As an exception, if such a dispute is between the Agency and NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU, SINTEF AS, GREEN DIGITAL FINANCE ALLIANCE, OSLO KOMMUNE, the competent Belgian courts have sole jurisdiction.

If a dispute concerns administrative sanctions, offsetting or an enforceable decision under Article 299 TFEU (see Articles 44, 45 and 46), the beneficiaries must bring action before the General Court — or, on appeal, the Court of Justice of the European Union — under Article 263 TFEU. Actions against offsetting and enforceable decisions must be brought against the Commission (not against the Agency).

ARTICLE 58 — ENTRY INTO FORCE OF THE AGREEMENT

The Agreement will enter into force on the day of signature by the Agency or the coordinator, depending on which is later.

SIGNATURES

For the coordinator

[redacted]

For the Agency

[redacted]

EUROPEAN COMMISSION

European Climate, Infrastructure and Environment Executive Agency (CINEA)

The Director

ANNEX 1 (part A)

Innovation action

NUMBER — 101036723 — ARV

Table of Contents

1.1. The project summary

Project Number [1]	101036723	Project Acronym [2]	ARV

One form per project

General information	
Project title [3]	Climate Positive Circular Communities
Starting date [4]	01/01/2022
Duration in months [5]	48
Call (part) identifier [6]	H2020-LC-GD-2020-7
Topic	LC-GD-4-1-2020 Building and renovating in an energy and resource efficient way
Fixed EC Keywords	Low/nearly zero &-energy positive buildings, Sustainable design (for recycling, for environment, eco-design), Architecture, smart buildings, smart cities, urban engineering, Integration of renewables, Energy efficient buildings, Ecodesign, Life Cycle Analysis
Free keywords	climate positive circular communities, zero emission neighbourhoods, stakeholder engagement, citizen awareness, circular economy, green digital financing, policy and regulations, IEQ

Abstract [7]

The vision of the ARV project is to contribute to speedy wide scale implementation of Climate Positive Circular Communities (CPCC) where people can thrive and prosper for generations to come.
The overall aim is to demonstrate and validate attractive, resilient, and affordable solutions for CPCC that will significantly speed up the deep energy renovations and the deployment of energy and climate measures in the construction and energy industries.
To achieve this, the ARV project will employ a novel concept relying on a combination of 3 conceptual pillars, 6 demonstration projects, and 9 thematic focus areas.
The 3 conceptual pillars are integration, circularity and simplicity. Integration in ARV means the coupling of people, buildings, and energy systems, through multi-stakeholder co-creation and use of innovative digital tools. Circularity in ARV means a systematic way of addressing circular economy through automated use of LCA, digital logbooks and material banks. Simplicity in ARV means to make the solutions easy to understand and use for all stakeholders, from manufacturers to end-users.
The 6 demos are urban regeneration projects in 6 locations around Europe. They have been carefully selected to represent the different European climates and contexts, and due to their high ambitions in environmental, social and economic sustainability. Renovation of social housing and public buildings are specifically focused. Together, they will demonstrate more than 50 innovations in more than 150,00 m2 of buildings.
The 9 thematic focus areas are 1) Effective planning and implementation of CPCCs, 2) Citizen engagement, environment and well-being, 3) Sustainable building re(design) 4) Resource efficient manufacturing and construction workflows, 5) Integrated renewables and storage, 6) Energy management and flexibility, 7) Monitoring and evaluation, 8) Business models, financial mechanisms, policy and exploitation, 9) Communication, dissemination, and stakeholder outreach.

1.2. List of Beneficiaries

Project Number [1]	101036723	Project Acronym [2]	ARV

List of Beneficiaries

No	Name	Short name	Country	Project entry month[8]	Project exit month
1	NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU	NTNU	Norway	1	48
2	CONSEIL DES ARCHITECTES D'EUROPE	ACE	Belgium	1	48
3	CESKE VYSOKE UCENI TECHNICKE V PRAZE	CVUT	Czech Republic	1	48
4	DANMARKS TEKNISKE UNIVERSITET	DTU	Denmark	1	48
5	DANFOSS A/S	DANFOSS A/S	Denmark	1	48
6	ENFOR AS	ENFOR	Denmark	1	48
7	PROJECT ZERO A/S	PROJECTZERO	Denmark	1	48
8	ACCADEMIA EUROPEA DI BOLZANO	EURAC	Italy	1	48
9	SINTEF AS	SINTEF	Norway	1	48
10	AYUNTAMENT DE PALMA DE MALLORCA	PALMA	Spain	1	48
11	INSTITUTO BALEAR DE LA VIVIENDA	IBAVI	Spain	1	48
12	FUNDACIO INSTITUT DE RECERCA DE L'ENERGIA DE CATALUNYA	IREC	Spain	1	48
13	METROVACESA, SA	MET	Spain	1	48
14	Stichting Hogeschool Utrecht	UAS Utrecht	Netherlands	1	48
15	COMITE EUROPEEN DE COORDINATION DE L'HABITAT SOCIAL AISBL	HOUSING EUROPE	Belgium	1	48
16	BURO DE HAAN INFORMATIE TECHNOLOGIE BV	Buro de Haan	Netherlands	1	48
17	CENTER DANMARK DRIFT APS	Center Denmark	Denmark	1	48
18	SONDERBORG ANDELSBOLIGFORENING	SAB	Denmark	1	48
19	GREEN DIGITAL FINANCE ALLIANCE	GDFA	Switzerland	1	48
20	STICHTING BO-EX 91	BOEX	Netherlands	1	48
21	RC PANELS BV	Rc Panels B.V.	Netherlands	1	48
22	UNIVERSITEIT UTRECHT	UU	Netherlands	1	48
23	GEMEENTE UTRECHT	CITY OF UTRECHT	Netherlands	1	48
24	BOS INSTALLATIEWERKEN BV	BOSGROEP	Netherlands	1	48
25	IWELL BV	iwell	Netherlands	1	48
26	ME X ARCHITECTS BV	MEX	Netherlands	1	48
27	STICHTING MITROS	Mitros	Netherlands	1	48

1.2. List of Beneficiaries

No	Name	Short name	Country	Project entry month[8]	Project exit month
28	STATUTARNI MESTO KARVINA	KARV	Czech Republic	1	48
29	DOLOMITI ENERGIA RINNOVABILI SOCIETA A RESPONSABILITA' LIMITATA	DOL	Italy	1	48
30	DISTRETTO TECNOLOGICO TRENTINO SCARL	DTTN	Italy	1	48
31	UNIVERSITA DEGLI STUDI DI TRENTO	UNITN	Italy	1	48
32	POLITECNICO DI TORINO	POLITO	Italy	1	48
33	OSLO KOMMUNE	OBF	Norway	1	48
34	NANO POWER AS	NANO	Czech Republic	1	48
35	SISTEMES AVANCATS D ENERGIA SOLAR TERMICA SCCL	AIGUASOL SAEST	Spain	1	48

1.3. Workplan Tables - Detailed Implementation

1.3.1. WT1 List of work packages

WP Number[9]	WP Title	Lead beneficiary[10]	Person-months[11]	Start month[12]	End month[13]
WP1	Project Management and coordination	1 - NTNU	162.00	1	48
WP2	Framework and tools for effective implementation and assessment of CPCC	12 - IREC	197.50	1	48
WP3	Community engagement, environment, and well-being	9 - SINTEF	213.00	1	48
WP4	Sustainable Building (re) Design	1 - NTNU	267.50	1	40
WP5	Resource Efficient (Pre)Manufacturing and Construction Workflows	14 - UAS Utrecht	231.50	1	48
WP6	Integrated renewables and storage systems	3 - CVUT	192.50	1	46
WP7	Efficient Operation and Flexibility	4 - DTU	253.50	1	48
WP8	Monitoring, Evaluation and Impact Assessment	8 - EURAC	228.00	1	48
WP9	Business models, financial instruments, policy and exploitation	19 - GDFA	155.00	3	48
WP10	Communication, disseminations and stakeholder outreach	2 - ACE	87.00	1	48
		Total	1 987.50		

1.3.2. WT2 list of deliverables

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D1.1	Overall Consortium Plan	WP1	1 - NTNU	Report	Confidential, only for members of the consortium (including the Commission Services)	3
D1.2	Progress report	WP1	1 - NTNU	Report	Confidential, only for members of the consortium (including the Commission Services)	12
D1.3	Innovation Management Plan	WP1	1 - NTNU	Report	Confidential, only for members of the consortium (including the Commission Services)	6
D1.4	Demo Project Innovation Progress Reports (annually)	WP1	1 - NTNU	Report	Confidential, only for members of the consortium (including the Commission Services)	12
D1.5	Quality Assurance Plan QAP	WP1	1 - NTNU	Report	Confidential, only for members of the consortium (including the Commission Services)	3
D1.6	Risk Management Plan	WP1	1 - NTNU	Report	Confidential, only for members of the consortium (including the Commission Services)	3
D1.7	Legal & Knowledge Management Plan	WP1	1 - NTNU	Report	Confidential, only for members of the consortium (including the Commission Services)	3
D1.8	ARV Data Management Plan DMP	WP1	1 - NTNU	ORDP: Open Research Data Pilot	Confidential, only for members of the consortium (including the Commission Services)	6

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D2.1	Assessment framework for CPCC	WP2	12 - IREC	Report	Public	9
D2.2	Description of methods and tools for Large-Scale Retrofitting in CPCC	WP2	4 - DTU	Report	Confidential, only for members of the consortium (including the Commission Services)	18
D2.3	Description of methods and tools for CEC in CPCC	WP2	12 - IREC	Report	Confidential, only for members of the consortium (including the Commission Services)	15
D2.4	Application of tools for Large-Scale Retrofitting actions. Uses cases and guidelines for replicability	WP2	12 - IREC	Report	Public	46
D2.5	Application of tools for implementation of Citizen Energy Communities. Uses cases and guidelines for replicability	WP2	12 - IREC	Report	Public	42
D2.6	Demos of Virtual Reality Environments	WP2	9 - SINTEF	Demonstrator	Public	36
D2.7	Description and lessons learnt from training & awareness sessions using Virtual Environments	WP2	9 - SINTEF	Report	Public	48
D2.8	Assessment framework for CPCC. Updated version	WP2	12 - IREC	Report	Public	48
D3.1	Plan and overall methodology design for establishing CPCC Living Labs, including stakeholder mapping	WP3	9 - SINTEF	Demonstrator	Public	12
D3.2	Implementation plan of CPCC Living Labs per demo site, demonstration of LL	WP3	10 - PALMA	Demonstrator	Public	13
D3.3	CPCC Living Labs reports	WP3	3 - CVUT	Report	Public	24

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D3.4	Analysis of citizen engagement tools and processes using a citizen science approach	WP3	9 - SINTEF	Report	Public	40
D3.5	Community-scale citizen engagement strategy and tools for the renovation wave	WP3	9 - SINTEF	Websites, patents filing, etc.	Public	48
D4.1	Design guidelines of zero-emission and positive energy buildings in a climate positive energy neighbourhood in Oslo	WP4	9 - SINTEF	Report	Public	12
D4.2	Design configuration for a modular, scalable, integrated retrofitting concept for Positive Energy Mid- & Highrise Buildings embedded in a green neighbourhood in Utrecht	WP4	14 - UAS Utrecht	Report	Public	12
D4.3	Design guidelines for zero-emission & positive energy refurbished and new buildings in Palma	WP4	12 - IREC	Report	Public	12
D4.4	Design guidelines for the zero-emission & positive energy renovation of the Health Care Centre in Karviná	WP4	3 - CVUT	Report	Public	12
D4.5	Design guidelines of timber-based construction & renovation of small-medium size buildings in Trento	WP4	31 - UNITN	Report	Public	12
D4.6	Design guidelines of new & retrofitting of existing buildings as zero-emission positive energy-buildings in climate positive circular communities	WP4	1 - NTNU	Report	Public	40
D5.1	Manufacturing configurator for	WP5	14 - UAS Utrecht	Report	Public	24

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
	high-rise apartment buildings to directly start production (File2Factory) process partly validated in participating European demo countries.					
D5.2	Workflow analyses and advise on how to move towards more prefabricated components and reduce work on-site.	WP5	14 - UAS Utrecht	Report	Public	36
D5.3	Resource Efficient (Pre)Manufacturing & Construction Workflows – Demo Utrecht	WP5	14 - UAS Utrecht	Report	Public	48
D5.4	Resource Efficient (Pre)Manufacturing & Construction Workflows – Demo Palma	WP5	12 - IREC	Report	Public	48
D5.5	Resource Efficient (Pre)Manufacturing & Construction Workflows – Demo Oslo	WP5	33 - OBF	Report	Public	48
D5.6	Resource Efficient (Pre)Manufacturing &Construction Workflows – Demo Karviná	WP5	3 - CVUT	Report	Public	48
D5.7	Resource Efficient (Pre)Manufacturing & Construction Workflows – Demo Trento	WP5	31 - UNITN	Report	Public	48
D5.8	Demonstration case of CPCC in Utrecht	WP5	14 - UAS Utrecht	Demonstrator	Public	36
D5.9	Demonstration case of CPCC in Palma	WP5	10 - PALMA	Demonstrator	Public	36
D5.10	Demonstration case of CPCC in Oslo	WP5	33 - OBF	Demonstrator	Public	36
D5.11	Demonstration case of CPCC in Karviná	WP5	3 - CVUT	Demonstrator	Public	36
D5.12	Demonstration case of CPCC in Trento	WP5	31 - UNITN	Demonstrator	Public	36

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D6.1	Guidelines for integrated design and implementation of RESs and ESSs for building/ neighbourhood's energy needs in Oslo	WP6	9 - SINTEF	Demonstrator	Public	42
D6.2	Guidelines for integrated design and implementation of RESs and ESSs for building/ neighbourhood's energy needs in Sønderborg	WP6	7 - PROJECTZERO	Demonstrator	Public	26
D6.3	Guidelines for integrated design and implementation of RESs and ESSs for building/ neighbourhood's energy needs in Utrecht	WP6	22 - UU	Demonstrator	Public	44
D6.4	Guidelines for integrated design and implementation of RESs and ESSs for building/ neighbourhood's energy needs in Karviná	WP6	3 - CVUT	Demonstrator	Public	44
D6.5	Guidelines for integrated design and implementation of RESs and ESSs for building/ neighbourhood's energy needs in Trento	WP6	8 - EURAC	Demonstrator	Public	46
D7.1	Establishment of ARV central digitalization hub and data lake	WP7	17 - Center Denmark	Demonstrator	Confidential, only for members of the consortium (including the Commission Services)	18
D7.2	Archetype building models	WP7	3 - CVUT	Report	Public	32
D7.3	City fine resolution weather forecasting at demo sites	WP7	6 - ENFOR	Demonstrator	Confidential, only for members of the consortium (including the Commission Services)	12

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D7.4	Forecasting of wind, solar, load, prices at demo sites	WP7	17 - Center Denmark	Demonstrator	Confidential, only for members of the consortium (including the Commission Services)	18
D7.5	Controllers with interface to provide user preferences	WP7	4 - DTU	Demonstrator	Confidential, only for members of the consortium (including the Commission Services)	32
D7.6	Guidelines on descriptions of smartness and flexibility	WP7	4 - DTU	Report	Public	24
D7.7	Guidelines on climate zone related design principles	WP7	1 - NTNU	Report	Public	32
D7.8	Handbook for smart communities	WP7	22 - UU	Report	Public	42
D7.9	Principles for CEC-DSO interactions	WP7	4 - DTU	Report	Public	46
D8.1	Monitoring, evaluation and impact assessment frameworks	WP8	8 - EURAC	Report	Public	12
D8.2	Data architecture, including description of monitoring systems in the ARV demos	WP8	17 - Center Denmark	Report	Public	18
D8.3	Structure and use of the data warehouse	WP8	17 - Center Denmark	Report	Public	48
D8.4	Evaluation results reports (including recommendations and guidelines for future projects)	WP8	1 - NTNU	Report	Public	48
D8.5	Streamlined LCA-LCCA comparing alternative solutions & scenarios	WP8	8 - EURAC	Report	Public	24
D8.6	LCA and LCC of the implemented solutions and social component	WP8	8 - EURAC	Report	Public	48
D8.7	Report on Multiple Benefits analysis and assessment	WP8	8 - EURAC	Report	Public	48

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D8.8	Guidelines and recommendations for replication and/or future research	WP8	8 - EURAC	Report	Public	48
D9.1	Develop an annual ARV Innovation Intel for Impact (AI3) report.	WP9	19 - GDFA	Report	Public	12
D9.2	Develop catalogue of business and financing models proven in other markets for adaptation in the EU to accelerate the renovation wave.	WP9	19 - GDFA	Report	Public	6
D9.3	Design business model blueprints for energy positive retrofits for different asset classes as modules for replication across the EU.	WP9	19 - GDFA	Report	Public	36
D9.4	Design Platform Based Prosumer Business Models with clear policy and regulatory recommendations.	WP9	19 - GDFA	Demonstrator	Public	41
D9.5	Design Building-linked financing instruments for FI adoption in re-estate portfolios	WP9	19 - GDFA	Demonstrator	Public	36
D9.6	Develop green digital bonds guide to scale prosumer flexible energy markets.	WP9	19 - GDFA	Other	Public	45
D9.7	Enable scaling across EU markets of energy positive renovation.	WP9	19 - GDFA	Other	Public	46
D10.1	ARV corporate identity	WP10	1 - NTNU	Other	Public	3
D10.2	i) Core Communication and Dissemination Plan & ii) tailored strategies for the 6 CPCC LL demos	WP10	2 - ACE	Report	Confidential, only for members of the consortium (including the Commission Services)	8
D10.3	Project website, e-marketplace &Social Media	WP10	15 - HOUSING EUROPE	Websites, patents filing, etc.	Public	6

Deliverable Number[14]	Deliverable Title	WP number[9]	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D10.4	Newsletters & dissemination material: Leaflet, Posters, Video, Infographic	WP10	15 - HOUSING EUROPE	Websites, patents filing, etc.	Public	6
D10.5	Project booklet summarising results achieved in ARV	WP10	15 - HOUSING EUROPE	Report	Public	42
D10.6	Final report on dissemination and communication activities	WP10	2 - ACE	Report	Public	48
D10.7	Report on contribution to common H2020 Activities	WP10	2 - ACE	Report	Public	44
D10.8	A blueprint for planning, (re)design, (re)construction, operation and use of CPCCs	WP10	1 - NTNU	Report	Public	12

1.3.3. WT3 Work package descriptions

Work package number [9]	WP1	**Lead beneficiary** [10]	1 - NTNU
Work package title	Project Management and coordination		
Start month	1	**End month**	48

Objectives

The aim of WP1 is to ensure sound management throughout the project period. including contractual and financial management, project documentation, monitoring and reporting, to ensure that the project achieves its objectives within the budget constraints and allocated time. WP1 has the following specific objectives:
• Coordinate the activities of the project so that the overall objectives, milestones, and deliverables are achieved to the highest possible quality, on time, and within budget.
• Manage the project's finances and accurately report them to the European Commission.
• Assist the project partners in adhering to their contractual obligations, as outlined in the Grant Agreement and the Consortium Agreement and associated Annexes.
• Systematically register, report and develop innovations from the demonstration projects and innovation clusters
• Coordinate and manage financial, contractual, ethical, and legal issues throughout all project phases including monitoring of progress and risks.
• Ensure effective exchange of information and knowledge sharing within the consortium by establishing a communication structure and regular consortium meetings.
• Coordinate with innovation cluster activities, external experts advisory and exploitation boards, and related projects.

Description of work and role of partners

WP1 - Project Management and coordination [Months: 1-48]
NTNU, ACE, CVUT, DTU, DANFOSS A/S, ENFOR, PROJECTZERO, EURAC, SINTEF, PALMA, IBAVI, IREC, MET, UAS Utrecht, HOUSING EUROPE, Buro de Haan, Center Denmark, SAB, GDFA, BOEX, Rc Panels B.V., UU, CITY OF UTRECHT, BOSGROEP, iwell, MEX, Mitros, KARV, DOL, DTTN, UNITN, POLITO, OBF, NANO, AIGUASOL SAEST
Task 1.1 (T1.1) Project Initiation: M1-M3. Task leader: NTNU
Organise the kick-off meeting (KOM) and the revised Overall Consortium Plan for the project including the detailed assignment of roles, responsibilities, and resources, the project timetable, and descriptions of each deliverable to be produced. This will be agreed with all the project partners at the kick-off meeting.

Task 1.2 (T1.2) Project Management M1-M48. Task leader: NTNU; Participants: All
This task will ensure project progress monitoring- and control and communication. It will manage administrative and contractual relationships of the Consortium and with the European Commission. The management consists of:
• Establishment of the liaison with the EU Commission through contacts with project advisors and officers, including periodic progress reports and response to any administrative or technical requests by the Commission.
• Draw up the Consortium agreement, ensure budget control, cost claims, legal, financial, administrative, and miscellaneous contractual management tasks.
• Securing information flow within the Consortium, coordination of technical activities and milestone control.
• Overseeing any ethical issues that could become relevant in the project.
• Production of Final Project Reports.

The PMT will establish a MS Teams project platform for day-to-day communication and document control. The PMT will organize regular teleconferences with the consortium to discuss work in progress, milestones deliverables, etc. The PMT is also responsible for regular communication with INEA and to keep the project officer up to date with any developments. The following meeting structure is envisaged:

Progress meetings in person will be scheduled at minimum annually with interim meetings every six months carried out either by electronic communication means or by a personal meeting. (Preliminary scheduling of these project events is set for Months 6, 12, 18, 24, 30, 36, 42).
• Final meeting (Month 47): Monitor the fulfilment of the whole Work Programme and the quality of the results obtained by the project during its duration, based on the general objectives of the project proposal

• Additional web-based teleconferences and meetings will be held on an 'ad hoc' basis to: i) address issues that may arise; ii) ensure common direction of the project research and innovations; iii) minimize travel costs.

Task 1.3 (T1.3) Innovation Management. M1-M48. Task leader: NTNU - Innovation Manager, Participants: Demo Leaders, Work Package Leaders
In this task, innovations from the demonstration projects and the innovation clusters will be registered and reported to realize up-scaling and commercialisation potentials of ARV innovations. The task will ensure discussions with all pilot representatives and partners. The Innovation Board will meet regularly with the ARV Exploitation Board in order to ensure early identification and scaling of commercially viable innovations Innovation management is important to ensure success in bringing ideas/innovations higher on the TRL scale and to have them adopted. It deals with measures to promote innovation in organizations and eventually bringing them to a larger market. The task will:
• Develop the best environment for innovation (internal).
• Provide regularly updates of the overall project Gantt chart and the resource matrix.
• Establish common approach to what innovation is and how to work with innovations within ARV.
• Develop a tool to register, monitor and report innovations, e.g. to support informed choices on future investments
• Analyse reported ideas including due diligence on ownership and user rights and regulations in relevant contracts: Prior art and patentability report and Patenting or other IPR protection
• Develop a commercialization strategy based on analysis of technology, market, partners, business model, team, and financing:
- Business development and possible establishment of a scalable spin-off company
- Project lead on commercial testing, verification, and prototyping.
- Identification of potential licensees and negotiation of license agreements based on NTNU standards.
- Establish Inter Institutional Agreements with other project partners on commercialization when needed.
• Bring all ARV innovations at least one step up the TRL scale, reaching TRL 7/8 by the end of the project period.

To align deliverables and expected innovations of the ARV project and the activities in the WPs, each Demo Project Leader (DPL) will provide an overview of joint challenges, opportunities, knowledge, and exchange questions for each WP. Each WP leader will provide plans for exchange and collaboration activities with the demo projects to create a collaboration framework which support the innovation clusters. This will follow a staged process:
• Starting with webinars on general topics followed with discussions
• Followed by peer-2-peer or expert-2-peer meetings on specific topics of relevance to demo-sites
• Followed by face-2-face workshops or site-visits to go deeper into the content
• Followed by joint publications and/or reports to really consolidate on the knowledge exchanged

The DPL and WPL will report on a quarterly basis to the Innovation Manager (IM) on the progress of the WPs and the demo projects, the status of the innovations, the compliance to and updates on the planning, potential problems, and their potential solution. This will help the IM keep track of the demo project status and the relations to the WP, in order to control the project, take timely measures and regularly update the overall project Gantt chart and the resource matrix.

Task 1.4 (T.1.4) Quality Assurance: M1-M48. Task leader: NTNU, Participants: All
The PMT will develop a comprehensive Quality Assurance Plan (QAP) in close collaboration with the Work Package Leaders. This will include a standard internal review process for all deliverables within the project to ensure that the standard of excellence for the ARV project is maintained. Regarding reporting, the PMT will keep an overview of deadlines and progress. They may remind partners of their obligations and request progress reports from work package leaders. The PMT will verify that all documents are complete and correct before they are submitted to the EC. The PMT will monitor the progress of the project activities focusing on:
• Method of work and integration of the partnership ensuring actual and timely implementation of the activities;
• Internal communication, using platforms described in Task 1.2;
• Project costs, to detect cases of potential overruns in due time and provide alternative solutions;
• The production of project deliverables and their quality;
• The action list produced at the end of each project meeting.

Task 1.5 (T.1.5) Risk Management: M1-M48. Task leader: NTNU, Participants: All
Update the Table of risks, outlined in Section 3.2 at each 6-month progress meeting review. Existing risks will be analysed. and their probability and severity rating modified if required, if any risk goes above medium, mitigation measures will be put in place to bring this risk back to a lower level. The Risk Management Plan (RMP) will be updated annually.

Task 1.6: Legal, Knowledge, and Data Management: M1-M48. Task leader: NTNU, Participants: All

This task will manage all IPR issues and set up a Legal, Knowledge, and Data Management Plans, to be updated annually. Data generated in the project will be made 'findable, accessible, interoperable and reusable (FAIR)', in line with the H2020 Guidelines on FAIR Data Management. The consortium will provide Open Data arising from the project to support benchmarking, dissemination, and exploitation, improving access and re-use of data generated within the project and knowledge sharing with citizens and other stakeholders. A private portal will be set up where all project partners will report progress and upload relevant project results. T1.6 will also analyse and describe GDPR, data and cybersecurity related aspects and reporting/feeding existing EU databases (e.g., EU building stock observatory). The task will be conducted in close collaboration with all WPs, but in particular WPs 7 and 8.

Participation per Partner

Partner number and short name	WP1 effort
1 - NTNU	77.00
2 - ACE	4.00
3 - CVUT	7.00
4 - DTU	4.00
5 - DANFOSS A/S	1.00
6 - ENFOR	1.00
7 - PROJECTZERO	7.00
8 - EURAC	2.00
9 - SINTEF	4.00
10 - PALMA	7.00
11 - IBAVI	1.00
12 - IREC	4.00
13 - MET	1.00
14 - UAS Utrecht	10.00
15 - HOUSING EUROPE	1.00
16 - Buro de Haan	0.50
17 - Center Denmark	1.00
18 - SAB	1.00
19 - GDFA	4.00
20 - BOEX	1.00
21 - Rc Panels B.V.	0.50
22 - UU	1.00
23 - CITY OF UTRECHT	1.00
24 - BOSGROEP	1.00
25 - iwell	1.00
26 - MEX	1.00
27 - Mitros	1.00
28 - KARV	1.00
29 - DOL	1.00

Partner number and short name	WP1 effort
30 - DTTN	2.50
Armalam	1.50
31 - UNITN	1.00
32 - POLITO	1.00
33 - OBF	7.00
34 - NANO	1.00
35 - AIGUASOL SAEST	1.00
Total	162.00

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D1.1	Overall Consortium Plan	1 - NTNU	Report	Confidential, only for members of the consortium (including the Commission Services)	3
D1.2	Progress report	1 - NTNU	Report	Confidential, only for members of the consortium (including the Commission Services)	12
D1.3	Innovation Management Plan	1 - NTNU	Report	Confidential, only for members of the consortium (including the Commission Services)	6
D1.4	Demo Project Innovation Progress Reports (annually)	1 - NTNU	Report	Confidential, only for members of the consortium (including the Commission Services)	12
D1.5	Quality Assurance Plan QAP	1 - NTNU	Report	Confidential, only for members of the consortium (including the Commission Services)	3
D1.6	Risk Management Plan	1 - NTNU	Report	Confidential, only for members of the consortium (including the Commission Services)	3
D1.7	Legal & Knowledge Management Plan	1 - NTNU	Report	Confidential, only for members of the	3

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
				consortium (including the Commission Services)	
D1.8	ARV Data Management Plan DMP	1 - NTNU	ORDP: Open Research Data Pilot	Confidential, only for members of the consortium (including the Commission Services)	6

Description of deliverables

D1.1 : Overall Consortium Plan [3]

deliverable will ensure project progress monitoring- and control and communication. It will manage administrative and contractual relationships of the Consortium and with the European Commission. Overall Consortium Plan for the project including the detailed assignment of roles, responsibilities, and resources, the project timetable, and descriptions of each deliverable to be produced

D1.2 : Progress report [12]

Short interrim management report on project status Revisions; M12, 24, 36 and 48

D1.3 : Innovation Management Plan [6]

innovations from the demonstration projects and the innovation clusters will be registered and reported to realize up-scaling and commercialisation potentials of ARV innovations Revisions planned for M18, M30, M42

D1.4 : Demo Project Innovation Progress Reports (annually) [12]

innovations from the demonstration projects and the innovation clusters will be registered and reported to realize up-scaling and commercialisation potentials of ARV innovations. Revisions in, M24, M36, M48

D1.5 : Quality Assurance Plan QAP [3]

The PMT will develop a comprehensive Quality Assurance Plan (QAP) in close collaboration with the Work Package Leaders. This will include a standard internal review process for all deliverables within the project to ensure that the standard of excellence for the ARV project is maintained. Revisions in: M3, M15, M27, M39

D1.6 : Risk Management Plan [3]

Update the Table of risks, outlined in Section 3.2 at each 6-month progress meeting review. Existing risks will be analysed. and their probability and severity rating modified if required, if any risk goes above medium, mitigation measures will be put in place to bring this risk back to a lower level. The Risk Management Plan (RMP) will be updated annually Revisions M15, M27, M39

D1.7 : Legal & Knowledge Management Plan [3]

To manage all IPR issues and set up a Legal, Knowledge, and Data Management Plans, to be updated annually. Data generated in the project will be made ‘findable, accessible, interoperable and reusable (FAIR)’, in line with the H2020 Guidelines on FAIR Data Management Revisions in M15, M27, M39

D1.8 : ARV Data Management Plan DMP [6]

manage all IPR issues and set up a Legal, Knowledge, and Data Management Plans, to be updated annually. Data generated in the project will be made ‘findable, accessible, interoperable and reusable (FAIR)’, in line with the H2020 Guidelines on FAIR Data Management Revision in, M18, M30, M42

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS1	Project initiation	1 - NTNU	3	CA & Minutes of KOM

Work package number [9]	WP2	Lead beneficiary [10]	12 - IREC
Work package title	Framework and tools for effective implementation and assessment of CPCC		
Start month	1	End month	48

Objectives

The purpose of WP2 is to refine, deploy and test methods and tools for effective design, implementation, and assessment of CPCC. The WP will establish a common multi-criteria framework for the integrated assessment and evaluation of CPCC to be used throughout the different phases of planning, design, construction and operation of the different demos in the project in close collaboration with WP8. Specific objectives of the WP include:

• Define, integrate, and extend already available assessment frameworks for zero-energy/zero-emission neighbourhoods under a multidimensional perspective to characterize the impact of CPCC, improving the integration of missing aspects such as circularity & overall quality in renovation / new construction on district level projects.

• Alignment of the assessment CPCC framework and its Key Performance Indicators KPIs, to be tested and validated through the different demos in ARV and to be implemented in the monitoring procedures (WP8)

• Adaptation of methods and tools to model and assess the impact of existing and projected CPCC`s from a multidimensional and holistic perspective. This includes leveraging georeferenced urban available GIS-based data sets, multi-scale models and co-simulation techniques, ready to integrate in district digital twins

• Test of methods and tools in the design, implementation, and assessment of main interventions in the demo sites: Large Scale Retrofitting actions and implementation of Citizen Energy Communities in CPCC.

• Integration of Virtual Reality /Augmented Reality engines and environments connected to results of assessment tools and/or live sensors data to achieve an effective communication to the different stakeholders of the CPCCs. In connection with the integrated strategy in Living Labs (WP3), Virtual Reality environments will be tested in activities to facilitate social innovation, promote education and training for sustainability.

Expected impact of WP2 is to prove that the use and adoption of simulation and assessment tools in a clear and established assessment framework are key aspects for effective and accelerated adoption of CPCC, by simplifying and helping decisions in integrated design processes, while connecting relevant stakeholders (policy makers, financing bodies, industry, regulatory bodies, etc) and citizens in a human-centric approach.

Description of work and role of partners

WP2 - Framework and tools for effective implementation and assessment of CPCC [Months: 1-48]
IREC, NTNU, ACE, CVUT, DTU, PROJECTZERO, EURAC, SINTEF, PALMA, IBAVI, UAS Utrecht, HOUSING EUROPE, Center Denmark, KARV, DTTN, OBF, AIGUASOL SAEST

Task 2.1 (T2.1). Innovation forum for WP2: M1-M48. Task leader: IREC; Participants PALMA, HU, OBF, NTNU, CVUT, DTTN, PZ, EURAC

The aim of this task is to support the implementation of the assessment framework of CPCC, as well as the community / district level assessment tools in the demo projects. The forum will act as a connection hub between technical partners, testing and validating innovation in WP2, and demo developers, to enhance the exploitation across the innovation clusters. Task 2.1 will ensure effective cooperation between the different innovation clusters in the demo projects, towards the aim of mutual learning and feedback loops between the demos and the WPs. The work will encompass innovation workshops between the demos and results will be reported and integrated as part of the innovations report (D1.4) in WP1. Task 2.2 (T2.2). Assessment framework for Climate Positive Circular Communities: M1- M48. Task leader: IREC; Participants: PALMA, IBAVI, NTNU, CVUT, Housing Europe, AIGUA, CVUT, EURAC, HU, ACE, KARV, PZ, OBF

Based on already existing works for Zero Emission Neighbourhoods, Sustainable Plus Energy Neighbourhoods, Positive Energy Districts & Cities, an extended assessment framework will be defined considering the multidimensional perspective to characterize the impact of CPCC. The main categories that will be considered in the CPCC framework are energy, environment, economy, well-being, social aspects, smartness and circularity, addressing aspects at both building and neighbourhood level.

Task 2.2 will form a common starting point for the ARV, bringing main stakeholders from demo-sites and expert partners in the consortium together to jointly prepare and define a clear framework with the specification of addressed Sustainable Development Goals SDGs, ambition levels, boundary conditions, & KPIs for CPCC. Specific KPIs and metrics to assess each thematic area will be proposed in the framework to support CPCC implementation along the life cycle, from design

through implementation and operation. Work will be strongly connected to WP8 where KPIs defined in Task 2.2 will be the basis of defining the specification and guidelines for monitoring, the impact of CPPC. This task will have its most intensive workload during the first year of the ARV project, but will follow the demo projects development to monitor how the framework is implemented and used in the demos. This will be done in yearly workshops and through follow-up questionnaires in cooperation with WP8. A preliminary version of the assessment framework will be presented in M6 of the project to demo developers to gather their feedback and refine a final version. A number of KPIs will be assessed in all the demos sites, while a set of additional ones will be demo dependent. Based on testing (WP8) and experience gained, WP2 will revise & improve the framework during the course of the ARV project. The continuous process will lead to a well-proven, validated & consistent framework at the end of the project.

Task 2.3 (T2.3). Use and testing tools for Large Scale Retrofitting actions in CPCC: M4 – M46. Task lead: IREC; Participants: PALMA, DTU, Center Denmark, NTNU
The aim of this task is to improve and adapt District Energy Simulation tools to effectively plan, design and analyse large scale retrofitting actions of the built environment and the impact at district level. The tools integrate different modelling strategies of the building stock and new constructions in a district, based on the use of building archetypes through different approaches such as white box detailed models; grey-box models, data driven models, etc and availability of data at urban scale, e.g. GIS-based data. Cooperation and coordination will be established with WP4 where BIM tools & Digital twins (archetypes & CityGML format) of specific buildings in the demo sites will be generated. Specific coordination actions for mutual learning will be established with Task 5.2 (WP5) where digital methods will be used in pre-manufacturing workflow. Methods and algorithms to calculate relevant KPIs based on the results of Task 2.2 will be integrated to provide techno-socio-economic outputs. Collaboration with WP8 will be established to incorporate findings of co-benefits analysis in renovation processes. The main objective of the use of these tools is to take informed decisions, and to showcase their usefulness to accelerate the renovation of building stock in cities. Use cases will be reported to facilitate the replicability in other environments at EU scale.

Subtask 2.3.1 Innovative methods and tools for Large-Scale Retrofitting actions in the demo of Palma de Mallorca:
Test of methods and tools for the techno-socio-economic evaluation and implementation of Public Private Partnership business models for Large-scale renovation in the Llevant Innovation District (area of La Soledat Sud). It will used as a test platform for the carbon footprint assessment of retrofitting of building stock in urban plans as established in the pioneer Climate Change and Energy Transition law of the Balearic Islands. The methodology will be tested hand-by-hand in all the steps of the renovation process from the initial planning steps to the analysis of operation and use after renovation.

Subtask 2.3.2 Innovative methods and tools for Large-Scale Retrofitting actions in the demo of Sønderborg:
Models of representative archetypes of the building stock in the district heating network will be established using different modelling approaches, i.e., using available heat meter data for data-driven or grey-box models and for any buildings without sufficient data white box models will be created. These building models will be integrated with district heating network model to identify buildings in which retrofitting has large impact on energy efficiency of the entire energy system. For the identified buildings, different retrofitting options will be studied to optimize cost-effectiveness.

Task 2.4 (T2.4). Use and testing tools for the implementation of Citizen Energy Communities in CPCC. M7 – M42. Task lead: IREC; Participants: PALMA, CVUT, AIGUA
The aim of this task is to integrate existing methods and tools to evaluate local RES generation in an urban environment using available free surface in public buildings and public spaces and to link with individual and aggregated energy consumption of participants in Citizen Energy Communities. Although Directive (EU) 2019/944 has enable the creation of Citizen Energy Communities (CEC), there is a lack of integrated tools to be used in the planning, selection, design, implementation and assessment of new Local and RES Energy Communities. Decision-making tools that integrate available urban scale information, models for local RES production and estimate energy consumption of potential participants in CEC will be tested in the framework of ARV. Method and tools should be able to calculate PV & BIPV generation, energy demand of the community and to be adapted to local regulation context & different governance aspects and financial models. Methods and tools will be tested and validated in real use environments in the demo projects to evaluate the energy and economic aspects of different business models (WP9) of the energy flexibility strategies (WP7) leading to optimized economic & environmental aspects and the engagement of citizens in the area as participants in CEC.

Subtask 2.4.1 Innovative methods and tools for CEC implementation in the demo of Palma de Mallorca:
Use of Tool for the techno-socio-economic assessment of implementing CEC and private crowd-funded innovative mechanisms to generate Renewable energy in available public roofs in the area e.g., schools & other public buildings

Subtask 2.4.2 Innovative methods and tools for CEC implementation in the demo of Karvina:

CVUT will collaborate with the municipality of Karvina that is working on Positive Energy District framework. Performance of a solar potential study of the municipality-owned building using 3D modelling in Rhino with Ladybug Tools & Radiance for more precise analyses. The study will include economic & technical parameters with visualisations.

Task 2.5 (T2.5) Virtual Visualization Environments for training of planners and citizen awareness: M4 – M48. Task lead: SINTEF; Participants: IREC, PALMA, OBF
The objective of this task is to explore, integrate and use a diversity of 3D and/or visualization techniques of Virtual Reality (VR) and/or Augmented Reality (AR) for the results use cases in Task 2.3 and Task 2.4. The aim is to better communicate results of different scenarios analysis to different types of stakeholders and facilitate citizen engagement, As the development of VR and AR applications can be targeted toward several distinct stakeholders, such as city planners &policy makers to school children & end-users, different user groups & external stakeholders will be identified. Decision on technical aspect of the application development will be made to best achieve the dissemination goals for each user/stakeholder group. This includes: (1) defining if a VR or AR approach for the specific group/goal, and if desktop compatibility are required; (2) defining & design locomotion method in VR world; (3) define interaction design; (4) define & design user guidance approach for navigation through the virtual model or physical world based on dissemination goals and (5) define & design data visualisation of renovation results and any live sensor streams based on dissemination goals. The design and implementation will imply a user-centric approach in a living-lab setting. VR/AR environments are planned as an integral part of the overall methodology of Living Labs LLs (Task 3.2) and will be applied in suitable demos/contexts (Task 3.3). Implementation of AR/VR applications will be carried out in connection with activities of Task 3.4. As format & availability of BIM models, laser scans, digital twins, in addition to any available live sensor data streams, will frame the technical possibilities and limitations for the development of the applications. This task is connected closely with WP5, Task 5.2 and Tasks 2.3 and 2.4.

Subtask 2.5.1 Innovative AR/VR Environment in the demo of Palma de Mallorca.
3D Virtual Reality Environment / Digital Twin of the Llevant Innovation District Innovation Llevant by means of integration with game engine Unreal to create interactive visualization &experiences based on 3D city data in connection with Living Lab activities in WP3. Connection with data and results of Task 2.3 &Task 2.4 in Palma

Subtask 2.5.2 Innovative AR/VR Environment in the demo of Oslo.
Use of AR/VR tools and environments in connection with Living Lab activities in WP3. The use of such tools will ensure the 1) integration of the different stakeholders involved in the development of the Oslo demo, and 2) will simplify the planning of CPPCs.

Participation per Partner

Partner number and short name	WP2 effort
1 - NTNU	9.00
2 - ACE	1.00
3 - CVUT	6.50
4 - DTU	16.00
7 - PROJECTZERO	3.00
8 - EURAC	3.00
9 - SINTEF	12.00
10 - PALMA	47.00
11 - IBAVI	3.00
12 - IREC	67.00
14 - UAS Utrecht	3.00
15 - HOUSING EUROPE	1.00
17 - Center Denmark	4.00

Partner number and short name	WP2 effort
28 - KARV	2.00
30 - DTTN	3.50
33 - OBF	7.00
35 - AIGUASOL SAEST	9.50
Total	197.50

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D2.1	Assessment framework for CPCC	12 - IREC	Report	Public	9
D2.2	Description of methods and tools for Large-Scale Retrofitting in CPCC	4 - DTU	Report	Confidential, only for members of the consortium (including the Commission Services)	18
D2.3	Description of methods and tools for CEC in CPCC	12 - IREC	Report	Confidential, only for members of the consortium (including the Commission Services)	15
D2.4	Application of tools for Large-Scale Retrofitting actions. Uses cases and guidelines for replicability	12 - IREC	Report	Public	46
D2.5	Application of tools for implementation of Citizen Energy Communities. Uses cases and guidelines for replicability	12 - IREC	Report	Public	42
D2.6	Demos of Virtual Reality Environments	9 - SINTEF	Demonstrator	Public	36
D2.7	Description and lessons learnt from training & awareness sessions using Virtual Environments	9 - SINTEF	Report	Public	48
D2.8	Assessment framework for CPCC. Updated version	12 - IREC	Report	Public	48

Description of deliverables

D2.1 : Assessment framework for CPCC [9]

assessment framework will be defined considering the multidimensional perspective to characterize the impact of CPCC. The main categories that will be considered in the CPCC framework are energy, environment, economy, well-being, social aspects, smartness and circularity, addressing aspects at both building and neighbourhood level.

D2.2 : Description of methods and tools for Large-Scale Retrofitting in CPCC [18]

This deliverable will report on how to improve and adapt District Energy Simulation tools to effectively plan, design and analyse large scale retrofitting actions of the built environment and the impact at district level

D2.3 : Description of methods and tools for CEC in CPCC [15]

How to improve and adapt District Energy Simulation tools to effectively plan, design and analyse large scale retrofitting actions of the built environment and the impact at district level. The tools integrate different modelling strategies of the building stock and new constructions in a district, based on the use of building archetypes through different approaches

D2.4 : Application of tools for Large-Scale Retrofitting actions. Uses cases and guidelines for replicability [46]

The application of the methodology as presented in D2.3. Reporting in the form of guidelines for replicability

D2.5 : Application of tools for implementation of Citizen Energy Communities. Uses cases and guidelines for replicability [42]

Deliverable presenting experiences with integrating existing methods and tools to evaluate local RES generation in an urban environment using available free surface in public buildings and public spaces and to link with individual and aggregated energy consumption of participants in Citizen Energy Communities

D2.6 : Demos of Virtual Reality Environments [36]

integrate and use a diversity of 3D and/or visualization techniques of Virtual Reality (VR) and/or Augmented Reality (AR) for the results use cases in Task 2.3 and Task 2.4. The aim is to better communicate results of different scenarios analysis to different types of stakeholders and facilitate citizen engagement

D2.7 : Description and lessons learnt from training & awareness sessions using Virtual Environments [48]

3D Virtual Reality Environment / Digital Twin will be tested and Palma Demo and) integration of the different stakeholders involved in the development of the Oslo demo. This deliverable will focus on how to simplify the planning of CPPCs

D2.8 : Assessment framework for CPCC. Updated version [48]

See deliverable 2.1 description

Schedule of relevant Milestones

Milestone number[18]	**Milestone title**	**Lead beneficiary**	**Due Date (in months)**	**Means of verification**
MS2	ARV Assessment framework	12 - IREC	9	Assessment framework defined
MS3	Implementation of tools	12 - IREC	15	Implementation of tools for Large Scale Retrofitting actions started
MS4	Virtual Reality Environments	12 - IREC	36	Virtual Reality Environments used and implemented

Work package number [9]	WP3	Lead beneficiary [10]	9 - SINTEF
Work package title	Community engagement, environment, and well-being		
Start month	1	End month	48

Objectives

The objective of WP3 is to promote active citizen engagement in processes of sustainable neighbourhood transformation. It is imperative to channel citizens' competences and experiences, ensuring their active engagement in producing plans for buildings and neighbourhoods, that reduce energy demand and enhance energy efficient behaviour. Active and explicit citizen engagement and feedback are often a missing link towards sustainable neighbourhood transformation. Living labs (LL) approaches are known for engaging with multi-stakeholder groups in real-life contexts. A LL is an innovation environment where new solutions are designed & tested alongside users, bridging the gap between the social and technical context, applying a user-centred multi-method approach. ARV LLs will be established involving different perspectives on a citizen's role - such as citizens as building occupants, citizens as residents of CPCC, citizens as green ambassadors.WP3 will focus on enhancing citizens` engagement methods by paying attention to time & cost intensity, reducing under-representation as well as understanding tacit and hidden needs of citizens. The outcome of increased citizens` engagement is expected to have a positive impact on their level of satisfaction and well-being and ensure that energy efficient behaviour is firmly established as part of everyday life.

WP3 includes the following objectives:
• Plan and develop an overall methodology for demos to set up and run community activities and Living Labs.
• The WP targets occupants of transformation projects of all ages but will have a special focus on engaging and empowering young citizens as representatives of the future generations, involving schools at demo sites.
• Offer education and training about reducing energy demand and promoting energy efficient behaviour.
• Establish LLs with two thematic foci: social innovation & energy transition.
• Engage citizens in different roles and at different stages of the decision-making processes.
• Collect qualitative & quantitative data about the LL approaches & relevant citizen engagement tools & methods.
• Capture feedback and learnings from CPCC Living Labs. Identify and classify relevant citizen engagement methods, tools and processes based on time and cost intensity, level of inclusivity, and the potential to uncover tacit levels of experience and latent needs of occupants' preferred usage of the building and neighbourhood.
• Assess the barriers and drivers for citizen engagement in renovation processes.
• Demonstrate the potential for replication and up-scaling of the citizen engagement tools for future projects.

Description of work and role of partners

WP3 - Community engagement, environment, and well-being [Months: 1-48]
SINTEF, NTNU, ACE, CVUT, PROJECTZERO, EURAC, PALMA, IREC, MET, UAS Utrecht, HOUSING EUROPE, Center Denmark, SAB, GDFA, BOEX, CITY OF UTRECHT, Mitros, KARV, DOL, DTTN, OBF
Task3.1 (T3.1) Innovation forum for WP3. M1-48. Task lead: SINTEF, Partners: CVUT, PALMA, IREC, KARV, OBF, HU, EURAC, NTNU, PZ.
The aim of this task is to coordinate the development of concise and affordable citizen engagement tools and guidelines in conjunction with the demo projects and other WPs. T3.1 will ensure effective cooperation between the different innovation clusters in the demo projects, securing the aim of mutual learning and feedback loops between the demos and the WPs. The work will encompass innovation workshops between the demos within the WP and ensure links between the demos. Results will be reported and integrated as part of the innovations report (D1.4) in WP1

Task 3.2 (T3.2) Plan and develop overall methodology for community activities and Living Labs. M1-12. Task lead: SINTEF, Partners: CVUT, IREC, PALMA, EURAC, MET, SAB, City of Utrecht, Housing Europe, Center Denmark, NTNU, DTTN.
The aim of this task is to develop the overall methodology for CPCC Living Labs focusing on social renovation and energy transition. T3.2 will keep the methods and tools open, flexible, and diverse but with a clear focus on actions for enhancing the local user/citizen engagement, awareness raising and learning. Methods and tools relevant for the development of the overall methodology:
• Physical HUB in districts for organizing participatory processes and supplying general information.
• Co-creation workshops (at least one per demo) addressing different stakeholder segments such as elderly, families, energy poverty affected people, etc.

• Renovation surveys (pre and post) (with WP8 & Housing Europe)
• Positive energy champions, competitions, Green ambassadors, Influencers
• Citizen diaries and blogs/vlogs (ACE)
• VR visualization of different renovation scenarios as basis for need assessment and co-creation (with Task 2.5)
• Idea sharing session, world café method, board games, or similar (physical or/and online)
• Mental mapping engaging with and illustrating citizen knowledge, preferences, requirements, and ideas
• Testing of energy related prototype solutions, feedback, and iteration
• Home energy monitoring systems and energy coaching of occupants.
An important aspect is the Corona-proof level of certain measures. A hybrid approach using both digital communication platforms and tools, as well as approaches requiring physical encounters are planned. A stakeholder mapping is performed as basis for the planning community activities in the Living Labs.

Task 3.3 (T3.3) Implementation of community activities and Living Labs. M6-36. Task lead: PALMA, Partners: SINTEF, City of Utrecht, IREC, CVUT, ACE, GDFA, PZ, NTNU, MET, SAB, BOEX, MITROS, KARV, OBF, DTTN, EURAC, Center Denmark.
The aim of this task is to adapt the Living Labs methodology developed in 3.2 to the respective demo`s local, socio-economic, and cultural context. While Social Renovation LLs will focus on engaging the community before renovation, during design process and on innovative financing solutions, Energy Transition LLs will establish a physical space (HUB) and focus on new solutions regarding energy transition and circularity (storage, electrical vehicles, renewables, reuse, etc.), testing and iteration of innovative and prototype solutions, as well as on energy coaching of occupants. T3.3 will also work closely with Task 10.4.1 to coordinate the necessary training of green ambassadors and to prepare adequate communication materials to the target group. Each demo will conduct series of co-creation workshops and community activities related to their innovations envisioned. Innovations relating to the thematic topics addressed by the LLs will be:

Subtask 3.3.1 Innovations in Demo Oslo (OBF, SINTEF)
• Energy transition: The school is at the core of the Norwegian demo and will serve as a HUB for involvement, engagement, and teaching pupils about energy transition technologies and sustainability. The building will include a demo-space for citizen's and children's education with a focus on new technologies like storage, electrical vehicles, renewables, etc. Activities such as green ambassadors and influencers promoting energy efficient behaviour and circular solutions to their peers, participatory methods where play, engage, inform, and educating young people and through them also their parents, are envisioned here. Such activities will be developed and implemented with the help of ICT tools (AR/VR environments, Task 2.5) and will ensure a smooth process of integrating the local community in the district development.

Subtask 3.3.2 Innovations in Demo Sønderborg (PZ)
• Energy transition: Involvement of tenants and citizens in new developed smart home control system. The energy saving results of the planned innovative energy technologies depend significantly on the daily energy behaviour of the tenants in the demo buildings. Therefore, information and training activities are planned to secure, that the tenants and the maintenance staff receive sufficient information on the new smart control systems and learn to operate the new energy saving appliances. Green Ambassadors will be appointed, one ambassador for each of the 19 buildings, to be trained to assist their neighbours and colleagues.

Subtask 3.3.3 Innovations in Demo Utrecht (City of Utrecht, MITROS, BOEX)
• Social renovation: Before the actual renovation, the two Utrecht housing corporations will engage with tenants to explore and deal with social challenges (e.g., debt, poverty, health issues) and identify opportunities to create a more engaged community. This subtask will focus on the post-renovation follow-up of the social renovation activities. The expected impact is a greater degree of citizen empowerment, and a greater degree of support for the renovation, as well as improvements to both, the social and physical living environment.
• The City of Utrecht is running a human capital program called 'Bouw=Wouw!', focusing on attracting young people of the district to work in the construction and technology sector. The two housing corporations & involved building value chain companies will create job and internship places related to the implementation and maintenance of ARV demonstration activities. The expected impacts are lessons, internships, job creation, involving and empowering of young people into ambitious building and renovation projects.
• Energy transition: Predictions about reductions in energy bills for residents is often used to promote energy efficient retrofitting programs in social housing corporations. This, however, is highly dependent on the future behaviour of residents. Energy coaching of residents is a key action to support them in the use of their renovated homes. This action builds upon the energy coaching program implemented in the Positive Energy Building retrofit (executed before the start of ARV) and is complemented with real-time monitoring data of energy usage (through a Home energy management

system HEMS). In this social action some residents are engaged and educated to act as local change agents coaching their fellow residents.
• Physical Hub in district: in 2021 the construction of a circular pavilion in the district is expected. This circular pavilion will support community engagement & development with training, promotion & dissemination of the district energy transition and renovation programs. This hub will be used as the location in the district where the co-creation activities related to social renovation, Bouw=Wouw! & energy coaching will take place.

Subtask 3.3.4 Innovations in Demo Karviná, (KARV; CVUT)
• Energy transition: Karviná Mizerov Health Centre as a living lab for the City of Karviná & other municipalities within Czech Republic. The LL will educate citizens such as students, creating energy & resource efficient neighbourhoods that increase citizen and stakeholder awareness and engagement. Promote user-friendly innovative & sustainable building solution through education and other communicational channels, implement user-centred design of building systems. Support a creation of long-term stakeholder ecosystems concerned with energetic transformation and the role of individual projects in driving broader organizational and procedural changes.
• Community engagement actions with young people in the school (16-19 years), exploring co-creation methods. Change agents promoting sustainability to their peers, parents, and the community.

Subtask 3.3.5 Innovations in Demo Palma (Municipality City of Palma, IREC, MET)
• Social renovation: Private Public Partnership one-stop shop mechanism for the large-scale renovation of urban areas, including participative strategies that involve district residents in the LL & the planning process before the renovation starts.
• Energy transition: Centre for Energy Transition TE21 will act as a HUB, and exhibition space for citizen engagement towards the energy transition in urban spaces and new sustainable technologies. Linked to local energy communities around schools, which will enable a set of training actions and awareness raising campaigns with special attention to engagement with the younger generations. Activities will combine use of digital tools, VR visualization (task 2.5), testing of prototype solutions and open visits to living labs. New buildings will be used as LLs where tailored actions to residents will be designed to increase awareness of energy use and energy transition solutions.
• CEC – Citizen Energy Community, as private crowd-funded / innovative mechanism to generate renewable energy in available public roofs in the area e.g., schools, public buildings. Tailored workshops, energy cafés & engagement actions will be designed for direct involvement of district residents and families in the CEC.

Subtask 3.3.6 Innovations in Demo Trento (DTTN, EURAC, DOL)
• Energy transition: Implementation of a local energy community linked to geothermal structure using former highway tunnels as an art and exhibition gallery, while permitting extraction of geothermal energy. Engagement strategies will be applied for involvement of citizens when connecting to geothermal energy, so that lower tariffs can be attained.
• Social renovation: One-stop shop concept linked to innovative financing incentives to engage a critical mass of the community to advance refurbishment (timber-based facades) on a district scale. Engagement strategies will be applied for involvement of citizens to assess feasibility of community financing and to renovate the district from an urban point of view without compromising aesthetics or architectural qualities

Task 3.4 (T3.4) Monitoring and reporting of CPCC Living Labs in demo sites. M8-48. Task lead: CVUT, Partners: SINTEF, City of Utrecht, PALMA, IREC, ACE, NTNU, MET, SAB, BOEX, MITROS, KARV, OBF, Center Denmark, Housing Europe, DTTN, EURAC, DOL
The aim of this task is to monitor and report the developments in the LLs as well as to document the barriers & drivers encountered with the applied engagement methods. This task will require involvement with respective demo partners to monitor progress. T3.4 will also work with WP8 on the multiple benefits analysis and the ex-ante, interim, ex-post survey evaluation, as well as with WP10 to coordinate the necessary reporting mechanisms relevant for CPCC Living Labs.
• Document drivers and barriers related to the social innovation approach experimented with in each demo.
• Collect qualitative and quantitative data and results on each of the LLs.
• Background data: Understanding the socio-cultural-economic constitution of the demo communities, as well as interests and needs of the stakeholders involved.

Task 3.5 (T3.5) Feedback and learning to develop a new strategy for citizen engagement. M16-48. Task lead: SINTEF, Partners: CVUT, Housing Europe, PALMA, IREC, MET, ACE, SAB, KARV, OBF, Center Denmark, EURAC, DTTN
The aim of this task is to enhance the innovative social engagement approaches explored, based on the analyses of the barriers and drivers, their effectiveness, costs, and learning potential. The goal is to promote replicable, feasible tools across deep renovation projects in Europe to fully reap the potential of the upcoming European Renovation Wave. The outcome of increased citizen engagement will impact the level of satisfaction and well-being as well as anchoring energy efficient behaviours as an accepted part of everyday life from an early stage. Task 3.5 will require involvement of all

demo partners to analyse the feedback and learnings from Living Labs, and to channel the learnings into a guidance handbook for future projects.
• Analyse costs, extent of inclusiveness and the potential to draw out hidden needs of citizens, using a Citizen Design Science approach. (while WP2 and WP8 focus on the overall framework and evaluation for CPCCs)
• Based on mapping and surveys in cooperation with WP 8, evaluate the change in satisfaction, perceived well-being, and impact of measures on energy demand.
• Enhance and secure relevant citizen engagement tools and methods and deliver a digital guidance handbook to future projects beyond ARV (with WP10).

Participation per Partner

Partner number and short name	WP3 effort
1 - NTNU	12.00
2 - ACE	4.00
3 - CVUT	18.00
7 - PROJECTZERO	3.00
8 - EURAC	4.00
9 - SINTEF	37.00
10 - PALMA	50.00
12 - IREC	16.00
13 - MET	8.00
14 - UAS Utrecht	1.00
15 - HOUSING EUROPE	6.00
17 - Center Denmark	4.00
18 - SAB	3.00
19 - GDFA	1.00
20 - BOEX	5.00
23 - CITY OF UTRECHT	11.00
27 - Mitros	5.00
28 - KARV	7.00
29 - DOL	1.00
30 - DTTN	6.00
33 - OBF	11.00
Total	213.00

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D3.1	Plan and overall methodology design	9 - SINTEF	Demonstrator	Public	12

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
	for establishing CPCC Living Labs, including stakeholder mapping				
D3.2	Implementation plan of CPCC Living Labs per demo site, demonstration of LL	10 - PALMA	Demonstrator	Public	13
D3.3	CPCC Living Labs reports	3 - CVUT	Report	Public	24
D3.4	Analysis of citizen engagement tools and processes using a citizen science approach	9 - SINTEF	Report	Public	40
D3.5	Community-scale citizen engagement strategy and tools for the renovation wave	9 - SINTEF	Websites, patents filing, etc.	Public	48

Description of deliverables

D3.1 : Plan and overall methodology design for establishing CPCC Living Labs, including stakeholder mapping [12]

Plan for overall methodology for CPCC Living Labs focusing on social renovation and energy transition. the methods and tools open, flexible, and diverse but with a clear focus on actions for enhancing the local user/citizen engagement, awareness raising and learning. Methods and tools relevant for the development of the overall methodology

D3.2 : Implementation plan of CPCC Living Labs per demo site, demonstration of LL [13]

A physical space (HUB) and focus on new solutions regarding energy transition and circularity (storage, electrical vehicles, renewables, reuse, etc.), testing and iteration of innovative and prototype solutions, as well as on energy coaching of occupants

D3.3 : CPCC Living Labs reports [24]

Each demo will conduct series of co-creation workshops and community activities related to their innovations envisioned. The aim is to monitor and report the developments in the LLs as well as to document the barriers & drivers encountered with the applied engagement methods. This task will require involvement with respective demo partners to monitor progress Revisions M36, M48

D3.4 : Analysis of citizen engagement tools and processes using a citizen science approach [40]

analyses of the barriers and drivers, their effectiveness, costs, and learning potential. The goal is to promote replicable, feasible tools across deep renovation projects in Europe to fully reap the potential of the upcoming European Renovation Wave

D3.5 : Community-scale citizen engagement strategy and tools for the renovation wave [48]

As for deliverable "Analysis of citizen engagement tools and processes using a citizen science approach ", this will result in a guidance handbook for future projects

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS5	Overall methodology in T3.2	9 - SINTEF	9	Methodology corresponding with the deliverable completed
MS6	LL reports	9 - SINTEF	24	First LL reports completed

Work package number [9]	WP4	Lead beneficiary [10]	1 - NTNU
Work package title	Sustainable Building (re) Design		
Start month	1	End month	40

Objectives

WP4 deals with the (re) design of new and retrofitting of existing buildings as zero-emission positive energy-buildings in sustainable climate positive circular communities (CPCC). The main objectives are to (i) reduce the embodied energy & emissions, (ii) to increase the energy efficiency, and to (iii) match sustainability with aesthetics and quality of life, by integrated circular design processes. The activities in WP4 are divided into six main tasks that address design strategies of buildings integrated in CPCCs.
The ARV integrated circular design includes adaptation to local climate conditions, deep renovation with minimum disruption for buildings occupants, significant reduction of CO2 emissions, high energy efficiency with active/passive solutions, high focus on circularity i.e. reduce, re-use & recycle of materials, elements & modules, add value, and resource & energy efficient integration of PVs i.e. BIPV & BAPV, while satisfying occupant well-being and architectural considerations. The design considerations will address the scalability, flexibility, durability, maintainability, fire &seismic safety of the buildings. The circular positive energy buildings & neighbourhoods will be embedded in the spatial, economic, technical, environmental, regulatory and social context of the demo sites. The ultimate goal of WP4 is integrated circular design that cultivates the aesthetics and improves amenities for the building's occupants while improving the performance of the buildings in line with the new European Bauhaus strategy.

Description of work and role of partners

WP4 - Sustainable Building (re) Design [Months: 1-40]
NTNU, ACE, CVUT, PROJECTZERO, EURAC, SINTEF, PALMA, IBAVI, IREC, UAS Utrecht, BOEX, Rc Panels B.V., UU, BOSGROEP, MEX, KARV, DTTN, UNITN, POLITO, OBF, AIGUASOL SAEST
Task 4.1. Innovation forum for WP4. M1-M40. Task leader: NTNU, Participants: OBF SINTEF, HU, UU, IREC, PALMA, CVUT, KARV, EURAC, DTTN, PZ, ACE
The aim of this task is to support the implementation of design innovations in the demo projects, and to enhance the exploitation across the innovation clusters. The forum will act as an incubator for co-creation of socially & aesthetically promising green, energy positive and circular buildings/neighbourhoods with the utilization of digital design solutions, modules & technologies, for both new buildings and renovation projects. T4.1 will ensure effective cooperation between the different innovation clusters in the demo projects, towards the aim of mutual learning and feedback loops between the demos and the WPs. The work will encompass innovation workshops on Integrated Circular Design between the demos within the WP and ensure the link to the other WPs.
A key output of T4.1 will be the D4.6 on the design guidelines of ARV real-life demo projects for achieving sustainable positive energy buildings at the neighbourhood scale. The demos represent different ways of realizing CPCC including both new construction & renovation in different European contexts, climates, cultures & markets. Moreover, results will be reported and integrated as part of the innovations report (D1.4) in WP1.

Task 4.2. Integrated Circular Design of the Demo Project in Oslo. M1-M36. Task leader: SINTEF, Participants: NTNU, OBF
The main goal is the integrated circular design & evaluation of different concepts for zero-emission and positive energy buildings in a climate positive energy neighbourhood in Oslo. In T4.2, we will analyse different scenarios with combinations of state-of-the-art materials, components, technologies & smart control systems with regards to the ARV KPIs as defined in WP2. The following will be of focus for the Demo project in Oslo:
• Digital design for optimum life cycle performance. Design of new positive energy building with 50% reduced GHG emissions from materials. BIM & Digital Twins will be used to document and optimize the performance throughout the design process. The environmental and economic impact of different strategies, considering parameters such as LCA, LCC, and energy needs, but also cultural & social aspects, will be assessed. Multiuse design strategies of buildings will be part of the design strategy to engage and provide social meeting areas for the local community.
• Climate adapted design using an innovative open surface water solution. This is the starting point for the design of the school project. The concept is a green & different schoolyard where vegetation and surface water management are used as a resource to create good & varied outdoor spaces.
• Effective application of low-carbon concrete, achieving 40% lower embodied emissions than standard concrete.

• Circular renovation strategies, where most of the walls and windows in the old factory will be reused & upgraded to new energy performance standards. Mapping of locally available building materials & components from existing & going-to-be demolished buildings. Design strategies for use of reused materials & components in relation to technical and aesthetical constraints.
• High energy ambition renovation design of cultural heritage building using a circular renovation strategy. Some of the LCI inventory will be reused in the other projects.
• Novel heating/cooling system using low-temperature thermal heating & high temperature thermal cooling using the same infrastructure coupled with ground source heat pump (district heating used for peaks loads).
• Architecturally integrated PV system design for façades using novel, angular & coloured modules with high degree of standardized module sizes & fastening solutions, significantly reducing the time & costs of applying such system. Design strategies focusing on panel-to-panel and panel-to building-surface connection for easy installation/replacement of components and replication in other building/contexts.
• Integrated design of green solutions where vegetation & open surface water handling are resources to create attractive outdoor spaces that are integrated with the adjacent areas. Integrated strategies of greenery types focusing on the potential benefits on local climate i.e. reduction of heat island effect, abatement of pollutants.

Task 4.3. Integrated Circular Design of the Demo Project in Utrecht. M1-M36. Task leader: HU, Participants: UU, BOEX, RCP, Bos Groep, MEX.
The demo actions in Utrecht focus on resource efficient, systematic retrofitting of four mid residential apartment buildings from the 1960s into Positive Energy Buildings and 6 residential apartment buildings from into Nearly Zero Emission Energy Buildings (with the intent of building owners to move in the project towards Positive Energy Buildings using ARV innovations) embedded in a green neighbourhood. The innovations & research will assess the current HeMuBo retrofitting approach (applied to 6 buildings reaching Nearly Zero Emission Building targets) and the current Inside-Out 1.0 approach (previously applied in one nationally funded project ending in 2021) and develop result in the Inside-Out concept 2.0. The integrated design will include specific building components that result in 30% cost reduction compared to traditional systems and will reduce GHGs substantially. To achieve these goals the re-design will focus on roof, façade, and balcony systems by exploring the following subjects

• The retrofit solutions will be designed for industrialization and will be scalable to serve different post war building typologies, such as 4 story, 6 story &10 story high-rise and other façade characteristics, through modular & adaptable roof, façade & balcony sections.
- For four mid-rise residential apartment buildings (type Bredero-4) the Inside-Out 2.0 retrofit solution will be designed and tailor made.
- For four mid-rise residential apartment buildings (type Intervam-4) and two high-rise residential apartment buildings (type Intervam-10) the HeMuBo retrofit solution, that is in pre-planning in 2022, will be assessed and advancements to this retrofit solution will be designed based on Inside-Out components. The expected improvements relate to increased energy performance from NZEB to PEB and lower retrofitting time and costs through the application Inside-Out components (energy and HVAC installations facades using sandwich panels) produced off-site and installed plug-and-play on-site and the application of additional BIPV / BAPV. The decision to implement these changes depend on outcomes of this task and external factors, such as existing contractual agreements between Bo-Ex, Mitros and their contractors (outside of ARV consortium) and the required investment.
• Modular installation design which allows different types of heating & ventilation per dwelling related to the needs of the occupant &location.
• Renovation concepts to create the architectural diversity of appearance, adapted to the context. An important part is the architectural connection of design in post-war renovations and the design of the adaptable retrofitting solution.
• Design for standardization and flexibility of the interfaces connecting modules e.g., detailing. Including flexible façade fixing that gains a higher adaptation potential
• Design for infrastructure compactness, at the outside of the building & integrated in the roof, balcony & façade components, including connection of PV modules for optimal energy harvesting.
• Integration of material data storage in a resource track system i.e. materials passport.
• Design for minimal disruption: Users will have the choice to sleep in their apartments during the renovation.
Design for Integrated Plug & Play installation solutions to link multiple facades (including integrated energy a/o ventilation installations) enhance modularity and reduce the total cost of ownership.
• Demonstration of architectural and aesthetic plug-and-play integration of BIPV/BAPV solutions:
- Analysis of current and new solutions of integration of PV in building components. Innovative BIPV solutions will be assessed on aesthetics and energy performance, and on feasibility for prefabrication, industrialization, integration & cost reduction, with varying features such as shape and colour

- Definition & designing of BIPV in pre-manufacturing process aiming to integrate PV in factory, leading to reduction in construction time and construction cost. Link with WP5.4
- Definition and designing of plug-n-play BIPV, generating solutions for connecting cabling of PV-panels and monitoring equipment between building components

Task 4.4. Integrated Circular Design of the Demo Project in Palma. M1-M36. Task leader: IREC, Participants: PALMA, IBAVI, AIGUA.
The main goal is the integrated circular design & evaluation of different concepts for zero-emission and positive energy buildings within sustainable climate positive circular districts in Palma. The key actions in the district can be summarized as:
• Large scale retrofitting action in La Soledat Sud of 250 private dwellings by means of a novel Public Private Partnership mechanism
• New positive energy social housing building with 36 apartments
• Energy Renovation of a flagship heritage protected building from the 70's modern movement
The design of new highly energy efficient & positive energy social housing buildings project will focus on the use of innovative local materials. Integrated Circular Design Process based on cross-ventilation strategies, use of vernacular shading systems, high inertia & green-housed based spaces, with high architectural quality. Integrated Design will consider hybrid ventilation solutions driven by IAQ metrics both for cooling and heating e.g. use of east/west oriented greenhouses. In order to reduce embodied emissions, solutions based on the recovery of eco-friendly local artisan industries with km 0 raw materials will be tested. The main solutions to be assessed in the project will be:
• Neptune grass thermal insulation, a nature-based solution that will be performance at the demo building, which can be applied only on those places where the Posidonia Oceanica is a local resource.
• "Pedra de Marés", Marés local stone used in vernacular architecture and extracted from local & km0 sources.
• Certified timber for floors and shading elements
Cost-optimal solutions for Large-Scale retrofitting process aiming to achieve a 50% reduction in the energy demand and a significant improvement in the thermal comfort conditions. A catalogue of technical solutions for replicability will be derived. The range of year of construction of the buildings to be renovated is 1920 – 1980.
Integrated energy design for the retrofitting of protected and iconic heritage office building from the Modern Movement (1970). Pre-testing of several last generation of BIPV solutions i.e. cladding-based systems & semi-transparent PV glass, and modelling of the impact in the integrated design. Design the best solution for high glazed office buildings regarding aesthetics aspects, impact of the heating & cooling loads and energy production. The listed building is characterized for a glass curtain wall & integrated design solution for the envelope is a necessity to reduce the energy demand to 50% compared with the pre-retrofit status. Several HVAC solutions and strategies will be analysed & designed adapted to the local climate by means of integrated design linked with the envelope solutions in the façades i.e. smart skin solutions adaptive to season conditions

Task 4.5. Integrated Circular Design of Demo Project in Karviná. M1-M36. Subtask leader: CVUT, Participants: KARV.
The Czech demo case encompasses the renovation of Karviná Mizerov Health Centre in the city of Karviná. The following will be of focus for the Demo project in Karviná:
• Become positive energy building, achieved by passive house standard & renewable energy generation
• Digital design & 3D simulations, i.e. digital twins, for solar irradiation potential & design of optimum shading devices
• Small-scale pilots of climate resilient solutions – use of heat pumps for summer cooling
• LCA of HVAC systems with focus on carbon footprint
• BIPV, BAPV, PV-T, solar thermal, heat pumps, active shading systems with weather forecast, innovative cooling solutions. BIPV integrated into ventilated facades
• Green roof for mitigation of heat island effect, and rainwater management e.g. rain gardens, greenery

Task 4.6. Integrated Circular Design of Demo Project in Trento. M1-M36. Subtask leader: UNITN, Participants: DTTN, POLITO, EURAC.
The demo project in Trento covers both, new construction & renovation of existing buildings & structures. The ambition is zero emission & plus energy level and a high level of energy efficiency. The following will be of focus in Trento:
• Development of a catalogue of Integrated Circular Design solutions for refurbishment of buildings with 50% of energy reduction and positive energy new construction, utilizing building envelopes with active (BAPV/BIPV) and passive elements.
• Nature based solutions integration. Inform Industry 4.0 via digital surveys. Comfort improvement (psychological, physiological). One-stop-shop co-creation approach enabling diffusion of design technology: replicability of solutions. Fire and seismic resistance co-benefits of timber-based construction/refurbishment.
• Timber based (new) construction, refurbishment and superelevation scenarios (local & circular value chain). Simplified Life cycle inventory. Circular economy-based design process. Land uses reduction via superelevation

(scenario development) - New constructions, renovation of existing buildings & superelevation - additional (new) volumes on existing buildings.
• Natural and mechanical ventilation concept for climate responsive buildings.
• Heat pumps integration for heating and cooling (connection to NSGE – tunnels, foundations, roads). Passive heating systems integration in buildings envelopes. Active thermal mass, heat storage. Active/Passive systems integration via Building Automation Systems. Architectural and Aesthetic integration of BIPV/BAPV solutions. Materials selection. Integration between PV, Solar Thermal and CMV systems.
• Analysis of existing models for scenarios elaboration to inform hybrid Energy/Nature-based solutions on building/ urban surfaces. Innovative materials (new and waste/by-products).
• Architectural and Aesthetic integration of BIPV/BAPV solutions. Materials selection. Integration between PV, Solar Thermal and CMV systems.
- Definition of BIPV solutions with high levels of adaptability able to ensure performance, reliability, durability and replicability in a cost competitive way and a certain reduction of construction phases' times.
- Analysis of new solutions of energy integration in order to define the main features of BIPV components as a sustainable building's skin with high standards of solutions about geometrical modularity, levels of prefabrication, construction technologies, material surfaces, chromatic and material features of PV cells, dissimulation/ mimicry of the elements, etc.
- Identification of latest PV and PVT (PV + solar collectors) components in the European market in order to define new construction elements combining good aesthetics, multi-functionality, cost-effectiveness, mass customization, etc.
- Definition of a designing and manufacturing system for high adaptability of PV/PVT components to different contexts – building retrofit, new construction, etc – with high standards of efficient fabrication and installation, high levels of efficiency in energy production and thermal behaviour, environmental and economic sustainability

Participation per Partner

Partner number and short name	WP4 effort
1 - NTNU	25.50
2 - ACE	2.00
3 - CVUT	18.00
7 - PROJECTZERO	1.00
8 - EURAC	3.00
9 - SINTEF	14.00
10 - PALMA	22.00
11 - IBAVI	16.00
12 - IREC	23.00
14 - UAS Utrecht	19.00
20 - BOEX	1.00
21 - Rc Panels B.V.	13.00
22 - UU	5.00
24 - BOSGROEP	13.00
26 - MEX	6.00
28 - KARV	4.00
30 - DTTN	4.00
Armalam	3.00
X-LAM DOLOMITI	0.50
FANTI LEGNAMI	0.50

Partner number and short name	WP4 effort
31 - UNITN	22.00
32 - POLITO	20.00
33 - OBF	9.00
35 - AIGUASOL SAEST	23.00
Total	267.50

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D4.1	Design guidelines of zero-emission and positive energy buildings in a climate positive energy neighbourhood in Oslo	9 - SINTEF	Report	Public	12
D4.2	Design configuration for a modular, scalable, integrated retrofitting concept for Positive Energy Mid- & Highrise Buildings embedded in a green neighbourhood in Utrecht	14 - UAS Utrecht	Report	Public	12
D4.3	Design guidelines for zero-emission & positive energy refurbished and new buildings in Palma	12 - IREC	Report	Public	12
D4.4	Design guidelines for the zero-emission & positive energy renovation of the Health Care Centre in Karviná	3 - CVUT	Report	Public	12
D4.5	Design guidelines of timber-based construction & renovation of small-medium size buildings in Trento	31 - UNITN	Report	Public	12
D4.6	Design guidelines of new & retrofitting of existing buildings as zero-emission positive energy-buildings in climate positive circular communities	1 - NTNU	Report	Public	40

Description of deliverables

D4.1 : Design guidelines of zero-emission and positive energy buildings in a climate positive energy neighbourhood in Oslo [12]

Integrated circular design & evaluation of different concepts for zero-emission and positive energy buildings in a climate positive energy neighbourhood. Each demo will report on this in a separate deliverable. Will be revised annually (M24 and M36)

D4.2 : Design configuration for a modular, scalable, integrated retrofitting concept for Positive Energy Mid- & Highrise Buildings embedded in a green neighbourhood in Utrecht [12]

Integrated circular design & evaluation of different concepts for zero-emission and positive energy buildings in a climate positive energy neighbourhood. Each demo will report on this in a separate deliverable. Revisions M24 and M36

D4.3 : Design guidelines for zero-emission & positive energy refurbished and new buildings in Palma [12]

Integrated circular design & evaluation of different concepts for zero-emission and positive energy buildings in a climate positive energy neighbourhood. Each demo will report on this in a separate deliverable. Revisions M24 and M36

D4.4 : Design guidelines for the zero-emission & positive energy renovation of the Health Care Centre in Karviná [12]

Integrated circular design & evaluation of different concepts for zero-emission and positive energy buildings in a climate positive energy neighbourhood. Each demo will report on this in a separate deliverable. Revisions M24 and M36

D4.5 : Design guidelines of timber-based construction & renovation of small-medium size buildings in Trento [12]

Integrated circular design & evaluation of different concepts for zero-emission and positive energy buildings in a climate positive energy neighbourhood. Each demo will report on this in a separate deliverable. Revisions M24 and M36

D4.6 : Design guidelines of new & retrofitting of existing buildings as zero-emission positive energy-buildings in climate positive circular communities [40]

A collected report with findings from deliverables D4.1 to D4.5. The ultimate goal of WP4 is integrated circular design that cultivates the aesthetics and improves amenities for the building's occupants while improving the performance of the buildings in line with the new European Bauhaus strategy

Schedule of relevant Milestones

Milestone number[18]	**Milestone title**	**Lead beneficiary**	**Due Date (in months)**	**Means of verification**
MS7	Integrated circular design progress	1 - NTNU	20	Design reports zero-emission & positive energy buildings in CPCCs D4.2-4.6

Work package number [9]	WP5	Lead beneficiary [10]	14 - UAS Utrecht
Work package title	Resource Efficient (Pre)Manufacturing and Construction Workflows		
Start month	1	End month	48

Objectives

WP5 aims to create and test resource efficient retrofit and new built workflows in the construction industry of skins of medium/high-rise buildings and similar typologies. The "business as usual" or traditional sales, design, engineering & construction workflow is too expensive, does not deliver on performance (design/built performance gap), uses large amount of specialized and increasingly scarce workforce, causes transport, congestion & use of space in cities, and is a nuisance for occupants (in retrofit). Therefore, we aim to reduce the overall cost by 30%, the CO2 emissions, and the nuisance for occupants substantially. To achieve these goals, we will explore the following:

- Realizing retrofits & new built skins aiming at and suitable for energy neutral or even energy plus, without overlooking the value of design
- Reducing the on-site construction costs
- Developing advanced ICT tools / processes for automated gathering & recognition of retrofit building- and site data. As well as a new zero engineering approach, which reduces costs & time in the pre-production phase.
- Construct to maintain. Demonstrating that maintenance is one of the primary objectives for the demos.
- Reducing CO2 emissions of the construction process & economic valorization (carbon trading).
- Reducing transport related nuisance &CO2 emissions.
- Reducing waste on-site and off-site ((pre)-manufacturing).

The performance gap needs to be diminished by integrating smart technological solutions to monitor & control the indoor air climate, the energy performance and degradation of (moving)parts.WP5 further aims to improve adoption of the retrofit technology during the construction phase in deep retrofit projects. The objectives of WP5 are to apply, develop, redesign & validate new workflows in an industry 4.0 approach for resource efficient (pre)manufacturing and constructing (deep)retrofit and new built concepts in both the virtual &the physical world. In this WP we identify three phases, 1) Pre-Manufacturing, 2) Manufacturing and 3) Construction. By developing innovative tools and processes in this workflow, a market worthy retrofit or new built concept can be realized that could be seriously disruptive in the market. In the Pre-Manufacturing phase IT-innovations aim to improve building component production & construction processes by a Project independent method of digital data harvesting by recognizing and classifying specific building characteristics & connecting these with typological data in a parametric information (BIM) system. On the basis of the typological data the configuration of the retrofit solutions is automated. When the project is acquired, drones & other techniques are used directly in the "file2factory" manufacturing. In the manufacturing phase by prefabricating & even integrating installations in building components and connections between them, we significantly reduce both the amount of workforce needed on site and the specialized skills needed: plug & play. In the construction phase we aim to realize the designed innovations in the demo's by developing innovative processes to minimize the amount of effort in constructing, carbon footprint & nuisance for occupants & all are aiming for a resource efficiency in this process.

Description of work and role of partners

WP5 - Resource Efficient (Pre)Manufacturing and Construction Workflows [Months: 1-48]
UAS Utrecht, NTNU, ACE, CVUT, EURAC, SINTEF, PALMA, IBAVI, IREC, Buro de Haan, BOEX, Rc Panels B.V., UU, CITY OF UTRECHT, BOSGROEP, MEX, KARV, DTTN, UNITN, POLITO, OBF
Task 5.1 Innovation forum WP5. M1-M48. Task leader: HU, Participants: NTNU, ACE, EURAC, PALMA, DTTN, UNITN, POLITO, OBF
This task will ensure effective cooperation between the different innovation clusters in the demo projects, towards the aim of mutual learning and feedback loops between the demos and the WPs. The work will encompass innovation workshops between the demos within the WP and ensure the link to the other WPs. The aim of this task is to support the implementation and integration of the sub-tasks in relation to the production & construction processes in the demo projects, and to enhance the exploitation across the innovation clusters. The forum will act as an incubator for co-creation of innovative production & construction processes. Results will be reported and integrated as part of the innovations report (D1.4) in WP1.

Task 5.2 Pre-Manufacturing workflow M1-M48. Task leader: HU, Participants: Buro de Haan, Bos Groep, MEX, UU, BOEX, EURAC, UNITN

T5.2 aiming at the digital workflow to create decisions for NetZero energy retrofits. In previous projects, the concept was developed of a Zero Engineering process and a harvesting of project independent characteristics & automated configuration. All the steps of subtasks from 5.2.1 till 5.2.5 are already developed for the ground-based housing typology in European projects (e.g., InduZero) and national projects (e.g., Factory Zero, Inside Out, IEBB). In ARV, this knowledge will be transferred to the high-rise apartment building typologies. T5.2 is linked to WP2 where the framework for Pre-Manufacturing workflows will be explored, while in WP5 will be applied & tested.

Subtask 5.2.1 Pre-recognition of façade, roof and context typologies and performance prediction
For a basically ground-based houses developed identification of building typologies, we will extrapolate and adapt this knowledge to the high-rise apartment building typologies.
In 5.2.1 we will identify and register specific characteristics of apartment building typologies, focusing on the outer shell. The harvested data will be used to create user-friendly integration of building-configuration in BIM models.

Subtask 5.2.2 Location and orientation identification using GIS
GIS and other data sources such as aerial photographs & drone-based local photos of facades will be used to identify buildings with similar characteristics. Data of these buildings will be used to enhance the models which can be used to improve knowledge of the variation within specific building typologies. Recognition of building types (apartments) in the demo countries will support the upscaling, industrialization of integrated renovation concepts.

Subtask 5.2.3 Automated configurations of roof and façade solutions
To assist during the design for manufacturing of the retrofit, a software generator helps in creating design alternatives. These will be presented to housing corporations, associations of private apartments and tenants, but also to the factory.

Subtask 5.2.4 Zero-engineering at project level
In the traditional processes it takes many hours to engineer the high-rise retrofit solutions on the existing building. Shortening this process will result in cost reduction, while increases the success rate during the decision stages for the project. It will as well as open up new markets: smaller projects will become feasible for prices of larger ones (from economy of scale towards mass customization). Therefore, the goal is to create a Zero Engineering process aiming at File2Factory. This ultimately will lead towards a process without the involvement of human engineering capacity. To achieve this the following steps will be explored in the demo projects:
• 3D point cloud scanning using drones and automated correction of the BIM model
• Appling AI recognition of building components and possible replacement solutions
• Automated calibration of prognosed maintenance performance
• Automated integration into BIM of building renovation technology through Parametric design tools (automated configuration)
• Feed-in to industrial production facility (File2Factory and production process support systems)

Task 5.3 Off-site manufacturing M1-M48. Task leader: UNITN, Participants: DTTN, UNITN, POLITO, Bos Groep, RCP, HU, IREC, IBAVI, PALMA, SINTEF, EURAC
All the demo projects aim to apply prefabrication. In T5.3, we will jointly identify the production methodologies and create an outlook on Industrie 4.0 within the manufacturing processes. The analysis is based on the EU projects InduZero & Build-in-wood. Also, we will identify which activities can be moved to the prefabrication phase through a workflow analysis. By identifying the limitations in production, we will take the next step to integrating installations (e.g., ventilation units, ducts, systems) into façade & roof modules. Thus, it is possible to transfer traditional onsite production & installation cost & time largely to off-site production. This reduces disturbing the environment within cities. It also reduces failure costs both by controlled industrial production and by smart plug & play connections on site. Through applying, validating & knowledge developing the following topics are explored:
• Identification of off-site production methodologies for MMC (Modern Methods of Construction) in dry tech, based on the main system used for panels production: CLT and/or framed wall
• Definition of standard modules (shape and dimension) with some flexibility (dimension, materials, layers) for easy adaptation to existing buildings (fabric and systems)
• Identification of BIM procedures for the panels design, to be fully compatible with production and control software, directly linked to client order handling, inventory management etc.
• Definition of possible layers and materials (bio-based and/or recycled): outer finishing (including green solutions, nano-based materials, reflective finishes, PV panels), ventilated façade, insulation, system/facilities passage (within the module or intra modules), inner finishing (including PCM and massive solutions)
• System integration: passage for pipes and electrical system (plug and play: correlation with existing systems), BAPV and BIPV, mini MV machine near windows
• Correlation with existing doors and windows (easy replacement and non-intrusive construction works)

• Fixing system of the panel to existing wall to be simple, fast, safe, reversible (wood/wood, wood/steel, steel/steel joints) considering installation and adjustment: particular attention will be paid to out-of-square walls and non-standard elements (corner, ground and roof joints, balconies etc.)
Definition of watertight and airtight sealing: panels-panels and panels-walls

Task 5.4 Optimization of on-site construction processes for the retrofit of occupied buildings and new built buildings M1-M48. Task leader: HU Participants: All listed under 5.4.1 - 5.4.5
In this sub task logistics management and assembly planning and monitoring tools are generated for coordinating the supply of the components from different sources and locations. The goal is rapid (re-)planning and simulation of alternative assembly sequences, managing nuisance and assessing status of completion. Different demos have content that applies to the construction phase to contribute to the goals set by each site.

Subtask 5.4.1 On-site construction Utrecht demo M1-M48. Task leader : HU, Participants: Bos Groep, BOEX, City of Utrecht, MEX, RCP
The Circular HUB: Closing supply chains that integrate local/regional production/assembly facilities into circular hubs allowing harvested materials and construction and demolition waste to be processed into new (sustainable) materials and reused in (integral) building components. Components are engineered and manufactured following the proposed off-site production solution as described in the previous paragraph.
Optimization of construction, material and work methods on-site of all contractors and subcontractors that prevent material loss and reduce waste produced (through integrated BIM). One-piece flow and the one at a time (N=1) workflow processes will be designed, tested & evaluated such that an occupant-friendly construction process is implemented and validated for full-scale retrofitting of medium and high-rise buildings in occupied state. The Circular HUB will be used to coordinate the flow of delivering of components and the return of demolished materials. Just in time and directly mounting of the retrofit components will be the goal.
Construct to maintain towards “energy and comfort” As a Retrofit Service solution. Through quick maintenance response. Plug and Play equipment (changeability) are there for exceptionally important.
Overall, in the Utrecht Demo Construction process the aim is to reduce the amount of human resource and decrease the variety of companies needed to apply/mount the retrofit solution. Relatively small multi-functional teams are necessary

Subtask 5.4.2 On-site construction Palma demo M1-M48. Task leader: PALMA, Participants: IBAVI, IREC
Integrated workflow for the Large-Scale Renovation of urban dense areas through Public Private Partnerships (PPP)
- Partner PALMA– Palma City Council. Validate and demonstrate the reduction of execution time and costs in a large-scale renovation process (200-300 dwellings; several building) in an integrated process with one Project Manager / Contractor in comparison with a process that goes one building by one building.
- Palma (IBAVI) New Social Housing 36 Apartments Building. To demonstrate and validate the use of repetitive construction modules for 3-floor apartment buildings with massive walls based on local harvested “marés” stone and minimum material use. Integration and manufacturing of pre-fabricated wooden floors offsite with the aim to reduce execution construction time by 2 months. The process will be documented, monitored & analysed.

Subtask 5.4.3 On-site construction Oslo demo M1-M48. Task leader: SINTEF, Participants: OBF
Carbon neutral construction process: Electric- and bio-based fuel construction machinery will be tested to reduce emissions in construction. Strategies/systems for electric heating of construction site will also be tested. Monitoring results from WP8 will be used to analyse power demands and presence of machinery to dimension power-supply for the construction site. As part of the Circular HUB, material HUBs can be established outside the construction site, so that large vehicles can de-load goods there and smaller (electric) vehicles will provide transport for the last leg to construction site. This will also reduce noise and local air-pollution. Such activities are part of the implementation of the Circularity ARV pillar in the Oslo demo.

Subtask 5.4.4 On-site construction Karviná demo M1-M48. Task leader: CVUT, Participants: KARV
On-site construction during building operation will be piloted in Karviná at installation of climate change adaptive measures that include summer cooling by heat pumps and green roof sample for cooling of heat islands and local rainwater management (rain gardens, greenery). Installation of swappable façade-integrated RES (flexible solution enabling easy application of PV/PV-T/solar thermal/façade heat exchangers for possible coupling with heat pumps).

Subtask 5.4.5 On-site construction Trento demo. M12-M48. Task leader: DTTN, Participants: UNITN, POLITO, EURAC
Timber and bio-based on-site construction/renovation (modular/plug&play) during building operation will be piloted in Trento at installation of climate change adaptive measures that include summer cooling by heat pumps and green roof sample for heat island mitigation and local rainwater management (rain gardens, greenery). Installation of swappable façade-integrated BAS controlled RES (flexible solution enabling easy application of PV/PV-T/solar thermal/façade

heat exchangers for possible coupling with heat pumps). Passive/Active solutions for improved comfort linked to psychological and physiological aspects. Carbon credit scheme linked to carbon stock in timber-based solutions

Participation per Partner

Partner number and short name	WP5 effort
1 - NTNU	3.50
2 - ACE	1.00
3 - CVUT	19.00
8 - EURAC	3.50
9 - SINTEF	7.00
10 - PALMA	16.00
11 - IBAVI	8.50
12 - IREC	10.00
14 - UAS Utrecht	35.00
16 - Buro de Haan	15.00
20 - BOEX	5.00
21 - Rc Panels B.V.	6.00
22 - UU	2.00
23 - CITY OF UTRECHT	2.00
24 - BOSGROEP	13.00
26 - MEX	9.00
28 - KARV	5.00
30 - DTTN	6.00
Armalam	12.00
X-LAM DOLOMITI	11.50
FANTI LEGNAMI	7.50
31 - UNITN	22.00
32 - POLITO	8.00
33 - OBF	4.00
Total	231.50

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D5.1	Manufacturing configurator for high-rise apartment buildings to directly start production	14 - UAS Utrecht	Report	Public	24

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
	(File2Factory) process partly validated in participating European demo countries.				
D5.2	Workflow analyses and advise on how to move towards more prefabricated components and reduce work on-site.	14 - UAS Utrecht	Report	Public	36
D5.3	Resource Efficient (Pre)Manufacturing & Construction Workflows – Demo Utrecht	14 - UAS Utrecht	Report	Public	48
D5.4	Resource Efficient (Pre)Manufacturing & Construction Workflows – Demo Palma	12 - IREC	Report	Public	48
D5.5	Resource Efficient (Pre)Manufacturing & Construction Workflows – Demo Oslo	33 - OBF	Report	Public	48
D5.6	Resource Efficient (Pre)Manufacturing &Construction Workflows – Demo Karviná	3 - CVUT	Report	Public	48
D5.7	Resource Efficient (Pre)Manufacturing & Construction Workflows – Demo Trento	31 - UNITN	Report	Public	48
D5.8	Demonstration case of CPCC in Utrecht	14 - UAS Utrecht	Demonstrator	Public	36
D5.9	Demonstration case of CPCC in Palma	10 - PALMA	Demonstrator	Public	36
D5.10	Demonstration case of CPCC in Oslo	33 - OBF	Demonstrator	Public	36
D5.11	Demonstration case of CPCC in Karviná	3 - CVUT	Demonstrator	Public	36
D5.12	Demonstration case of CPCC in Trento	31 - UNITN	Demonstrator	Public	36

Description of deliverables

D5.1 : Manufacturing configurator for high-rise apartment buildings to directly start production (File2Factory) process partly validated in participating European demo countries. [24]

A configurator tool. The aim is to reduce the overall cost by 30%, the CO2 emissions, and the nuisance for occupants substantially.

D5.2 : Workflow analyses and advise on how to move towards more prefabricated components and reduce work on-site. [36]

Decisions for NetZero energy retrofits. In previous projects, the concept was developed of a Zero Engineering process and a harvesting of project independent characteristics & automated

D5.3 : Resource Efficient (Pre)Manufacturing & Construction Workflows – Demo Utrecht [48]

WP2 will develop the framework for Pre-Manufacturing workflows will be explored. This deliverable will applie & test the framework for the respective demo case.

D5.4 : Resource Efficient (Pre)Manufacturing & Construction Workflows – Demo Palma [48]

WP2 will develop the framework for Pre-Manufacturing workflows will be explored. This deliverable will applie & test the framework for the respective demo case.

D5.5 : Resource Efficient (Pre)Manufacturing & Construction Workflows – Demo Oslo [48]

WP2 will develop the framework for Pre-Manufacturing workflows will be explored. This deliverable will applie & test the framework for the respective demo case.

D5.6 : Resource Efficient (Pre)Manufacturing &Construction Workflows – Demo Karviná [48]

WP2 will develop the framework for Pre-Manufacturing workflows will be explored. This deliverable will applie & test the framework for the respective demo case.

D5.7 : Resource Efficient (Pre)Manufacturing & Construction Workflows – Demo Trento [48]

WP2 will develop the framework for Pre-Manufacturing workflows will be explored. This deliverable will applie & test the framework for the respective demo case.

D5.8 : Demonstration case of CPCC in Utrecht [36]

"Each demo case will report separately on the following topics which will be explored in the demos. • Realizing retrofits & new built skins aiming at and suitable for energy neutral or even energy plus, without overlooking the value of design • Reducing the on-site construction costs • Developing advanced ICT tools / processes for automated gathering & recognition of retrofit building- and site data. As well as a new zero engineering approach, which reduces costs & time in the pre-production phase. • Construct to maintain. Demonstrating that maintenance is one of the primary objectives for the demos. • Reducing CO2 emissions of the construction process & economic valorization (carbon trading). • Reducing transport related nuisance &CO2 emissions. • Reducing waste on-site and off-site ((pre)-manufacturing)."

D5.9 : Demonstration case of CPCC in Palma [36]

"Each demo case will report separately on the following topics which will be explored in the demos. • Realizing retrofits & new built skins aiming at and suitable for energy neutral or even energy plus, without overlooking the value of design • Reducing the on-site construction costs • Developing advanced ICT tools / processes for automated gathering & recognition of retrofit building- and site data. As well as a new zero engineering approach, which reduces costs & time in the pre-production phase. • Construct to maintain. Demonstrating that maintenance is one of the primary objectives for the demos. • Reducing CO2 emissions of the construction process & economic valorization (carbon trading). • Reducing transport related nuisance &CO2 emissions. • Reducing waste on-site and off-site ((pre)-manufacturing)."

D5.10 : Demonstration case of CPCC in Oslo [36]

"Each demo case will report separately on the following topics which will be explored in the demos. • Realizing retrofits & new built skins aiming at and suitable for energy neutral or even energy plus, without overlooking the value of design • Reducing the on-site construction costs • Developing advanced ICT tools / processes for automated gathering & recognition of retrofit building- and site data. As well as a new zero engineering approach, which reduces costs & time in the pre-production phase. • Construct to maintain. Demonstrating that maintenance is one of the primary objectives for the demos. • Reducing CO2 emissions of the construction process & economic valorization (carbon trading). • Reducing transport related nuisance &CO2 emissions. • Reducing waste on-site and off-site ((pre)-manufacturing)."

D5.11 : Demonstration case of CPCC in Karviná [36]

"Each demo case will report separately on the following topics which will be explored in the demos. • Realizing retrofits & new built skins aiming at and suitable for energy neutral or even energy plus, without overlooking the

value of design • Reducing the on-site construction costs • Developing advanced ICT tools / processes for automated gathering & recognition of retrofit building- and site data. As well as a new zero engineering approach, which reduces costs & time in the pre-production phase. • Construct to maintain. Demonstrating that maintenance is one of the primary objectives for the demos. • Reducing CO2 emissions of the construction process & economic valorization (carbon trading). • Reducing transport related nuisance &CO2 emissions. • Reducing waste on-site and off-site ((pre)-manufacturing)."

D5.12 : Demonstration case of CPCC in Trento [36]

"Each demo case will report separately on the following topics which will be explored in the demos. • Realizing retrofits & new built skins aiming at and suitable for energy neutral or even energy plus, without overlooking the value of design • Reducing the on-site construction costs • Developing advanced ICT tools / processes for automated gathering & recognition of retrofit building- and site data. As well as a new zero engineering approach, which reduces costs & time in the pre-production phase. • Construct to maintain. Demonstrating that maintenance is one of the primary objectives for the demos. • Reducing CO2 emissions of the construction process & economic valorization (carbon trading). • Reducing transport related nuisance &CO2 emissions. • Reducing waste on-site and off-site ((pre)-manufacturing)."

Schedule of relevant Milestones

Milestone number[18]	**Milestone title**	**Lead beneficiary**	**Due Date (in months)**	**Means of verification**
MS8	First iteration of recognized typologies	14 - UAS Utrecht	12	Amount and quality of recognized typologies
MS9	Final iteration of recognized typologies and the Pre-Manufacturing workflow.	14 - UAS Utrecht	24	Verification of automated delivered input for File2Factory
MS10	First iteration of manufacturing workflow analyses	14 - UAS Utrecht	30	Amount of activities changed to the off-site manufacturing.
MS11	Manufacturing principles realized	14 - UAS Utrecht	36	Analyses output manufacturing. Delivered modules to construction site
MS12	Realization of demo projects	14 - UAS Utrecht	36	Construction of the projects completed

Work package number [9]	WP6	Lead beneficiary [10]	3 - CVUT
Work package title	Integrated renewables and storage systems		
Start month	1	End month	46

Objectives

WP6 deals with the system design, deployment & evaluation of the overall ARV innovative solutions in the different demonstration sites with respect to renewable energy sources (RESs) & energy storage systems (ESSs) implemented in buildings & neighbourhoods. This is essential to achieve the ambitions of the ARV project in creating net positive energy and zero emission communities, as well as, accelerating the wide-scale deployment of CPCCs around Europe.
There is a strong collaboration between WP6 and other work packages in terms of collecting feedbacks and providing inputs for the design (to WP4), citizen participation (WP3), simulation models (to WP2), as well as the effective operation of the innovative solutions (to WP7). Thus, the final innovative RESs & ESSs solutions will cover different aspects related to aesthetics, environmental, user's acceptance, life cycle economic & flexibility. Furthermore, this WP will share experiences & knowledge between the six demo-sites along the project development in order to overcome issues which may occur during the implementation of the innovative solutions.
The evaluation of the innovative ESSs & RESs solutions is carried out through advanced simulations enforced with real measurements data and KPIs defined in WP2. The obtained results from the evaluation of the demo-sites will allow to build holistic approaches for the improvement of building and district energy systems, and the replicability/scalability of the solutions at other locations with different climate conditions. The main objectives of this WP are the following:
• Integrated energy design for the implementation of RESs & ESSs solutions to fulfil the electrical & thermal needs of buildings/neighbourhoods
• Provide processes for implementation, design, scalability, & recirculation of energy systems in buildings & neighbourhoods
• Support & knowledge sharing during the development of all RESs & ESSs innovative solutions in the demos

Description of work and role of partners

WP6 - Integrated renewables and storage systems [Months: 1-46]
CVUT, NTNU, DTU, DANFOSS A/S, ENFOR, PROJECTZERO, EURAC, SINTEF, PALMA, IREC, UAS Utrecht, Center Denmark, SAB, BOEX, Rc Panels B.V., UU, BOSGROEP, MEX, Mitros, KARV, DOL, POLITO, OBF, NANO
The work in this WP brings together the contribution of ARV demo-sites that aim to implement innovative renewable energy & storage solutions. Apart from the T6.1 task where all the demos are involved, each task from T6.2 to T6.6 will be dedicated to a specific demo project & will implicitly include the activities related to the main objectives of this WP.

Task 6.1 Innovation forum for RES and storage implementation in CPCC. M1-M46. Lead: CVUT, Partners: KARV, HU, PALMA, PZ, OBF, DTTN, NTNU, IREC, SINTEF, DTU, EURAC, GDFA, ACE
The aim of this task is to support the implementation of innovative RESs & storage solutions in the six demo sites of the ARV project & highlights the role of RESs in the wide-scale deployment CPCCs around Europe. T6.1 will encompass workshops to ensure cooperation & share of knowledge between the partners involved in the design, construction and operation of the innovative solution of each demo. The results from this task will be added to the deliverables D1.4 / WP1.

Task 6.2 Integrated innovative RESs & ESSs solution in demo Oslo. M1-M42. Lead: SINTEF, Partners: OBF, NTNU, ENFOR
• Electricity: The on-site renewable energy generation system consists of innovative BIPV &BAPV. Innovation lies in different colourings & vertical orientation of the photovoltaic panels, to ensure an optimized balancing between PV energy production & aesthetic expression & appearance. Regarding local energy storage, ARV will seek to design & construct an innovative system using recycled batteries. An alternative & environmentally friendly solution to new batteries is to build up the battery storage from recycled electric car batteries. Normally, the electric car's battery is replaced when its capacity has been reduced to less than 70-80% of starting capacity, which it is still a lot of storage capacity. This solution is cost effective & environmentally friendly as it is expected to reduce 50% of GHG emissions across the battery production process & 20% of their environmental impact. Moreover, it may become an increasingly relevant alternative when a number of electric cars have to replace their batteries in the near future.

• Thermal: Innovative heating/cooling system, i.e. LowEx system, using low-temperature thermal heating & high temperature thermal cooling using the same infrastructure coupled with the ground source heat pump and district heating as peak load plant. This type of super-efficient thermal energy technology may supply the thermal needs with very low use of primary energy, typically in the order of 3 to 10 kWh/m2year, for delivering heating & cooling in near-zero energy, zero energy ZEB or positive buildings. The solution enables a greatly reduced peak load on the electricity grid, and it also permits higher self-use of locally produced renewable energy, which makes local electricity production more economically advantageous with current electricity tariffs. Moreover, it produces a very stable thermal indoor climate throughout the year, which increases the thermal comfort & IAQ. The LowEx system will be integrated in the Oslo demo by using the existing infrastructure, thus saving cost & embodied energies from the material use.

Task 6.3 Integrated innovative RESs and ESSs solution in demo Sønderborg. M1-M26. Lead: PZ, Partners: ENFOR, SAB, DTU, DAN, Center Denmark
• Electricity: Roof integrated PV system combined with new developed flow-batteries for maximizing the consumption of locally harvested energy. In 2017, more than 3.000 m2 solar PV panels were integrated in the roofs of all 19 apartment buildings chosen as demo site. The solar PV system can produce 460 kW solar electricity corresponding to 408.000 kWh per year covering 37 % of the total electricity consumption. The solar PV system has performed very well during the last three years, and it planned to install battery systems together with the solar PV panels in each block. At the beginning of 2021, batteries with a capacity of 15 kWh/4 kW each will be implemented in each of the 19 blocks. Installation of the 19 batteries means, that extra 60.000 kWh solar electricity can potentially be used in the buildings per year instead of exporting the solar electricity to the grid. The innovation remains in the operation of the batteries based on self-consumption forecasting, and calculation of available flexibility for grid support
• Thermal: Domestic hot water boosted by heat pump: Normally the district heating return temperature is too high due to a necessary high temperature in the domestic hot water circulation system. The district heating return temperature can be lowered by implementing a small heat pump (3-5 kW) in the system. The heat pump extracts heat from the circulation pipe circuit, and thereby reduces the return temperature. Depending on actual electricity costs and value of district heating return bonus, the operation of the heat pump can be optimized (on/off) resulting in fuel shift option between district heating and electricity.

Task 6.4 Integrated innovative RESs and ESSs solution in demo Utrecht. M1-M44. Lead: UU, Partners: Bos Groep, MITROS, HU, MEX, RCP, BOEX, DTU, ENFOR
• Electricity: An innovative solution consisting of BIPV/BAPV for maximizing solar energy harvesting combined with local & district electricity storage providing support to the grid as well as EV-V2G will be demonstrated in buildings embedded in green neighbourhood. Prior to ARV, a high-rise building is retrofitted to become a PEB, implementing BAPV & BIPV along with heat pumps to generate heating and hot tap water and battery storage contributing to peak shaving in the building (TRL5-6). This first positive energy high-rise retrofitted building provides the opportunity to deduct design parameters for retrofitting approaches that integrate prefabricated building components with energy installations pre-installed in a plug-and-play design. This optimized approach will be underpinned by forecasting the PV energy production, through the utilization of cloud detection cameras & meteorological station data together with a fast network of sensors that measure irradiation & temperature of approximately 1100 BAPV/BIPV-panels, and electricity demand and will be demonstrated at other building types, i.e. different heights & construction types, to create an industrialized approach bringing it to TRL7-8. Actions in T6.4 consist of energy analysis of the demonstration buildings & implementation of BIPV/BAPV in the renovation workflow process, and direct usage of DC power outage from BIPV/BAPV to reduce energy losses.
• Thermal: Implementation & demonstration of a modular heating ventilation & cooling infrastructure for high-rise buildings. This modular HVAC system is compatible for multiple heating sources such as: Low- & mid-temperature district heating, geothermal heat pump systems, and air to water heat pump systems. In addition, this solution is compatible for all-electric solutions such as infrared or combined electrical & ventilation heating. The implications for ventilation & heat recovery solutions & insulation requirements are deducted, aiming to retrofit the apartment buildings at a business-as-usual cost level, while raising the energy performance of the building & comfort levels for the tenants.

Task 6.5 Integrated innovative RESs and ESSs solution in demo Karviná. M1-M42. Lead: CVUT, Partners: KARV, NANO
• Electricity: Implementation of innovative PV system, combining BIPV & BAPV, will be considered in the demo Karviná. The PV system will consist of high efficiency panels providing enough energy to the building. Moreover, the PV system will contribute in improving the indoor environment by supplying energy to drive external shading elements limiting the sunlight access to the interior, while keeping architectural aesthetics of BIPV at top level. A central second-life energy storage will be designed adequately in order to operate the demo as a local microgrid, which supports various functionalities related to building energy flexibility, load-shifting and peak shaving. Additionally, EV charging stations & the implementation of V2G/V2H services are also considered. Finally, local sensors for solar irradiance and

temperature as well as sky imager solution will be installed for accurate predictions of the PV generation & operation of the whole system assured by WP7.
• Thermal: Implementation of innovative heat pump system for building refurbishment providing heating & cooling energy. The system will combine heat pump with PVT and use of waste heat. Additionally, a thermal storage design will be considered for balancing the heat pumps, providing potential for heating demand flexibility in building and provides necessary heating energy in winter and cooling during summer and to target positive energy district requirements. Local weather station will be implemented with indoor temperature measurements for effective operation of the HVAC systems.

Task 6.6 Integrated innovative RESs and ESSs solution in demo Trento. M1-M46. Lead: EURAC, Partners: ENFOR
• Electricity: EURAC will work on integrated concepts of PV designed for heat-pump operation.1st and 2nd life batteries will be considered including vehicle-to-home (V2H) applications in refurbished buildings. Piedicastello Destra Adige is characterized by integrating innovative solutions and approaches for sustainable urban development, like using second-life batteries, the vehicle-to-grid/home (V2G/V2H) technology. DOL will consider including this area in the infrastructure plan for V2G EV charging stations in the Ex-Zuffo exchange parking lot.
• Thermal: DOL and POLITO will work to implement a new prototype of energy tunnel in the existing Piedicastello tunnel composed of two twin tunnels, approximately 200 m long, running parallel with a separation of few meters and a maximum cover of around 130 m. A section of 15 m length of the tunnels located at 100 m from the portals (i.e. in the area of maximum cover) is to be transformed into a prototype of energy tunnel to demonstrate the technology in the relevant environment. The characteristics of the prototype will be:
- Installation of radial borehole heat exchangers, 30m length, at the contour of the crown (3 per cross section, at 15°, 60° &105° from the crown vertical). One section every 7m for a total of 3 sections of radial BHE that will be installed.
- Installation of a circuit of pipes at the intrados of the tunnel crown, along the same 15m length, covered by a 5cm thick sprayed reinforced concrete and isolating foam.
- Pipes for connection to a heat pump system located at the portal.
- Secondary system used for heating and cooling in the exhibition hall.
- Measurement plan including temperature sensors in the ground, in the tunnel, heat flow, etc.
The system is expected to allow for an exploitation of thermal power in the order of 25kW and will serve the refurbished buildings block. It is envisaged that the system may serve both in winter and in summer season. To support the project scope of the creation of a nearly zero energy buildings in the area 1 (former Ex-Italcementi area), energy geostructures will be adopted. The following characteristics can be envisaged:
- thermal activation of the foundation thanks to the installation of a circuit of pipes in the foundation slab.
- thermal activation of the retaining walls by means of the GeothermSkin elements (patent priority n°. 102016000020821).

Participation per Partner

Partner number and short name	WP6 effort
1 - NTNU	15.00
3 - CVUT	37.00
4 - DTU	20.00
5 - DANFOSS A/S	1.00
6 - ENFOR	18.00
7 - PROJECTZERO	3.50
8 - EURAC	2.00
9 - SINTEF	4.00
10 - PALMA	1.00
12 - IREC	1.00
14 - UAS Utrecht	2.00
17 - Center Denmark	4.00

Partner number and short name	WP6 effort
18 - SAB	2.00
20 - BOEX	2.00
21 - Rc Panels B.V.	2.00
22 - UU	14.00
24 - BOSGROEP	10.00
26 - MEX	2.00
27 - Mitros	6.00
28 - KARV	6.00
29 - DOL	15.00
32 - POLITO	11.00
33 - OBF	4.00
34 - NANO	10.00
Total	192.50

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D6.1	Guidelines for integrated design and implementation of RESs and ESSs for building/ neighbourhood's energy needs in Oslo	9 - SINTEF	Demonstrator	Public	42
D6.2	Guidelines for integrated design and implementation of RESs and ESSs for building/ neighbourhood's energy needs in Sønderborg	7 - PROJECTZERO	Demonstrator	Public	26
D6.3	Guidelines for integrated design and implementation of RESs and ESSs for building/ neighbourhood's energy needs in Utrecht	22 - UU	Demonstrator	Public	44
D6.4	Guidelines for integrated design and implementation of RESs and ESSs for building/ neighbourhood's energy needs in Karviná	3 - CVUT	Demonstrator	Public	44
D6.5	Guidelines for integrated design and	8 - EURAC	Demonstrator	Public	46

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
	implementation of RESs and ESSs for building/ neighbourhood's energy needs in Trento				

Description of deliverables

D6.1 : Guidelines for integrated design and implementation of RESs and ESSs for building/neighbourhood's energy needs in Oslo [42]

The deliverables brings together the contribution of ARV demo-sites that aim to implement innovative renewable energy & storage solutions. Each demo case will report separately as Guidelines for integrated design and implementation of RESs and ESSs for building/neighbourhood's energy needs

D6.2 : Guidelines for integrated design and implementation of RESs and ESSs for building/neighbourhood's energy needs in Sønderborg [26]

The deliverables brings together the contribution of ARV demo-sites that aim to implement innovative renewable energy & storage solutions. Each demo case will report separately as Guidelines for integrated design and implementation of RESs and ESSs for building/neighbourhood's energy needs

D6.3 : Guidelines for integrated design and implementation of RESs and ESSs for building/neighbourhood's energy needs in Utrecht [44]

The deliverables brings together the contribution of ARV demo-sites that aim to implement innovative renewable energy & storage solutions. Each demo case will report separately as Guidelines for integrated design and implementation of RESs and ESSs for building/neighbourhood's energy needs

D6.4 : Guidelines for integrated design and implementation of RESs and ESSs for building/neighbourhood's energy needs in Karviná [44]

The deliverables brings together the contribution of ARV demo-sites that aim to implement innovative renewable energy & storage solutions. Each demo case will report separately as Guidelines for integrated design and implementation of RESs and ESSs for building/neighbourhood's energy needs

D6.5 : Guidelines for integrated design and implementation of RESs and ESSs for building/neighbourhood's energy needs in Trento [46]

The deliverables brings together the contribution of ARV demo-sites that aim to implement innovative renewable energy & storage solutions. Each demo case will report separately as Guidelines for integrated design and implementation of RESs and ESSs for building/neighbourhood's energy needs

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS13	Integrated renewables and storage systems progress	3 - CVUT	20	Process reports on integrated renewables and storage systems in CPCCs D6.2-6.6

Work package number [9]	WP7	Lead beneficiary [10]	4 - DTU
Work package title	Efficient Operation and Flexibility		
Start month	1	End month	48

Objectives

This WP focuses on the deployment of solutions for optimizing the performance during the operation of the six demo sites in ARV. The performance will be measured by a user-oriented preference metrics related to energy efficiency, flexibility, and cost efficiency while serious considerations are taken in the direction of energy positive districts and buildings. This is realized using a hierarchy of nested digital solutions spanning from a central ARV Cloud Hub (Center Denmark), national hubs, and local building centred energy management systems. The digital solutions will reflect the geographical structure and hereby valuable experiences on how to operate neighbourhoods efficiently in different European climate zones will be obtained. The ARV Cloud Hub will also make it possible to test and optimize the regulatory framework for enabling an efficient and accelerated path towards a low-carbon society.
In the future weather-driven energy system, end-user flexibility will play an important role, and consequently we will interact with the individual demo sites in ARV to maximize engagement, transparency, fairness, and acceptance. This will be facilitated by non-energy related benefits like indoor air quality, health, comfort, and cooperative interactions to be monitored and evaluated in collaboration with WP3, WP6, WP8 and WP9. Deployment of the ARV digital Cloud Hub will be instrumental in harmonizing the building, district, and occupants` interaction.
A next generation of building energy management systems (BEMS) optimized for interactions with the energy grid, local energy generation, demand response and user interactions will be deployed. The BEMS will be based on grey-box and digital twin models to be used for model-based control, which takes user preferences and constrains into account. The smartness of the individual buildings will be described by the Smart Readiness Indicator (SRI). The practical and observed smartness of buildings and districts will be described by Flexibility Functions (FFs) and Flexibility Indices (FIs). The flexibility index for a building can be optimized for the climate zone specific challenges. Consequently, WP7 will interact with WP4 on optimal design of energy efficient buildings and CPCCs.
Flexibility functions and the concepts of virtual power plants (VPPs) will be employed for the management of geographically dispersed resources at various levels (e.g., building, district & city level). In both cases we will deploy hierarchical optimization & control that enables the provision of flexibility at all relevant scales. Economic & technical aggregators will be used for the coordination and for creating an interface between the districts and energy market/grid operators. In summary, WP7 will focus on digital solutions & infrastructures for efficient operations in ARV. The focus is on unlocking the available flexibility in all the six demo sites for optimizing the self-consumption and minimizing the carbon footprint by data-driven and intelligent operations. WP7 will take advantage of the information and description of energy storage solutions from WP6, design optimal solutions from WP4 and the information about sensors and actuators from WP8. The solutions will respect privacy, GDPR & aim at creating robust and resilient systems by design.

Description of work and role of partners

WP7 - Efficient Operation and Flexibility [Months: 1-48]
DTU, NTNU, CVUT, DANFOSS A/S, ENFOR, PROJECTZERO, EURAC, SINTEF, PALMA, IREC, MET, UAS Utrecht, HOUSING EUROPE, Center Denmark, SAB, BOEX, UU, CITY OF UTRECHT, iwell, Mitros, KARV, DOL, DTTN, UNITN, OBF, NANO
The work in this WP gathers contribution from all the demonstration sites considered in the ARV project and the work is organized based on the following tasks:

Task 7.1 Innovation forum for data handling and efficient operation. M1-M48. Lead: Center Denmark, Partners: all demos
The aim of this task to ensure an efficient cooperation between the innovation clusters in the six demo sites. This includes aims towards mutual learning and feedback loops between the clusters and the central ARV cloud hub (Center Denmark) on data storage, communication, computing, and software. The innovation forum will arrange a mixture of open innovation activities and innovation workshops and activities between the six clusters. The activities will enhance the exploitation across the innovation clusters and act as an incubator for co-creation of efficient and flexible innovative solutions for large-scale deployment at CPCCs across different climate zones in Europe.

Task 7.2 European digitalisation hub for smart buildings and districts. M1-M48. Task Lead: Center Denmark, Partners: DTU, UU, ENFOR, IREC, PALMA, CVUT, NTNU, SINTEF

Federated data lake setup including data analytics pulling from fog, edge, and cloud computing environments including GDPR, cyber security, data ethics compliance. ARV will deploy the centralized European digitalization hub (cloud level) connected to sub-hubs (fog level) at the individual demo sites, which again are connected to building and occupant systems or apps (edge level). By using a state-of-the-art data lake principle, the ARV cloud hub will provide storage for monitoring data and allow efficient use of data on various scales. It will also provide user interfaces for occupants, operators, building owners, and other stakeholders. Establishment of a data lake setup for software, data management and storage (D7.1).

Task 7.3 Models for energy-efficient operation of buildings and districts. M1-M36. Lead: CVUT, Partners: DTU, all demos, IREC, UU, SINTEF, NTNU
Identification of models for energy efficient management of buildings and districts. Models for indoor climate, state estimation, and virtual (software) sensors. Models with integrated HVAC and battery characteristics. APP- and WEB-based interactions with the occupants. Models for PV integration and integration with local meteorological stations. Models with integrated short-term weather forecasts (including sky imagers). This task will be based on information on storage systems WP6. Archetype building models (D7.2).

Subtask 7.3.1 Deployment of low-order models optimised for low-temperature district heating networks (Sønderborg demo)
Subtask 7.3.2 Model with a seasonal focus for urban energy geostructure in former 400-m highway tunnels for long term storage to supply a new city district with heating and cooling energy (Trento demo)
Subtask 7.3.3 Low-order models tailored for centralized HVAC systems in multifamily apartment buildings (Palma demo)
Subtask 7.3.4 Deployment of PV forecasting for modelling the operation of BAPV/BIPV and battery storage in building (Karviná demo and Utrecht demo)
Subtask 7.3.5 Deployment of low-order models for the LowEx system control (Oslo demo)

Task 7.4 Deployment of solutions for forecasting. M4-M42. Lead: ENFOR, Partners: DTU, Center Denmark, all Demos, CVUT, KARV, UU, IREC, SINTEF
This task will deploy and evaluate methods for local weather forecasting based on municipality or city operated local weather stations combined with meteorological weather forecasts. Fine resolution forecasting of city and district climate. Implementation using the central ARV cloud hub in combinations with local city hubs. Forecasting of local and aggregated PV production. Use of combined forecasting for optimized accuracy. Forecasting of energy prices. Forecasting of CO2 profile of the power mix. Consideration to Global Geodetic Observing System GGOs contracts. Probabilistic forecasting. Generation of scenarios for decision making under uncertainty. Joint and multivariate forecasting of all relevant parameters (wind power, solar power, load, prices, emission, ...). Best practice on fine resolution city weather foresting (D7.3). Implementation at the ARV cloud hub and at local clouds related to some of the demo sites (D7.4).

Subtask 7.4.1 Deployment of sky-imaging solution for very short-term solar irradiance forecasting (Karviná demo)
Subtask 7.4.2 Deployment and evaluation of local weather forecasting (all demos)
Subtask 7.4.3 Forecasting of local PV generation (Sønderborg demo, Utrecht demo, Karviná demo, Oslo demo)
Subtask 7.4.4 Forecasting of electricity and heat load profiles (ARV Demos: Sønderborg, Utrecht, Palma, Karviná, Oslo)
Subtask 7.4.5 Forecasting of energy generation for BIPV and BAPV sites (ARV Demos: Utrecht, Palma, Karviná, Oslo)
Subtask 7.4.6 Deployment of PV forecast with respect to specific city environment weather conditions (Karviná demo)

Task 7.5 Deployment and evaluation of control algorithms. M4 - M44). Task Lead: DTU. Contributors: UU, IWELL, Bos Groep, MITROS, BOEX, City of Utrecht, IREC, MET, Center Denmark, NANO, CVUT, KARV, SINTEF
Model Predictive Controllers (MPCs) with integrated weather and load forecasts. Controllers for district and BEMS. Controllers with built-in forecast of occupancy. Input from monitoring (WP8). Optimal control of BIPV and BAPV systems. Control of heat pumps in buildings and city scale systems. Predictive control of indoor comfort. Multi-objective controllers (e.g., cost, energy, and emission). Stochastic controllers. Controllers taking into account app- and web-based user feedback. Implementation at the central ARV cloud hub, local hubs and in BEMS. Guidelines (D7.5).

Subtask 7.5.1 Controllers for building energy management systems (BEMS) (all demos)
Subtask 7.5.2 Controllers for low-temperature district heating operation (Sønderborg, ...)
Subtask 7.5.3 Controllers for operating temperature zones in district heating network (Sønderborg, ...)
Subtask 7.5.4 Control of battery systems (Utrecht, Sønderborg, Karviná, ...)
Subtask 7.5.5 Control of Heat Pumps and temperatures in centralized HVAC systems in multifamily buildings (Palma)
Subtask 7.5.6 Control of Heat Pumps and operating temperatures in centralized HVAC LowEx system in educational and multifunctional buildings (Oslo)

Task 7.6 Describe energy flexibility functions and measures (M6-M46) Task Lead: NTNU. Task Contributors: DTU, ENFOR, all Demos, IREC, PALMA, UU, SINTEF.
The task deploys methods for description and identification of energy flexibility related to demand response solutions. With input from WP6 & WP5, the task formulates Flexibility Functions (FFs) for providing local grid support or other power system services. Based on the operational data of the demo projects, task evaluates the Flexibility Index (FI) and the Smart Readiness Indicator (SRI). This is tailored and designed for optimized local flexibility for the climate zones related to the six demo projects and implemented through the central ARV Cloud Hub. Methodologies for operational description of flexibility (D7.6). Guideline on climate related design principles (D7.7).

Subtask 7.6.1 Flexibility functions for heat pumps in district heating networks (Sønderborg)
Subtask 7.6.2 Seasonal flexibility function for city tunnel (Trento)
Subtask 7.6.2 Identification of flexibility in buildings (Utrecht)
Subtask 7.6.3 Flexibility functions in LowEx system (Oslo)

Task 7.7 Smart communities and optimisation. M18-M48. Task Lead: UU. Contributors: IWELL, Bos Groep, City of Utrecht, MITROS, BOEX , Center Denmark, DTU, DAN, PZ, CVUT, KARV, NTNU, SINTEF
This task will integrate the modelling, forecasting, and control solutions for smart energy buildings and communities from T7.3-T7.6. A hierarchical control framework will be employed to exploit the flexibility, which is inherent in an aggregation of distributed resources, for both market optimisation purposes and the provision of ancillary services to the system (see T7.8). It will enable interaction between local communities and energy networks, and optimal use of local renewable energy generation including EV/V2G charging algorithms. The employed framework will be generic and scalable framework enabling the provision of flexibility in power systems operations through aggregators. Emphasis is given on both wholesale energy trade functions and the provision of ancillary services to the system such as fast operating reserves for system balancing, and local network support. The BEMS of the various buildings participating in the demonstrations will be connected via aggregators, which will use either the Virtual Power Plat (VPP) principles or the concept of hierarchical controllers to activate the flexibility. Peer-to-Peer (P2P) trading among positive and regular buildings will also be explored as follows: i) design P2P market features for each demo site, ii) test and simulate the P2P frameworks, iii) implement the P2P markets in each demo site and monitor their suitability and economic viability to reach TRL6-7. The methods will integrate input from grid sensors (WP8), user preferences (WP3, WP5) and interaction with flexibility markets. The implementation at the central ARV cloud hub. Handbook for Smart Communities (D7.8).

Subtask 7.7.1 Optimization of district heating networks for optimal use of excess heat from supermarkets (Sønderborg)
Subtask 7.7.2 Optimal operation of interconnected battery storage and EVs (Utrecht, Sønderborg, Karviná)
Subtask 7.7.3 Connecting the various BEMS platforms for aggregating flexibility and enabling flexibility at district scale (Utrecht, Sønderborg, Karviná)
Subtask 7.7.4 Optimal operation of LowEx system (Oslo)

Task 7.8 Market interfaces. M24-M48. Task Lead: DTU. Contributors: UU, IWELL, Center Denmark, IREC, PALMA
Linking of conventional markets with aggregated flexibility for buildings and districts. Interface to balancing and flexibility markets. Guidelines on new business models for energy communities. Markets for energy system integration (heating, cooling, gas, electricity). Models for auctions related to long term contracts. V2G/V2B solutions. Tools for investment and energy systems planning. Methods for CEC-DSO interactions to solve possible DSO issues and conflicts. Interaction with WP9 on financial instruments (including P2P trading/DLTs such as blockchain among CECs). Business models and guidelines. Principles for CEC-DSO interactions (D7.9)

Subtask 7.8.1 Peak load reductions and congestion management in collaboration with DSOs (Utrecht)
Subtask 7.8.2 V2G-EV-charging network and battery storage for providing grid flexibility and balancing reserves at different scale levels (Utrecht, Sønderborg)
Subtask 7.8.3 Evaluation of different investment, optimization policies and market structures for CEC (Palma)

Participation per Partner

Partner number and short name	WP7 effort
1 - NTNU	14.00
3 - CVUT	23.50
4 - DTU	46.00

Partner number and short name	WP7 effort
5 - DANFOSS A/S	9.00
6 - ENFOR	18.00
7 - PROJECTZERO	4.00
8 - EURAC	3.00
9 - SINTEF	7.00
10 - PALMA	5.00
12 - IREC	20.00
13 - MET	4.00
14 - UAS Utrecht	1.00
15 - HOUSING EUROPE	2.00
17 - Center Denmark	33.00
18 - SAB	3.00
20 - BOEX	3.00
22 - UU	19.00
23 - CITY OF UTRECHT	2.00
25 - iwell	17.00
27 - Mitros	3.00
28 - KARV	5.00
29 - DOL	1.00
30 - DTTN	2.00
Armalam	1.00
31 - UNITN	2.00
33 - OBF	2.00
34 - NANO	4.00
Total	253.50

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D7.1	Establishment of ARV central digitalization hub and data lake	17 - Center Denmark	Demonstrator	Confidential, only for members of the consortium (including the Commission Services)	18
D7.2	Archetype building models	3 - CVUT	Report	Public	32

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D7.3	City fine resolution weather forecasting at demo sites	6 - ENFOR	Demonstrator	Confidential, only for members of the consortium (including the Commission Services)	12
D7.4	Forecasting of wind, solar, load, prices at demo sites	17 - Center Denmark	Demonstrator	Confidential, only for members of the consortium (including the Commission Services)	18
D7.5	Controllers with interface to provide user preferences	4 - DTU	Demonstrator	Confidential, only for members of the consortium (including the Commission Services)	32
D7.6	Guidelines on descriptions of smartness and flexibility	4 - DTU	Report	Public	24
D7.7	Guidelines on climate zone related design principles	1 - NTNU	Report	Public	32
D7.8	Handbook for smart communities	22 - UU	Report	Public	42
D7.9	Principles for CEC-DSO interactions	4 - DTU	Report	Public	46

Description of deliverables

D7.1 : Establishment of ARV central digitalization hub and data lake [18]

Federated data lake setup including data analytics pulling from fog, edge, and cloud computing environments including GDPR, cyber security, data ethics compliance. ARV will deploy the centralized European digitalization hub (cloud level) connected to sub-hubs (fog level) at the individual demo sites, which again are connected to building and occupant systems or apps (edge level). By using a state-of-the-art data lake principle, the ARV cloud hub will provide storage for monitoring data and allow efficient use of data on various scales. It will also provide user interfaces for occupants, operators, building owners, and other stakeholders. Establishment of a data lake setup for software, data management and storage

D7.2 : Archetype building models [32]

Identification of models for energy efficient management of buildings and districts. Models for indoor climate, state estimation, and virtual (software) sensors. Models with integrated HVAC and battery characteristics. APP- and WEB-based interactions with the occupants. Models for PV integration and integration with local meteorological stations. Models with integrated short-term weather forecasts (including sky imagers). This task will be based on information on storage systems WP6. Archetype building models

D7.3 : City fine resolution weather forecasting at demo sites [12]

Best practice on fine resolution city weather foresting. deploy and evaluate methods for local weather forecasting based on municipality or city operated local weather stations combined with meteorological weather forecasts. Fine resolution forecasting of city and district climate. Implementation using the central ARV cloud hub in combinations with local city hubs.

D7.4 : Forecasting of wind, solar, load, prices at demo sites [18]

Implementation at the ARV cloud hub and at local clouds related to some of the demo sites. deploy and evaluate methods for local weather forecasting based on municipality or city operated local weather stations combined with meteorological weather forecasts. Fine resolution forecasting of city and district climate. Implementation using the central ARV cloud hub in combinations with local city hubs

D7.5 : Controllers with interface to provide user preferences [32]

Model Predictive Controllers (MPCs) with integrated weather and load forecasts. Controllers for district and BEMS. Controllers with built-in forecast of occupancy. Input from monitoring (WP8

D7.6 : Guidelines on descriptions of smartness and flexibility [24]

Methodologies for operational description of flexibility based on the operational data of the demo projects, task evaluates the Flexibility Index (FI) and the Smart Readiness Indicator (SRI). This is tailored and designed for optimized local flexibility for the climate zones related to the six demo projects and implemented through the central ARV Cloud Hub.

D7.7 : Guidelines on climate zone related design principles [32]

Guideline on climate related design principles, based on the operational data of the demo projects, task evaluates the Flexibility Index (FI) and the Smart Readiness Indicator (SRI). This is tailored and designed for optimized local flexibility for the climate zones related to the six demo projects and implemented through the central ARV Cloud Hub. Methodologies for operational description of flexibility (D7.6).

D7.8 : Handbook for smart communities [42]

The methods will integrate input from grid sensors (WP8), user preferences (WP3, WP5) and interaction with flexibility markets. The implementation at the central ARV cloud hub. Handbook for Smart Communities

D7.9 : Principles for CEC-DSO interactions [46]

Methods for CEC-DSO interactions to solve possible DSO issues and conflicts. Interaction with WP9 on financial instruments (including P2P trading/DLTs such as blockchain among CECs). Business models and guidelines. Principles for CEC-DSO interactions (D7.9

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS14	Efficient & flexible operation	4 - DTU	34	Efficient & flexible operation at demo sites

Work package number [9]	WP8	Lead beneficiary [10]	8 - EURAC
Work package title	Monitoring, Evaluation and Impact Assessment		
Start month	1	End month	48

Objectives

This WP will: (OB.1) develop and implement the frameworks for monitoring, evaluation and impact assessment of the ARV Demos; (OB.2) perform the quality check, rating and final reporting of the overall performance of ARV Demos; (OB.3) create and deploy the interface between monitored, collected and processed data, and final users; (OB.4) perform the environmental, social and economic impact assessment of the ARV interventions, both to support the design and implementation of solutions during the project, and provide a detailed assessment of the results, with a cradle-to-cradle perspective, and with (OB.5) a multiple-benefit analysis.

Description of work and role of partners

WP8 - Monitoring, Evaluation and Impact Assessment [Months: 1-48]
EURAC, NTNU, ACE, CVUT, DTU, DANFOSS A/S, PROJECTZERO, SINTEF, PALMA, IBAVI, IREC, MET, UAS Utrecht, Center Denmark, SAB, GDFA, BOEX, Rc Panels B.V., UU, CITY OF UTRECHT, BOSGROEP, iwell, MEX, KARV, DOL, DTTN, UNITN, POLITO, OBF, NANO
This WP starts at the beginning of the project with (i) the design and development of the frameworks for monitoring, evaluation and impact assessment of six ARV Demos. Second, (ii) an ex-ante evaluation (i.e., before intervention) will take place (incl. monitoring of existing buildings to be retrofitted). Then, (iii) a streamlined assessment of environmental impacts and costs of alternative solutions (scenarios) will be performed to support the design of interventions. Moreover, (iv) the continuous monitoring and feedback to demos and stakeholders during the deployment in the demos and (v) an interim monitoring and evaluation of the on-site construction activities will take place. After implementation, (vi) an ex-post evaluation of the ARV Demos will be performed, including a detailed life-cycle environmental, economic and social impact assessment, with a cradle-to-cradle perspective, and (vii) a multiple benefit analysis. Drawing on the results, (viii) a synthesis will be provided, including interpretation, guidelines and recommendations for replication.
This WP has a strong link with WP2, as it builds on its KPIs, methods and tools; with WP3 on informing users (and their energy behaviours); with WP4 informing stakeholders during the integrated design and deployment phases; with WP5 informing the production process; with WP6 on monitoring of energy production, electricity grid and storage systems, and with WP7 in the connection between occupants' behaviour, building energy management (BEM) and control systems.

Task 8.1 Development of monitoring, evaluation and impact assessment specifications and guidelines. M01 – M12. Task leader: EURAC; Participants: IREC, PZ

Subtask 8.1.1. Elaboration of specifications and guidelines for the data monitoring
This subtask will set the standards, specifications and guidelines for the monitoring systems in the six ARV demos. Specifically, it will establish a common data monitoring framework and quality requirements for the specific monitoring systems, which will be tailor made according to needs of each demo (defined in Task 8.2), and facilitate the harmonisation of demos' data in a centralized data warehouse, in the ARV cloud hub. To support the evaluation and impact assessment of interventions, monitored data will include building energy consumption and production, indoor environmental quality (IEQ), users' behaviour, noise, dust and other emissions during on-site construction activities, and outdoor (external) micro-climate conditions. Inputs are expected from WP7 on the management of building energy systems.

Subtask 8.1.2 Elaboration of specifications and guidelines for the evaluation
This subtask will define the goal, scope, data sources and methods used for the evaluation of ARV demo interventions. In particular, it will select and define: the processes that will be addressed in the evaluation; how building performance gaps will be evaluated; how to estimate the construction and/or retrofitting time (to ensure a reduction > 30%), as well as the associated noise, dust and other emissions (which should be reduced by > 30%); how to analyse potential factors affecting the performance and results of the interventions, seismic behaviour of the construction systems, the evaluation of IEQ (to ensure an improvement of >30%) and the evaluation of the overall quality and rating of the ARV demos.

Subtask 8.1.3 Elaboration of specifications and guidelines for the impact assessment

This subtask will define the goal, scope, materials and methods of the impact assessment of ARV demos. Environmental, social and economic impacts will be assessed, building on internationally standardized and scientifically sound methodologies, e.g., life-cycle assessment (LCA), life-cycle costing (LCC) and social life-cycle assessment (SLCA). Two frameworks will be established, one comparing alternatives at an early stage, informing the design and development of ARV interventions, and another assessing the implemented interventions. The assessment will ensure the reduction of GHG emissions (in t CO2-eq/year) and ambient air pollution (e.g., kg PM2.5/year), among other impacts, in comparison with a baseline. Lastly, a multiple-benefit approach will be defined addressing environmental, economic and social aspects (see T8.5). For retrofit interventions, the impact assessment will compare pre- and post-intervention monitoring; for new construction, baselines will be defined based on legal requirements, standards or average performance (for new/ recent construction), depending on the scope and data availability.

Task 8.2 Static and dynamic data collection and monitoring. M01 – M48. Task leader: Center Denmark; Participants: EURAC, PZ, IBAVI, PCC, MET, IREC, HU, UU

Subtask 8.2.1 Description of monitoring systems in the six ARV demos
This subtask will define and describe the monitoring systems in each of the ARV demos, complying with the requirements (subtask 8.1.1). This description will include a list of technologies, data requirements and sources, covering the physical architectures of monitoring systems, their network architectures, the sensors to be installed, the functioning of data collection processes (frequency of the measurements, local storage, backup systems), and the data-related protocols. The monitoring system of each demo will be tailor-made and consider the inputs from demo lead partners. The following aspects will be monitored in each demo: (i) Energy production (on-site monitoring), (ii) Energy distribution (on-site monitoring), (iii) Energy consumption (on-site monitoring), (iv) Comfort (indoor) (TH – CO2), (v) User behaviours (i.e., opening of windows, CMV, etc.), and (vi) External micro-climate conditions (at district scale).

Subtask 8.2.2 Data architecture design
In this subtask, the data architecture will be designed, building on the results of subtask 8.2.1 and applying open standards. First, database technologies to use will be selected. Then, common protocols to adopt for data collection will be defined together with the demo leaders, and the data coming from each monitoring system will be unified into a unique database. EURAC will provide a platform for the centralized collection of monitored data produced by each ARV Demo.

Subtask 8.2.3 Data quality assessment (applying open standards)
This subtask will comprise regular data quality checks and provide feedback to respective ARV demos on the quality of the data they send, to ensure high quality and consistency of data. To identify the monitoring systems malfunction we will integrate a specific alert system in the automated workflow that evaluates the data quality, checking the completeness of the data (e.g., missing data) and the presence of anomalies (e.g., outliers).

Subtask 8.2.4 Data warehouse implementation and population
This subtask will integrate the data from demos in a centralized data warehouse, in the ARV Cloud Hub, incl. extraction, transformation and loading processes. We will include data on, construction activities and occupancy, in new buildings; retrofit activities, pre- and post-intervention occupancy, in case of retrofitted buildings; applied surveys; and simulations.

Task 8.3 Evaluation of the interventions and analysis of building performance gaps. M06-M48. Task leader: NTNU; Participants: EURAC, DAN, IBAVI, PCC, MET, IREC, UU, iWell, HU, RC, Bos Groep, MEX

Subtask 8.3.1 Quality of the intervention
This subtask will evaluate the quality of the interventions, building on the KPIs provided by WP2, together with monitored, project and literature data. It will address several aspects, incl.: IEQ, primary energy savings, investment in sustainable energy, production of energy from RES and design quality. Indoor environmental quality and comfort will be analysed incl. air quality, natural ventilation, lighting and acoustic indicators. This analysis will be linked to WP7 on building energy management (BEM) systems. The operational primary energy savings will be calculated, disaggregated into renewable and non-renewable energy (in GWh/year), incl. space heating, domestic hot water (DHW) and electricity demand. The investment in environmentally sustainable energy (in M€) and the share of energy and electricity supplied from RES (local production and grid supply) will also be estimated for all ARV demos. Lastly, building on the Design quality indicator (DQI), selected interventions in ARV Demos will be evaluated (through stakeholder engagement) in terms of functionality (user experience), construction quality, and architectural image (incl. form, design and integration).

Subtask 8.3.2 Building performance gaps evaluation and analysis

This subtask will evaluate building performance gaps (i.e., deviations between planned and actual building performance). Building energy performance gaps will be evaluated for the six ARV Demos, comparing the energy simulation and project targets (planned or expected energy performance and operational requirements) and monitored data. Other performance gaps, including IEQ and operation costs, will also be addressed in selected demos, according to data availability. An analysis of potential factors contributing to the performance gaps (e.g., occupants' behaviour, technological issues) will be performed, based on site-specific and literature data, and recommendations will be provided (incl. countermeasures).

Subtask 8.3.3 Evaluation of on-site construction and retrofit activities
An evaluation of on-site construction and/or retrofit activities will be performed, incl. (i) time, (ii) noise, dust and other emissions to air, and (iii) other selected indicators from the literature on construction productivity/efficiency. On-site construction/retrofit time and cost should be reduced by at least 30%, in order to enable market uptake and social affordability. Evaluation of on-site construction/retrofit activities regarding noise, dust and other emissions will be performed to ensure improved final indoor environment quality and reduction of dust and noise (by at least 30%), leading to higher rate of users' satisfaction, demonstrated with the relevant CEN standard (or equivalent).

Subtask 8.3.4 Analysis of factors that influence the monitored indicators and evaluation results
This subtask consists of an analysis of the factors that influence (cause-effect and/or correlation links) with the monitored indicators and evaluation results, such as: (i) factors that might influence energy consumption (indicators incl. monitored electricity, space and DW heating): occupancy, household characteristics; windows, solar exposure, indoor temperature, etc.; and (ii) factors influencing indoor environmental quality (indicators incl. temperature, CO2, PM, noise): use patterns and behaviour (e.g., opening windows, time at home, occupancy, natural ventilation).

Task 8.4 Assessment of environmental, social and economic impacts. M06-M48. Task leader: EURAC; Participants: NTNU, IREC, IBAVI, PCC, HU, BOEX, MU

Subtask 8.4.1 Streamlined environmental impact and cost assessment at support ARV interventions at design stage
In this subtask, an integrated streamlined LCA-LCC assessment model will be developed, with a cradle-to-cradle perspective, specifically oriented to inform and support the design of solutions for the ARV demos. The assessment will focus on potential non-renewable energy (NRE) requirements, GHG emissions and costs, per living area over a year (m2•year). To overcome the limited availability and quality of data on interventions, the approach will incorporate a building attribute to impact algorithm. Moreover, a multiple scenario analysis will be carried out to compare alternative strategies and solutions, potential shifts and trade-offs, and identify cost-optimal solutions and tipping points between reducing operational requirements and increased embodied environmental impacts and costs.

Subtask 8.4.2 Comprehensive life-cycle environmental and cost assessment of implemented ARV solutions
This subtask will perform a comprehensive assessment of potential life-cycle environmental impacts and costs (LCA and LCC) of the final (implemented) solutions in each ARV demo, within a cradle-to-cradle perspective. The assessment will address a wide range of impact categories, incl. primary non-renewable and renewable energy requirements, GHG emissions, ambient air pollution (e.g., PM2.5), acidification and eutrophication. Two functional units will be used, per person•year and per m2•year, to ease interpretation and comparability. A sensitivity analysis will provide insight on the influence of critical parameters on the results (e.g., occupancy, behaviour; electricity mix; and an uncertainty analysis. The assessment should demonstrate (i) high building energy performance (nearly zero-energy, Directive 2010/31/EU); (ii) reduction of GHG emissions (in t CO2-eq); (iii) reduction of embodied energy by 50%, without trade-offs in energy use and comfort (in connection to T8.3); and reduction of air pollution (in kg).

Subtask 8.4.3 Social life-cycle assessment of implemented ARV solutions
A SLCA will be performed building on UNEP/SETAC guidelines, considering impacts on four stakeholder groups: workers (incl. raw material extraction, manufacturing of building products and on-site construction), building occupants, local communities (i.e., living near production/construction sites) and society (general public in ARV Demo regions). The impact categories (selected based on existing social impact assessments of buildings and data availability) will include: (i) workers: health & safety, fair salary, working hours, discrimination, forced labour; (ii) building occupants: functionality/usability, health & comfort, accessibility; (iii) local communities: health & safety, accessibility, local employment; and (iv) society: technology development, public commitment to sustainability issues. These categories will be addressed through quantitative and semi-quantitative indicators, using both generic and site-specific data.

Task 8.5 Multiple-benefits analysis and assessment. M1-M48. Task leader: EURAC; Participants: POLITO; SINTEF, IREC, GDFA, demo leaders
The development of urban regeneration projects and activities related to CPCC implies a broad range of interventions, exceeding new buildings and energy infrastructure development (and/or refurbishment/upgrade of existing ones). Such

projects aim at social inclusion, increasing the quality of life of citizens, enhancing the valorisation of local social and cultural assets, protecting the environmental resources, boosting sustainable economic development, and so on. Under this perspective, other impacts, costs and benefits must be addressed within a multiple benefits approach (Ürge-Vorsatz et al. 2016) (Bisello, 2020) to provide a comprehensive overview on their magnitude. This task will apply the multiple benefits concept and its practical application towards the achievement of UN SDGs. The theoretical background will be developed by POLITO and EURAC. The goal is to maximize interdisciplinary and inter-sectoral collaboration (urban planning, social sciences, economics, buildings physics).

Subtask 8.5.1 Multiple benefits analysis: testing and fine tuning on ARV demo cases
With the collaboration of SINTEF (WP3 leader), IREC, and in close cooperation with the ARV demo leaders, and according to the framework defined in 8.1.3, a multiple benefits analysis will be performed at the local level (demo / CPCC / city scale). Thanks to stakeholders' engagement and active involvement, roadmaps to impact and multiple benefits mind maps will be locally defined and compared, to produce a shared framework.

Subtask 8.5.2 Measuring the success of ARV, towards an impact investing approach
The commonly accepted definition for impact investing is an investment that creates social or environmental benefits while also providing a return of principal, with returns ranging from zero to market. The subtask aims to sustain an impact investing approach, where the success of the project (investment) is measured through financial and economic criteria alongside Environmental, Social, and Governance (ESG) criteria, to leverage further investments, contributing to scale up and replication. An impact investing approach tailored on the outcomes of ARV project is tested, taking into account results of subtask 8.5.1, gathering data and analysing KPIs from demos, and in close cooperation with WP9 – GDFA.

Participation per Partner

Partner number and short name	WP8 effort
1 - NTNU	15.00
2 - ACE	0.50
3 - CVUT	19.50
4 - DTU	9.00
5 - DANFOSS A/S	3.00
7 - PROJECTZERO	5.00
8 - EURAC	36.00
9 - SINTEF	6.00
10 - PALMA	25.00
11 - IBAVI	21.00
12 - IREC	15.00
13 - MET	8.00
14 - UAS Utrecht	3.00
17 - Center Denmark	8.00
18 - SAB	3.00
19 - GDFA	2.00
20 - BOEX	1.00
21 - Rc Panels B.V.	1.00
22 - UU	2.00
23 - CITY OF UTRECHT	1.00

Partner number and short name	WP8 effort
24 - BOSGROEP	1.00
25 - iwell	1.00
26 - MEX	1.00
28 - KARV	9.00
29 - DOL	1.00
30 - DTTN	2.00
Armalam	1.00
31 - UNITN	8.00
32 - POLITO	10.00
33 - OBF	7.00
34 - NANO	3.00
Total	228.00

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D8.1	Monitoring, evaluation and impact assessment frameworks	8 - EURAC	Report	Public	12
D8.2	Data architecture, including description of monitoring systems in the ARV demos	17 - Center Denmark	Report	Public	18
D8.3	Structure and use of the data warehouse	17 - Center Denmark	Report	Public	48
D8.4	Evaluation results reports (including recommendations and guidelines for future projects)	1 - NTNU	Report	Public	48
D8.5	Streamlined LCA-LCCA comparing alternative solutions & scenarios	8 - EURAC	Report	Public	24
D8.6	LCA and LCC of the implemented solutions and social component	8 - EURAC	Report	Public	48
D8.7	Report on Multiple Benefits analysis and assessment	8 - EURAC	Report	Public	48
D8.8	Guidelines and recommendations for	8 - EURAC	Report	Public	48

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
	replication and/or future research				

Description of deliverables

D8.1 : Monitoring, evaluation and impact assessment frameworks [12]

guidelines for the monitoring systems in the six ARV demos. Specifically, it will establish a common data monitoring framework and quality requirements for the specific monitoring systems, which will be tailor made according to needs of each demo. Deliverable should be seen in context opf D2.1

D8.2 : Data architecture, including description of monitoring systems in the ARV demos [18]

This description will include a list of technologies, data requirements and sources, covering the physical architectures of monitoring systems, their network architectures, the sensors to be installed, the functioning of data collection processes (frequency of the measurements, local storage, backup systems), and the data-related protocols. The monitoring system of each demo will be tailor-made and consider the inputs from demo lead partners. The following aspects will be monitored in each demo: (i) Energy production (on-site monitoring), (ii) Energy distribution (on-site monitoring), (iii) Energy consumption (on-site monitoring), (iv) Comfort (indoor) (TH – CO2), (v) User behaviours (i.e., opening of windows, CMV, etc.), and (vi) External micro-climate conditions (at district scale).

D8.3 : Structure and use of the data warehouse [48]

integrate the data from demos in a centralized data warehouse, in the ARV Cloud Hub, incl. extraction, transformation and loading processes. We will include data on, construction activities and occupancy, in new buildings; retrofit activities, pre- and post-intervention occupancy, in case of retrofitted buildings; applied surveys; and simulations

D8.4 : Evaluation results reports (including recommendations and guidelines for future projects) [48]

quality of the interventions, building on the KPIs provided by WP2, together with monitored, project and literature data. It will address several aspects. Demos will be evaluated (through stakeholder engagement) in terms of functionality (user experience), construction quality, and architectural image

D8.5 : Streamlined LCA-LCCA comparing alternative solutions & scenarios [24]

an integrated streamlined LCA-LCC assessment model will be developed, with a cradle-to-cradle perspective, specifically oriented to inform and support the design of solutions for the ARV demos

D8.6 : LCA and LCC of the implemented solutions and social component [48]

comprehensive assessment of potential life-cycle environmental impacts and costs (LCA and LCC) of the final (implemented) solutions in each ARV demo, within a cradle-to-cradle perspective. The assessment will address a wide range of impact categories

D8.7 : Report on Multiple Benefits analysis and assessment [48]

apply the multiple benefits concept and its practical application towards the achievement of UN SDGs. The theoretical background will be developed by POLITO and EURAC. The goal is to maximize interdisciplinary and inter-sectoral collaboration (urban planning, social sciences, economics, buildings physics).

D8.8 : Guidelines and recommendations for replication and/or future research [48]

"Summarizing report with findings from activities in WP8. This WP has a strong link with WP2, as it builds on its KPIs, methods and tools; with WP3 on informing users (and their energy behaviours); with WP4 informing stakeholders during the integrated design and deployment phases; with WP5 informing the production process; with WP6 on monitoring of energy production, electricity grid and storage systems, and with WP7 in the connection between occupants' behaviour, building energy management (BEM) and control systems. These interconnections will be central here "

Schedule of relevant Milestones

Milestone number[18]	Milestone title	Lead beneficiary	Due Date (in months)	Means of verification
MS15	Preliminary LCA-LCC assessment	8 - EURAC	18	Preliminary report will be sent to relevant partners, on each demo, to have their review and feedback

Work package number [9]	WP9	Lead beneficiary [10]	19 - GDFA
Work package title	Business models, financial instruments, policy and exploitation		
Start month	3	End month	48

Objectives

Buildings energy efficiency is not moving fast enough to meet the Paris Agreement goals. Innovative business models and financial instruments are urgently needed. The benefits of the smart energy positive real estate of the demo sites go beyond energy/cost reductions and direct CO2 savings, but also enable energy flexibility to be commoditized and traded by the citizens as prosumers. The current low interest rate environment limits the ability to offer discounts on green loans and Energy Efficient Mortgages (EEMs), which acts as a disincentive to scale marked-based energy efficiency finance. Integration of flexible energy solutions in real-estate portfolios offers a new pathway to address this barrier by offering tools to strengthen returns on energy retrofit financing, whereby offering an innovative pathway to scale. In short, the work aims to use smart flexible energy solutions to accelerate the scaling of existing market-based financing, such as Energy Efficient Mortgages (EEMs), as well as to design entirely new financing mechanisms based on the citizen as prosumer.
Objective: Leverage the benefits of energy positive neighbourhoods to create new incentives for citizens and financial service institutions to invest in energy efficiency via business model and financial instrument innovation.

Description of work and role of partners

WP9 - Business models, financial instruments, policy and exploitation [Months: 3-48]
GDFA, NTNU, ACE, CVUT, DTU, DANFOSS A/S, ENFOR, PROJECTZERO, EURAC, SINTEF, PALMA, IBAVI, IREC, MET, UAS Utrecht, HOUSING EUROPE, Buro de Haan, Center Denmark, SAB, BOEX, Rc Panels B.V., UU, CITY OF UTRECHT, BOSGROEP, iwell, MEX, Mitros, KARV, DOL, DTTN, UNITN, POLITO, OBF, NANO, AIGUASOL SAEST
Task 9.1 Climate Positive Circular Communities Innovation Forum. M3-M48. Task Lead: NTNU, GDFA; Contributors: All
This task will collect, analyse, & disseminate demonstrated innovations across WPs 2-8 (intra-project & externally), collated into an annual ARV Innovation Intel for Impact (AI3) report. In addition, T9.1 will facilitate knowledge exchange with the ARV Exploitation Board to ensure early identification & scaling of commercially viable innovations (D9.1, D9.2, D9.3, & D9.4). As “demo-site leader Utrecht cluster” will ensure connection & collaboration with WP9-leader and demo-site clusters.

Task 9.2 Map scalable business models and financial instruments adaptable to EU. M3-M9. Task Lead: GDFA, Contributors: All
This task will first map existing market, policy and regulatory practices of real estate linked to EE financing for different real-estate asset classes (social housing, rental and privately owned) and of flexible energy solutions/practices/concepts both in and outside of the EU. Focus will be on practices that have proven ability to scale in other regions. Analysis of transferability of the practices to the six jurisdictions will be undertaken as well as analysis of how to link revenue from flexible energy assets to the real-estate financing models to strengthen return potential. The mapping will be conducted via interviews and web search. Additionally, regulatory and policy instruments at the EU level will be integrated into the mapping, including the Blockchain Observatory, SET PLAN Action 3.2, Clean Energy for All Europeans, and the Renovation Wave (D9.5). The results will be issued as a practice catalogue to be shared with European policy makers and FI in the six demo site countries.

Task 9.3 Design new bankable business models for energy positive neighborhoods. M9-41. Task Lead: GDFA. Contributors: City of Utrecht, DAN, PALMA, DTU, iWell, Bos Groep, UU, RCP, BOEX, HU, IREC, IBAVI, MET, AIGUA SINTEF, SAB, MEX, OBF ACE, NTNU
Building directly on Task 9.2, Develop, deploy, and evaluate new scalable for-profit and not-for-profit business and community models for design of flexibility/RES markets via smart trading platforms. Successfully working business models for different real-estate ownership structures (social housing, rental and privately owned) will be co-designed with the ARV demo sites to be trialled, evaluated and finally, working closely with WP7 and the six demo sites, design novel flexibility/RES markets and trading platforms (D9.6). Focus on a scaled approach that highlights simplification, ease of use/application via automation.

Subtask 9.3.1—Design Scalable Business Models (GDFA, contributors all listed in T9.3)

The work will design and test easily replicable innovative business models for the retrofitting and energy operation value chain. Design and tests will be undertaken on different ownership structures hereunder social and privately owned real estate (e.g., Netherlands in Utrecht demo-cluster for social housing and for private real estate in Spain). Focus will be on creating incentives for large scale retrofit including modes of demand aggregation. Business models to be explored include: Product-Service combinations (e.g., lease models) in the field of energy, safety, comfort, and renovation (WP4, WP5). Energy performance contracting based on the KPIs and Building Energy Management monitoring system (WP7) as well as new ways to overcome the split incentive problem in rented real-estate. For privately owned multi-family real-estate in Spain. Results of business model innovation work will be captured in business model blueprints as modules for replication in other jurisdictions across the EU.

Subtask 9.3.2—Design Platform Based Prosumer Business Models (GDFA, contributors all listed in T9.3)
Existing prosumer models in the EU are often not for profit. Current prices and tariff structures are not always geared to create sufficiently high margins to increase attractiveness of local energy market trading. The work will experiment with platform-based business model and market design that increase incentives to boost investments. Design and experimentation will be based on demo site conditions in jurisdictions with regulatory readiness e.g., in Spain where a Royal Decree allows residents in multi-occupancy buildings and local communities to establish 'collective auto-consumption' models that the local grid operator enables by close management of prosumers meter data. Also, the Netherlands, where specific tax breaks for co-operative prosumers have been secured. The work will identify barriers (technological, policy and regulatory) as well as avenues to replication into other EU markets on policy and regulatory environments and pathways from niche to mainstream, while safeguarding citizen participation and transparency on digital trading platforms.

Subtask 9.3.3 Economic viability and supporting market uptake (NTNU, contributors all listed in T9.3)
Select the most suitable business models and prepare a market analysis to elaborate strategies to support market uptake. To understand market uptake and replicability opportunities, this sub-task performs an economic analysis (quantifying revenues, cost-benefits, long-term viability, etc.) to set guidelines on the exploitation and commercialization CPCC related business models while considering regulatory and policy aspects reviewed in Task 9.2

Task 9.4 Design innovative financial instruments for energy positive real estate and communities. M15-M46. Task Lead: GDFA. Contributors: Housing Europe, DTU, PALMA, IREC, MET, SINTEF, OBF, NTNU

Subtask 9.4.1: Design building-linked financing solutions (GDFA, contributors all listed in T9.4)
The work will design innovative financing solutions that best accelerate transition to energy positive real-estate while being affordable and effective for buildings' owners and users. The work will collaborate with demo sites to design financing instrument to scale energy positive retrofits of different asset classes (social, rental, &privately owned). This will be done by experimentation and testing different ways to leverage surplus tradable energy (e.g. local markets or P2P frameworks) to innovate finance through strengthening collateral, allocating energy profits to internal fund structures in social housing tied to net-positive outcome retrofits, or use income from energy traded to service capital costs of EEMs.

Subtask 9.4.2 — Design digital bonds to scale prosumer flexible energy markets (GDFA, contributors all listed in T9.4)
This work will use demo site data to calculate cost and offer an overall design of a standard STO (green digital bond) for financing of flexible energy. Currently, the EU does not have a green Security Token Offering (STO) standard or principles equivalent to the EU green bond principles for centralized green bond issuances. GDFA will build on its work on digitalization of green bonds to demonstrate the potentials of using automation to enable cost efficient issuance of STO for flexible energy and retrofits. This will be done on a bank/or none bank managed "Do-It-Yourself" small bond issuance platform. The results will be captured in a green STO guide. A future foresight element will be built into this work which will be to explore the potential to use future carbon credits as collateral for energy efficiency finance discussing with banks on the structure and requirements for carbon credit future to be included into a financing instrument design (green loans, EEMs or green STOs). The timing is right as the European & international market infrastructure for trading carbon credits is growing making it inevitable that lenders will increasingly be asked to consider taking carbon credits as collateral. Hence, pushing forward this awareness among European FI can accelerate the interests in EE financing.

Task 9.5 CPCC pathways for scaling through the Exploitation Board. M27 – M46 Task Lead GDFA, Contributors All
An exploitation board will be established as a vehicle for scaling the business models and financing instruments. The Exploitation Board will be composed in part by strong innovation clusters as well as financial sector players that will spread the green building and renovation concepts to provide momentum to the 'renovation wave' that will be politically underpinned. GDFA will link the work to European Banks through UNEP FI as well as through the banking federations in the six living lab countries for market adoption of the new instruments. The demo clusters will setup a regional scale-up advisory groups of stakeholders and multipliers from the regional innovation cluster, such as regional housing

corporations, national housing corporation branches, construction (branches) organizations, other municipalities, to prepare replication and scale-up of the ARV CPCCs.

Participation per Partner

Partner number and short name	WP9 effort
1 - NTNU	11.00
2 - ACE	0.50
3 - CVUT	0.50
4 - DTU	8.00
5 - DANFOSS A/S	3.00
6 - ENFOR	1.00
7 - PROJECTZERO	0.50
8 - EURAC	1.00
9 - SINTEF	2.00
10 - PALMA	9.00
11 - IBAVI	1.50
12 - IREC	5.00
13 - MET	2.00
14 - UAS Utrecht	5.00
15 - HOUSING EUROPE	3.00
16 - Buro de Haan	1.50
17 - Center Denmark	1.00
18 - SAB	2.00
19 - GDFA	58.50
20 - BOEX	2.00
21 - Rc Panels B.V.	3.00
22 - UU	3.00
23 - CITY OF UTRECHT	4.00
24 - BOSGROEP	3.00
25 - iwell	3.00
26 - MEX	3.00
27 - Mitros	2.00
28 - KARV	0.50
29 - DOL	1.00
30 - DTTN	2.50
Armalam	2.50
31 - UNITN	0.50

Partner number and short name	WP9 effort
32 - POLITO	1.00
33 - OBF	6.00
34 - NANO	0.50
35 - AIGUASOL SAEST	1.50
Total	155.00

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D9.1	Develop an annual ARV Innovation Intel for Impact (AI3) report.	19 - GDFA	Report	Public	12
D9.2	Develop catalogue of business and financing models proven in other markets for adaptation in the EU to accelerate the renovation wave.	19 - GDFA	Report	Public	6
D9.3	Design business model blueprints for energy positive retrofits for different asset classes as modules for replication across the EU.	19 - GDFA	Report	Public	36
D9.4	Design Platform Based Prosumer Business Models with clear policy and regulatory recommendations.	19 - GDFA	Demonstrator	Public	41
D9.5	Design Building-linked financing instruments for FI adoption in re-estate portfolios	19 - GDFA	Demonstrator	Public	36
D9.6	Develop green digital bonds guide to scale prosumer flexible energy markets.	19 - GDFA	Other	Public	45
D9.7	Enable scaling across EU markets of energy positive renovation.	19 - GDFA	Other	Public	46

Description of deliverables

D9.1 : Develop an annual ARV Innovation Intel for Impact (AI3) report. [12]

collect, analyse, & disseminate demonstrated innovations across WPs 2-8 (intra-project & externally), collated into an annual ARV Innovation Intel for Impact (AI3) report. In addition, T9.1 will facilitate knowledge exchange with the

ARV Exploitation Board to ensure early identification & scaling of commercially viable innovations. Revisions: M12, M24, M36, M48

D9.2 : Develop catalogue of business and financing models proven in other markets for adaptation in the EU to accelerate the renovation wave. [6]

As for D9.1: To collect, analyse, & disseminate demonstrated innovations across WPs 2-8 (intra-project & externally), collated into an annual ARV Innovation Intel for Impact (AI3) report. In addition, T9.1 will facilitate knowledge exchange with the ARV Exploitation Board to ensure early identification & scaling of commercially viable innovations.

D9.3 : Design business model blueprints for energy positive retrofits for different asset classes as modules for replication across the EU. [36]

As for D9.1: To collect, analyse, & disseminate demonstrated innovations across WPs 2-8 (intra-project & externally), collated into an annual ARV Innovation Intel for Impact (AI3) report. In addition, T9.1 will facilitate knowledge exchange with the ARV Exploitation Board to ensure early identification & scaling of commercially viable innovations.

D9.4 : Design Platform Based Prosumer Business Models with clear policy and regulatory recommendations. [41]

As for D9.1: To collect, analyse, & disseminate demonstrated innovations across WPs 2-8 (intra-project & externally), collated into an annual ARV Innovation Intel for Impact (AI3) report. In addition, T9.1 will facilitate knowledge exchange with the ARV Exploitation Board to ensure early identification & scaling of commercially viable innovations.

D9.5 : Design Building-linked financing instruments for FI adoption in re-estate portfolios [36]

A mapping conducted via interviews and web search. Additionally, regulatory and policy instruments at the EU level will be integrated into the mapping, including the Blockchain Observatory, SET PLAN Action 3.2, Clean Energy for All Europeans, and the Renovation Wave

D9.6 : Develop green digital bonds guide to scale prosumer flexible energy markets. [45]

Develop, deploy, and evaluate new scalable for-profit and not-for-profit business and community models for design of flexibility/RES markets via smart trading platforms vSoftware development

D9.7 : Enable scaling across EU markets of energy positive renovation. [46]

Made up of several sub-topics: Design building-linked financing solutions, — Design digital bonds to scale prosumer flexible energy markets. CPCC pathways for scaling will be utilized through the Exploitation Board

Schedule of relevant Milestones

Milestone number[18]	**Milestone title**	**Lead beneficiary**	**Due Date (in months)**	**Means of verification**
MS16	Business model blueprints finalised	19 - GDFA	36	Blueprints available
MS17	Prosumer models proven	19 - GDFA	41	Model design ready and disseminated
MS18	Digital bond guide and digital structure ready	19 - GDFA	45	Guide distributed and digital bond interface ready

Work package number [9]	WP10	Lead beneficiary [10]	2 - ACE
Work package title	Communication, disseminations and stakeholder outreach		
Start month	1	End month	48

Objectives

The main objective of WP10 is to guarantee professional and public coverage of the project results and achievements, via the adoption of a large variety of distribution channels. A dual approach will be followed for this purpose, addressing through appropriate strategies a) the project as a whole and b) each CPCC demo in particular. In this view, carefully planned activities will be carried out so as to successfully outreach the whole of the stakeholder value chain needed to achieve a transformation to CPCC. ARV will contribute, upon invitation by the CINEA, to common information and dissemination activities to increase the visibility and synergies between H2020 supported actions. In particular, Communication and Dissemination(D&C) activities will aim to:
• Develop a comprehensive D&C plan, setting up an effective communication and dissemination strategy that will be contextualised to the specific communities at each CPCC Living Lab (LL).
• Enable-at local level- stakeholder engagement and outreach activities, supporting the co-creation process (WP3) by providing for each demo tailor-made packages.
• Identifying Green Ambassadors and facilitating their training (WP3) so they can act as multipliers.
• Increase awareness and promote the scalability and uptake of the developed innovative solutions -at a wider level- by addressing industry, academia, policy makers, governance and civil society
• Foster synergies -at EU level- contributing to common activities under the Green Deal initiatives
• Accelerate the impact of ARV innovative solutions, creating optimal conditions for their exploitation, among others through an e-marketplace platform.

Description of work and role of partners

WP10 - Communication, disseminations and stakeholder outreach [Months: 1-48]
ACE, NTNU, CVUT, DTU, DANFOSS A/S, ENFOR, PROJECTZERO, EURAC, SINTEF, PALMA, IBAVI, IREC, MET, UAS Utrecht, HOUSING EUROPE, Center Denmark, SAB, GDFA, UU, KARV, DOL, DTTN, UNITN, POLITO, OBF, NANO, AIGUASOL SAEST
Task 10.1 (T10.1) ARV project visual design. M1-M3Lead: NTNU, Participants: ACE
To ensure a common visual identity for the project, a corporate visual identity package will be developed, including a project logo, templates for presentations and newsletters and as a website eye-catcher. The visual elements will be formulated taking into account the need to incorporate existing graphic illustration of logos of related projects and partners. Professionally conceptualized and designed, the visual identity will not fail the test of time, thus, ensuring consistency and longevity for the initiative. The logo, the colors, the typeface, the imagery and photography will be in harmony and will be graphically representative of all objectives on all developed materials and strategies. Due consideration to the Graphical Guidelines of the European Commission will be given.

Task 10.2 (T10.2) Dissemination and Communication plan. M1-M48 Lead: ACE, Participants: ALL
Subtask 10.2.1 Core Dissemination and Communication strategy. Lead: ACE, Participants: ALL
A detailed D&C plan will be delivered within M6. This Plan will constitute the core document outlining the objectives and processes on the basis of the project's dissemination and communication activities. Additionally, this document addressing the two thematic areas (of social innovation and energy transition) will describe the strategy to effectively reach key stakeholders (identified in WP3), at local and European level, so as to create optimal conditions for the exploitation and market uptake of the developed solutions, building upon and supporting WP9 objectives. It will be subject to revision on a yearly basis and thus also report on undertaken dissemination/ communication activities and audience reached by all partners.

Subtask 10.2.2 Contextualized Dissemination and Communication strategies per CPCC Living Lab demo. M1-M48 Lead: SINTEF, Participants: ALL
The representatives of the CPCC Living Lab demos with the support of SINTEF and using the Core Dissemination and Communication strategy as a roadmap, will develop tailor-made Dissemination and Communication strategies, addressing the specific communities at neighborhood level for each of the 6 CPCC LLs. The first tailor made D&C strategies will be developed by M8 and will be revised in M20 and M38. They will specify the key stakeholders per demo to be targeted, as well as the key messages, outreach activities and tools devised to reach them. Customised

marketing tools and material will be described to support the tailor-made D&C strategy, such as press releases, vlogs, local language mini websites, LLs video diaries, podcasts, etc. The number and type of audience outreached will be monitored and reported at every revision of the document, following gender-equality and ethical considerations.

Task 10.3 (T10.3) ARV communication channels and dissemination material. M1-M48 Lead: Housing Europe, Participants: ALL

Subtask 10.3.1 Project website. Lead: ACE, Partners: ALL
The project will set up a website that shall be used as the main interface towards the stakeholders, who are interested in training possibilities, and information and outputs of the project. The website will act as a communication and dissemination channel for the results and for involving and enlarging the stakeholder's community.

Subtask 10.3.2 E-marketplace area. M1-M48 Lead: Housing Europe, Participants: ALL
An e- marketplace area will be set up and embedded on the website, as a "one stop shop". There, all project results will be merged, providing guidelines for end users, links to different resources, information on product suppliers, software, spreadsheets and datasets. Training material and technical guidance will also be included. Information will be easily filtered by type, topic, scale, country, license, etc. This area will also serve as a contact point for all demonstration projects targeting Climate Positive Circular Communities, enabling virtual connectivity and collaboration.

Subtask 10.3.3 Social Media channels. M1-M48 Lead: ACE, Participants: ALL
In addition to the website and e-marketplace area, Social media channels will be set up. These networks will acquire high importance thus bridging the gap in international and national communication. Social media: Twitter, LinkedIn Group, Facebook Community, YouTube Channel. The content of these media channels will be constantly updated with demo-site focused news (among others video diaries, citizen journalism, storytelling, etc.)

Subtask 10.3.3 Newsletters and dissemination material. M1-M48 Lead: Housing Europe, Participants: ALL
• A bi-annual e-Newsletter providing information on project progress and results, links to press and news releases, articles and interviews. The newsletter will in turn address different stakeholder groups e.g.: a) stakeholders in construction value chain b) housing providers, property owners and occupiers and c) local authorities. This will allow for a differentiation between groups adapting the knowledge transfer channels.
• Information on the project will also be provided by a project leaflet produced in English and in all languages in the consortium to guarantee a wider geographical coverage.
• 1 A0 poster and 1 roll-up poster will be produced to be displayed during workshops, fairs and conferences. 1 infographic (M36) will summarize the main objectives and solutions implemented in the 6 CPCC LLs. Relevant project partners will be responsible for the translations of the above-described material.
• A subtitled video for the 6 CPCC demos will present the local context and the solutions developed by ARV project, as well as the feasibility, reliability and replicability of the solutions proposed. The video will show the interactions of the activities around the demos with the local community. It will be shared widely on the website and the relevant social network channels, supporting the sustainability of the project results beyond the project's lifetime. The key deliverables of the project will be presented briefly in short video recordings representing the relevant partners, summarizing their reports. These videos will be uploaded on the project's YouTube channel and website and will be widely promoted through the project's Social Media. Additionally, informational factsheets illustrating project progress and published deliverables will be developed regularly to be distributed to the relevant target groups. Based on the informational factsheets, a project result booklet containing description of all the results achieved in ARV will be produced with the contributions of all partners involved in the 6 CPCC demos.

Task 10.4 (T10.4) Stakeholder outreach and capacity building. M1-M48 Lead: Housing Europe, Participants: ACE, All

Subtask 10.4.1 Outreach and engagement of Citizens with workshops, training and socio/cultural events. Lead: Housing Europe Partners: All
Engagement activities within WP3 need the support of WP10 in order to successfully outreach and engage citizens. The tailor-made D&C Strategies developed in T10.2 will address the thematic focus areas of the Living Labs in the demo sites. They will include support packages with decision support tools, description of processes for mentoring of the LLs managers, and training material (e.g., board games), to be devised in WP3 citizen engagement activities. Special focus will be given to high school students and young researchers to be targeted through local seminars. Open days and interactive guided tours will be organised, showcasing the demos in detail. A series of programmes, including talks, workshops and festivals will take place at local level, in order to make the experience of each CPCC LL demo more engaging and accessible. Alternatively, online events will be used if physical gatherings are not possible. Moreover, each CPCC LL demo will build on local initiatives and participate at local social and cultural events as part of more general outreach and public engagement activities, aiming to maximize visibility of the project. Citizens will be invited to

follow social media and will receive relevant dissemination material. They will also be invited to share their experiences and viewpoints through video diaries and podcasts. This material will be widely disseminated through the project communication channels. Furthermore, each CPCC LL demo will setup a regional scale-up advisory group from the regional innovation cluster, such as regional housing corporations, national housing corporation branches, construction (branches) organisations, other municipalities, to prepare replication and scale-up of the ARV demonstration tested in the CPCC LL demos. These identified stakeholders, (four per regional advisory group) will form the "Local Green Ambassadors" and will receive training in order to ensure the scalability of the developed solutions and systems (T3.3).

Subtask 10.4.2 Outreach and engagement with municipalities and policy makers M1-M48 Lead: Housing Europe Partners: All
The CPCC Living Labs will engage the local councils and municipalities (WP2 & WP3) working closely with them in order to better address their needs combined within a framework linked to potential governance models. Through the participation in international events and other activities, municipalities outside the already established network will be reached to show the replication potential. The CPCC Living Lab results and technologies, will be widely communicated aiming to multiply implementation of ARV solutions while policy briefs and recommendations will be highlighted.
Subtask 10.4.3 Outreach and engagement with industry and civil society. M1-M48 Lead: ACE Participants: Housing Europe, DAN, MET, AIGUA, PALMA, OBF, City of Utrecht, PZ, KARV, DTTN
- Two conferences- one technological and the other more political- will be held towards the end of the project where innovative solutions, the CPCC and recommendations will be highlighted, addressing SMEs/ industry, end-users, as well as developers and cities.
- Targeted events will be organized by each of the participating umbrella organizations (ACE and Housing Europe) in order to promote through awareness raising workshops the ARV approach and support further exploitation. Workshops can be coupled with site visits of the demos if applicable. ACE: Four awareness raising events will be organized throughout Europe with a workshop and poster display (of demonstration buildings) with an aimed attendance of 25-50 people per event. The National Member Organizations will be invited to participate in these events in order to enhance the impact. The main aim is to raise awareness on Citizen Engagement and the Co-creation process, advocating the importance of the architects' role from the early stages of every process. Housing Europe: Four workshops aiming at awareness raising will be organized for the Housing Europe Member Associations. The main aim is to promote the acceptance and market uptake of the CPCC models, promote and raise awareness on the Citizen Engagement (2x) and Market Uptake (2x) and get feedback of the members of the usefulness of these outputs.

Subtask 10.4.4 Outreach and engagement with academia. M1-M48 Lead: CVUT, Partners: NTNU, DTU, HU, UU, UNITN, POLITO, IREC
Project results will be published and presented in at least 10 scientific conferences. The academic/ research partners will publish a minimum of 14 Open Access papers in high impact scientific journals to spread the ARV results to the specialist and wider research community.

Task 10.5 (T10.5). Clustering and contribution to common H2020 Activities and other EU events. M1-M48 Lead: ACE, Partners: ALL This task covers resources to contribute, in mutual agreement with EASME, to common dissemination activities to increase synergies between, and the visibility of H2020 supported actions. ARV will be present at the EU Sustainable Energy week, and other EU initiatives or supported activities (e.g., Sustainable Places conference series) ARV will contribute upon invitation to EASME to common information and dissemination activities to increase synergies & visibility of EC supported actions. Moreover, we will gather lessons learned from the ARV demo projects, and innovations in all WPs to produce a guide for stakeholders to implement successful CPCC.

Participation per Partner

Partner number and short name	WP10 effort
1 - NTNU	10.00
2 - ACE	12.00
3 - CVUT	2.00
4 - DTU	2.50
5 - DANFOSS A/S	1.00
6 - ENFOR	0.50

Partner number and short name	WP10 effort
7 - PROJECTZERO	3.00
8 - EURAC	2.00
9 - SINTEF	5.00
10 - PALMA	7.00
11 - IBAVI	1.50
12 - IREC	4.00
13 - MET	1.00
14 - UAS Utrecht	2.00
15 - HOUSING EUROPE	22.00
17 - Center Denmark	1.00
18 - SAB	3.00
19 - GDFA	0.50
22 - UU	2.00
28 - KARV	1.00
29 - DOL	0.50
30 - DTTN	0.50
31 - UNITN	0.50
32 - POLITO	1.00
33 - OBF	0.50
34 - NANO	0.50
35 - AIGUASOL SAEST	0.50
Total	87.00

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
D10.1	ARV corporate identity	1 - NTNU	Other	Public	3
D10.2	i) Core Communication and Dissemination Plan & ii) tailored strategies for the 6 CPCC LL demos	2 - ACE	Report	Confidential, only for members of the consortium (including the Commission Services)	8
D10.3	Project website, e-marketplace &Social Media	15 - HOUSING EUROPE	Websites, patents filing, etc.	Public	6
D10.4	Newsletters & dissemination material:	15 - HOUSING EUROPE	Websites, patents filing, etc.	Public	6

List of deliverables

Deliverable Number[14]	Deliverable Title	Lead beneficiary	Type[15]	Dissemination level[16]	Due Date (in months)[17]
	Leaflet, Posters, Video, Infographic				
D10.5	Project booklet summarising results achieved in ARV	15 - HOUSING EUROPE	Report	Public	42
D10.6	Final report on dissemination and communication activities	2 - ACE	Report	Public	48
D10.7	Report on contribution to common H2020 Activities	2 - ACE	Report	Public	44
D10.8	A blueprint for planning, (re)design, (re)construction, operation and use of CPCCs	1 - NTNU	Report	Public	12

Description of deliverables

D10.1 : ARV corporate identity [3]

To ensure a common visual identity for the project, a corporate visual identity package will be developed, including a project logo, templates for presentations and newsletters and as a website eye-catcher. Due consideration to the Graphical Guidelines of the European Commission will be given

D10.2 : i) Core Communication and Dissemination Plan & ii) tailored strategies for the 6 CPCC LL demos [8]

A detailed D&C plan will be delivered within M6. This Plan will constitute the core document outlining the objectives and processes on the basis of the project's dissemination and communication activities. The second part is to develop tailor-made Dissemination and Communication strategies, addressing the specific communities at neighborhood level for each of the 6 CPCC LLs. The first tailor made D&C strategies will be developed by M8 and will be revised in M20 and M38

D10.3 : Project website, e-marketplace &Social Media [6]

The project will set up a website that shall be used as the main interface towards the stakeholders, who are interested in training possibilities, and information and outputs of the project. The website will act as a communication and dissemination channel for the results and for involving and enlarging the stakeholder's community Revisions planned for M6, M12, M24, M436, M48

D10.4 : Newsletters & dissemination material: Leaflet, Posters, Video, Infographic [6]

"• A bi-annual e-Newsletter providing information on project progress and results, links to press and news releases, articles and interviews. The newsletter will in turn address different stakeholder groups e.g.: a) stakeholders in construction value chain b) housing providers, property owners and occupiers and c) local authorities. This will allow for a differentiation between groups adapting the knowledge transfer channels. • Information on the project will also be provided by a project leaflet produced in English and in all languages in the consortium to guarantee a wider geographical coverage. • 1 A0 poster and 1 roll-up poster will be produced to be displayed during workshops, fairs and conferences. 1 infographic (M36) will summarize the main objectives and solutions implemented in the 6 CPCC LLs. Relevant project partners will be responsible for the translations of the above-described material. • A subtitled video for the 6 CPCC demos will present the local context and the solutions developed by ARV project, as well as the feasibility, reliability and replicability of the solutions proposed. The video will show the interactions of the activities around the demos with the local community. It will be shared widely on the website and the relevant social network channels, supporting the sustainability of the project results beyond the project's lifetime. • The key deliverables of the project will be presented briefly in short video recordings representing the relevant partners, summarizing their

reports. These videos will be uploaded on the project's YouTube channel and website and will be widely promoted through the project's Social Media. Additionally, informational factsheets illustrating project progress and published deliverables will be developed regularly to be distributed to the relevant target groups. Based on the informational factsheets, a project result booklet containing description of all the results achieved in ARV will be produced with the contributions of all partners involved in the 6 CPCC demos." Several sub-deliverables. M6 & M30 (Leaflet) M9 (Posters) M18 (Video) M36 (Infographic)

D10.5 : Project booklet summarising results achieved in ARV [42]

Project booklet summarising results achieved in ARV

D10.6 : Final report on dissemination and communication activities [48]

The final report on dissemination and communication activities.

D10.7 : Report on contribution to common H2020 Activities [44]

Report on contribution to common H2020 Activities

D10.8 : A blueprint for planning, (re)design, (re)construction, operation and use of CPCCs [12]

A blueprint for planning, (re)design, (re)construction, operation and use of CPCCs Revisions M12, 24, 36, 48

Schedule of relevant Milestones

Milestone number[18]	**Milestone title**	**Lead beneficiary**	**Due Date (in months)**	**Means of verification**
MS19	ARV Website	2 - ACE	6	Website Up and running
MS20	E-marketplace platform launched	2 - ACE	6	E-marketplace platform operational with the full structure defined and first contents uploaded, with a plan for continuous updating

1.3.4. WT4 List of milestones

Milestone number[18]	Milestone title	WP number[9]	Lead beneficiary	Due Date (in months)[17]	Means of verification
MS1	Project initiation	WP1	1 - NTNU	3	CA & Minutes of KOM
MS2	ARV Assessment framework	WP2	12 - IREC	9	Assessment framework defined
MS3	Implementation of tools	WP2	12 - IREC	15	Implementation of tools for Large Scale Retrofitting actions started
MS4	Virtual Reality Environments	WP2	12 - IREC	36	Virtual Reality Environments used and implemented
MS5	Overall methodology in T3.2	WP3	9 - SINTEF	9	Methodology corresponding with the deliverable completed
MS6	LL reports	WP3	9 - SINTEF	24	First LL reports completed
MS7	Integrated circular design progress	WP4	1 - NTNU	20	Design reports zero-emission & positive energy buildings in CPCCs D4.2-4.6
MS8	First iteration of recognized typologies	WP5	14 - UAS Utrecht	12	Amount and quality of recognized typologies
MS9	Final iteration of recognized typologies and the Pre-Manufacturing workflow.	WP5	14 - UAS Utrecht	24	Verification of automated delivered input for File2Factory
MS10	First iteration of manufacturing workflow analyses	WP5	14 - UAS Utrecht	30	Amount of activities changed to the off-site manufacturing.
MS11	Manufacturing principles realized	WP5	14 - UAS Utrecht	36	Analyses output manufacturing. Delivered modules to construction site
MS12	Realization of demo projects	WP5	14 - UAS Utrecht	36	Construction of the projects completed
MS13	Integrated renewables and storage systems progress	WP6	3 - CVUT	20	Process reports on integrated renewables and storage systems in CPCCs D6.2-6.6
MS14	Efficient & flexible operation	WP7	4 - DTU	34	Efficient & flexible operation at demo sites
MS15	Preliminary LCA-LCC assessment	WP8	8 - EURAC	18	Preliminary report will be sent to relevant partners, on each demo, to have their review and feedback
MS16	Business model blueprints finalised	WP9	19 - GDFA	36	Blueprints available

Milestone number[18]	Milestone title	WP number[9]	Lead beneficiary	Due Date (in months)[17]	Means of verification
MS17	Prosumer models proven	WP9	19 - GDFA	41	Model design ready and disseminated
MS18	Digital bond guide and digital structure ready	WP9	19 - GDFA	45	Guide distributed and digital bond interface ready
MS19	ARV Website	WP10	2 - ACE	6	Website Up and running
MS20	E-marketplace platform launched	WP10	2 - ACE	6	E-marketplace platform operational with the full structure defined and first contents uploaded, with a plan for continuous updating

1.3.5. WT5 Critical Implementation risks and mitigation actions

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
1	Delay of technical deliverables (general risk)	WP2, WP3, WP4, WP5, WP6, WP7, WP8, WP9	WP1 will ensure the project schedule & deal with obstacles as soon as they arise. WP leaders and partners have proven their ability to deliver on time in other projects.
2	Design errors & barriers in the integration of different technologies & components (general risk)	WP4, WP5, WP6, WP7	To ensure that technologies fit together properly, integrated energy design with modelling will be applied for design, evaluation & optimization.
3	District Digital Twin models may be complex and heavy (general risk)	WP2, WP4, WP5, WP6, WP7, WP8	This risk will be mitigated by the distributed nature of the ARV digital cloud hub. If performance issues still are encountered, these will be addressed by developing additional levels of detail.
4	Unclear formulation of goals or deliverables (general risk)	WP1	WP1 will ensure clearly formulated goals and milestones. Involvement from stakeholders in other projects show their ability to formulate goals and design a project accordingly.
5	Delay in the demonstration cases (demonstration cases)	WP4, WP5, WP6	Building owners and stakeholders have confirmed commitment in a Letter of Support. If a project cannot continue due to external factors, the ARV consortium will propose measures and provide a replacement with equal quality.
6	Insufficient financing to pursue/scale-up the demo innovations (demonstration cases)	WP2, WP3, WP4, WP5, WP6, WP7, WP8, WP9	Financial incentives in countries and the EU as a whole will be mapped and pursued by demos.
7	Low interest/involvement among occupants (demonstration cases)	WP3	Make it simple and attractive for occupants to get involved, e.g. arrange competitions, integrate living labs in existing arenas, games, apps, etc.
8	Failure to reach TRL 7-8 of innovations (demonstration cases)	WP2, WP3, WP4, WP5, WP6, WP7, WP8, WP9	All innovations are relatively mature (TRL 5-6)
9	Underestimated resources for demonstration activities (demonstration cases)	WP2, WP3, WP4, WP5, WP6	Funding for demos are committed by stakeholders. The reserved budget in ARV will be dedicated to support innovative activities (e.g implementing Cloud Hub)
10	Inability to collect data and ensure its quality for evaluation (demonstration cases)	WP8	A dedicated WP8 will ensure success for data collection in the demos
11	National/EU-wide regulations leading to sub-optimal innovation implementation (demonstration cases)	WP2, WP3, WP4, WP5, WP6, WP7, WP8, WP9	Innovations will be adapted to necessary regulations – ARV Innovation Forum and dedicated tasks in WP9

Risk number	Description of risk	WP Number	Proposed risk-mitigation measures
12	Consultant or contractor delays/errors (demonstration cases)	WP4, WP5, WP6	The lead time will be included in the schedule and communicated as early as possible.
13	Poor performance of a beneficiary (Management)	WP1, WP10, WP2, WP3, WP4, WP5, WP6, WP7, WP8, WP9	The project management team will monitor compliance of partners. If performing unsatisfactory, they will be formally notified and given one month to correct. If the situation does not improve, the partner may be voted defaulting by the General Assembly
14	Unclear allocation of tasks and responsibilities by partners and countries (management)	WP1, WP10, WP2, WP3, WP4, WP5, WP6, WP7, WP8, WP9	All meetings in the ARV project will include a mandatory list of tasks along with a proposal of who will follow up on each task
15	A key project staff could change their position in their organisations (management)	WP1	All key persons are highly committed to ARV. Coordinator and WP leaders are from highly competent organisations able to replace a key person.
16	Technical / administrative disagreement among consortium partners. (management)	WP1	All partners are experienced in EU research projects. Many have collaborated previously. All have signed a collaboration agreement and will sign a Consortium Agreement (w/conflict resolution clauses).
17	Lack of communication, causing lack of clarity (Management)	WP1, WP10, WP2, WP3, WP4, WP5, WP6, WP7, WP8, WP9	A communication plan which includes frequency, goals and the target group of each communication will be set up.
18	Unauthorized decision making or delays causing poor deliverable quality (Management)	WP1, WP10, WP2, WP3, WP4, WP5, WP6, WP7, WP8, WP9	A dedicated task in WP1 ensure frequent status meetings between researchers, partners, and management to minimize uncertainty of obstacles.
19	Inadequate market uptake acceleration caused by unclear exploitation and business plans (Other)	WP9	Business model design in WP9 will be undertaken in dialogue with financial service institutions and the exploitation board to ensure alignment to requirements of financiers and cross jurisdiction market needs.
20	Limited coverage of communication to disseminate the innovation (Other)	WP10	The PMT and the communication experts in WP10 will use the Communication Plan actively to ensure dissemination. ARV's consortium is well represented in EERA Smart Cities, ECTP, many IEA Annexes & Clusters, maximising impact.
21	Insufficient quality of deliverables and dissemination (Other)	WP1, WP10, WP2, WP3, WP4, WP5, WP6, WP7, WP8, WP9	The QAP, the communication experts and project stakeholders have precious experience in disseminating high quality deliverables from many projects.

1.3.6. WT6 Summary of project effort in person-months

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	WP10	Total Person/Months per Participant
1 - NTNU	77	9	12	25.50	3.50	15	14	15	11	10	192
2 - ACE	4	1	4	2	1	0	0	0.50	0.50	12	25
3 - CVUT	7	6.50	18	18	19	37	23.50	19.50	0.50	2	151
4 - DTU	4	16	0	0	0	20	46	9	8	2.50	105.50
5 - DANFOSS A/S	1	0	0	0	0	1	9	3	3	1	18
6 - ENFOR	1	0	0	0	0	18	18	0	1	0.50	38.50
7 - PROJECTZERO	7	3	3	1	0	3.50	4	5	0.50	3	30
8 - EURAC	2	3	4	3	3.50	2	3	36	1	2	59.50
9 - SINTEF	4	12	37	14	7	4	7	6	2	5	98
10 - PALMA	7	47	50	22	16	1	5	25	9	7	189
11 - IBAVI	1	3	0	16	8.50	0	0	21	1.50	1.50	52.50
12 - IREC	4	67	16	23	10	1	20	15	5	4	165
13 - MET	1	0	8	0	0	0	4	8	2	1	24
14 - UAS Utrecht	10	3	1	19	35	2	1	3	5	2	81
15 - HOUSING EUROPE	1	1	6	0	0	0	2	0	3	22	35
16 - Buro de Haan	0.50	0	0	0	15	0	0	0	1.50	0	17
17 - Center Denmark	1	4	4	0	0	4	33	8	1	1	56
18 - SAB	1	0	3	0	0	2	3	3	2	3	17
19 - GDFA	4	0	1	0	0	0	0	2	58.50	0.50	66
20 - BOEX	1	0	5	1	5	2	3	1	2	0	20
21 - Rc Panels B.V.	0.50	0	0	13	6	2	0	1	3	0	25.50
22 - UU	1	0	0	5	2	14	19	2	3	2	48
23 - CITY OF UTRECHT	1	0	11	0	2	0	2	1	4	0	21

	WP1	WP2	WP3	WP4	WP5	WP6	WP7	WP8	WP9	WP10	Total Person/Months per Participant
24 - BOSGROEP	1	0	0	13	13	10	0	1	3	0	41
25 - iwell	1	0	0	0	0	0	17	1	3	0	22
26 - MEX	1	0	0	6	9	2	0	1	3	0	22
27 - Mitros	1	0	5	0	0	6	3	0	2	0	17
28 - KARV	1	2	7	4	5	6	5	9	0.50	1	40.50
29 - DOL	1	0	1	0	0	15	1	1	1	0.50	20.50
30 - DTTN	2.50	3.50	6	4	6	0	2	2	2.50	0.50	29
· Armalam	1.50	0	0	3	12	0	1	1	2.50	0	21
· X-LAM DOLOMITI	0	0	0	0.50	11.50	0	0	0	0	0	12
· FANTI LEGNAMI	0	0	0	0.50	7.50	0	0	0	0	0	8
31 - UNITN	1	0	0	22	22	0	2	8	0.50	0.50	56
32 - POLITO	1	0	0	20	8	11	0	10	1	1	52
33 - OBF	7	7	11	9	4	4	2	7	6	0.50	57.50
34 - NANO	1	0	0	0	0	10	4	3	0.50	0.50	19
35 - AIGUASOL SAEST	1	9.50	0	23	0	0	0	0	1.50	0.50	35.50
Total Person/Months	162	197.50	213	267.50	231.50	192.50	253.50	228	155	87	1987.50

1.3.7. WT7 Tentative schedule of project reviews

Review number [19]	Tentative timing	Planned venue of review	Comments, if any
RV1	21	Brussels or online	
RV2	39	Brussels or online	
RV3	48	Brussels or online	

1. Project number

The project number has been assigned by the Commission as the unique identifier for your project. It cannot be changed. The project number **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

2. Project acronym

Use the project acronym as given in the submitted proposal. It can generally not be changed. The same acronym **should appear on each page of the grant agreement preparation documents (part A and part B)** to prevent errors during its handling.

3. Project title

Use the title (preferably no longer than 200 characters) as indicated in the submitted proposal. Minor corrections are possible if agreed during the preparation of the grant agreement.

4. Starting date

Unless a specific (fixed) starting date is duly justified and agreed upon during the preparation of the Grant Agreement, the project will start on the first day of the month following the entry into force of the Grant Agreement (NB : entry into force = signature by the Agency). Please note that if a fixed starting date is used, you will be required to provide a written justification.

5. Duration

Insert the duration of the project in full months.

6. Call (part) identifier

The Call (part) identifier is the reference number given in the call or part of the call you were addressing, as indicated in the publication of the call in the Official Journal of the European Union. You have to use the identifier given by the Commission in the letter inviting to prepare the grant agreement.

7. Abstract

8. Project Entry Month

The month at which the participant joined the consortium, month 1 marking the start date of the project, and all other start dates being relative to this start date.

9. Work Package number

Work package number: WP1, WP2, WP3, ..., WPn

10. Lead beneficiary

This must be one of the beneficiaries in the grant (not a third party) - Number of the beneficiary leading the work in this work package

11. Person-months per work package

The total number of person-months allocated to each work package.

12. Start month

Relative start date for the work in the specific work packages, month 1 marking the start date of the project, and all other start dates being relative to this start date.

13. End month

Relative end date, month 1 marking the start date of the project, and all end dates being relative to this start date.

14. Deliverable number

Deliverable numbers: D1 - Dn

15. Type

Please indicate the type of the deliverable using one of the following codes:

R	Document, report
DEM	Demonstrator, pilot, prototype
DEC	Websites, patent fillings, videos, etc.
OTHER	
ETHICS	Ethics requirement
ORDP	Open Research Data Pilot
DATA	data sets, microdata, etc.

16. Dissemination level

Please indicate the dissemination level using one of the following codes:

PU	Public
CO	Confidential, only for members of the consortium (including the Commission Services)
EU-RES	Classified Information: RESTREINT UE (Commission Decision 2005/444/EC)
EU-CON	Classified Information: CONFIDENTIEL UE (Commission Decision 2005/444/EC)
EU-SEC	Classified Information: SECRET UE (Commission Decision 2005/444/EC)

17. Delivery date for Deliverable

Month in which the deliverables will be available, month 1 marking the start date of the project, and all delivery dates being relative to this start date.

18. Milestone number

Milestone number:MS1, MS2, ..., MSn

19. Review number

Review number: RV1, RV2, ..., RVn

20. Installation Number

Number progressively the installations of a same infrastructure. An installation is a part of an infrastructure that could be used independently from the rest.

21. Installation country

Code of the country where the installation is located or IO if the access provider (the beneficiary or linked third party) is an international organization, an ERIC or a similar legal entity.

22. Type of access

TA-uc	if trans-national access with access costs declared on the basis of unit cost,
TA-ac	if trans-national access with access costs declared as actual costs, and
TA-cb	if trans-national access with access costs declared as a combination of actual costs and costs on the basis of unit cost,
VA-uc	if virtual access with access costs declared on the basis of unit cost,
VA-ac	if virtual access with access costs declared as actual costs, and
VA-cb	if virtual access with access costs declared as a combination of actual costs and costs on the basis of unit cost.

23. Access costs

Cost of the access provided under the project. For virtual access fill only the second column. For trans-national access fill one of the two columns or both according to the way access costs are declared. Trans-national access costs on the basis of unit cost will result from the unit cost by the quantity of access to be provided.

CLIMATE POSITIVE CIRCULAR COMMUNITIES — ARV

History of changes

Revision date	Change:	Justification for change
21.05.2021	Table of Content added. Tables and sections removed.	As requested by the Agency according to GAP Preparation procedure.
21.05.2021	Table 2.10: Revision of targets have been made	The change was implemented to address the following comment from the Evaluation Summary Report: "Some targets in Table 2.10 are not fully ambitious."
21.05.2021	Section 2.2.5 Communication activities have been updates with # of visits to schools, seminars etc.	The change was implemented to address the following comment from the Evaluation Summary Report: "The quality of the communication measures is very good, however, some activities are not clearly quantified."
21.05.2021	Information on PV-system added to the section on the Norwegian Demo case.	The change was implemented to address the following comment from the Evaluation Summary Report: "There is not sufficient clarity on the size of some actions (e.g. the area of installed photovoltaics in Norway)."
21.05.2021	Following text added to section 3.4: All depreciation costs for equipment, infrastructure or other assets in the project are in compliance with Article 6 and will be recorded in the appropriate beneficiary's accounts, purchased in accordance with Article 10 of the grant agreement and written off in accordance with international accounting standards and the beneficiary's usual accounting practices.	As requested by the Agency.
03.06.2021	Increased number of PMs for P33 POLITO in WP4 (from 12 to 20 PMs), WP6 (from 9 to 11 PMs), WP8 (from 8 to 10 PMs). Budget unchanged. Relevant tables updated accordingly.	Justification from partner: "We did not (erroneously) foresee this in the budget preparation as at the time of the submission of the proposal the team included only senior personnel and it was not foreseeable that younger scientist could be enrolled. The post pandemic governmental actions now do allow us to consider this."
03.06.2021	CFS costs for P10 Palma added to Table 3.4b.	As requested by the Agency.
09.06.2021	Beneficiary short-names have been changed as following: : - HAB replaced with DTTN - HE replaced with Housing Europe - BdH replaced with Buro de Haan - EUDIH replaced with Center Denmark - UTR replaced with City of Utrecht	As requested by the Agency in order to ensure consistency between Part A and Part B.

	- BOS replaced with Bos Groep - MITR replaced with MITROS - PORT replaced with Portaal - OBY replaced with OBF - UITR replaced with UNITN	
09.06.2021	GANNT-chart updated: - D3.3 moved to M13 - D3.4 moved to M24 as first delivery date - D5.2 renumbered to D5.1 - Deliverables D5.2 and 5.8-5.12 in M36	As requested by the Agency in order to ensure consistency between Part A and Part B.
11.06.2021	For the third parties involved in the project, updated the tables in Section 4.2: - To include the WP, the task and/or subtask that work is being subcontracted - To include amounts of subcontracts - To include the following sentence: "Subcontractor t.b.d. The subcontract will be awarded according to the principles for best value for money and absence of any conflict of interest (according to Articles 10, and 13 of AMGA)."	As requested by the Agency.
11.06.2021	DTTN has introduced two additional linked third parties: X-LAM Dolomiti and Fanti Legnami. Relevant tables in 3.4 Use of resources and 4.2: Third parties involved in the project updated	Justification from partner: "The purpose to involve 3 LTPs instead of a single one was conceived in a logic of cost reduction. […] Nonetheless, at the proposal stage of the ARV project, it was not possible to set a proper definition of the design, prototyping, construction, and installation phases among the potential Linked Third Parties, basically due to the shortage of time and the strict schedule to comply with the deadline for submission. […] The actual cost and task distribution reflect the fine-tuning process and enhancement of the specific expertise which each Linked Third Party may offer in the framework of the Trento Demo."
11.06.2021	Updated Table 3.4b: 'Other direct cost' items (travel, equipment, other goods and services, large research infrastructure) for the following partners: - P1 NTNU: shifted €7 700 to NTNU as a result of a €11 000 reduction in Total Eligible Costs for DANFOSS, as explained below. This is added to the pots for publication costs and translation costs for the consortium.	As requested by the Agency.

	- P5 DANFOSS: split up costs between categories Equipment and Other goods and services, and removed ineligible part of Equipment costs initially included (€11 000 for electricity use, which is covered by indirect costs). Due to the 70% reimbursement rate for DANFOSS, this freed up €7 700 in Max EU Contribution that was shifted to NTNU. - P31 DTTN: shifted costs between newly introduced Linked Third Parties, as detailed below. All amounts have been shifted from linked third party Armalam: o PMs: 0.5 to X-LAM Dolomiti and 0.5 to Fanti Legnami (WP4), 11.5 to X-LAM Dolomiti and 7.5 to Fanti Legnami (WP5). o Direct personnel costs: €64 826 to X-LAM Dolomiti, €41 127 to Fanti Legnami o Other goods and services: €454 000 to X-LAM Dolomiti, €285 000 to Fanti Legnami.	
24.06.2021	Added - Standard text to the opening of Section 4.2. - Standard text for the description of subcontracting for partners IBAVI, Mitros, Portaal in Table 4.2. - Task and WP reference to the description of subcontracting for partner RC Panels in Table 4.2.	As requested by the Agency.
24.06.2021	All references to Portaal have been removed throughout the document	Due to Portaal leaving the consortium
24.06.2021	Section 1.4.2 - Table 1.7 :revision of key innovations for WP4 due to Portaal exit - Dutch demo descriptions have been revised due to Portaal leaving.	Due to Portaal leaving the consortium. Further details can be found in formal letter from Portaal
24.06.2021	Gantt-chart updated	To accommodate for consistency between Sygma and this document
24.06.2021	Task references added for Linked Third Parties in description in Section 4.2.	As requested by the Agency.
24.06.2021	Budget reallocations due to Portaal leaving the consortium, also resulting in revised descriptions in Section 3.4b and Section 4.2. The Max EU Contributions remains the same. Detailed breakdown of budget increases for relevant partners: - NTNU: added 4 PMs in WP1 and 4.5 PMs in WP4. Added €2 541 to Other goods and	Justification for NTNU: increased PMs in WP1 for project management and for implementation of risk reducing payment schedules. Increased PMs in WP4 for close follow-up of demonstration buildings/communities,

	services, allocated to translation and publication costs for the consortium. - UAS Utrecht: added 2 PMs in WP4, 2 PMs in WP5, 1 PM in WP9. - Buro de Haan: 1 PM in WP9. - BOEX: 1 PM in WP3, €25 000 in subcontracting in WP3, €15 000 in subcontracting in WP4, €75 000 in equipment costs in WP5, €30 000 in equipment costs in WP6, €77 000 in equipment costs in WP7. - RC Panels: 4 PMs in WP4, 1 PM in WP5, 1 PM in WP9. - UU: 2 PMs in WP4, 1 PM in WP9. - City of Utrecht: 1 PM in WP3, 1 PM in WP9. - BOESGROEP: 4 PMs in WP4, 2 PMs in WP5, 1 PM in WP9. - iWell: 1 PM in WP9. - MEX: 1PM in WP9. - Mitros: 1 PM in WP3, €25 000 in subcontracting in WP3, €15 000 in subcontracting in WP4, €75 000 in equipment costs in WP5	for continuously risk and performance monitoring/management. Justification from Dutch partners: On increased personnel efforts: "With the introduction of the new retrofitting buildings we are also adding a new innovation to the project: the HeMuBo renovation concept. This […] leads to an evaluation of the Inside Out and the Hemubo renovation concepts. The evaluation leads to optimizations in both concepts, both in energy performance, construction runtime and logistics. The evaluation itself and the implementation of its results in design and construction phases takes extra personnel effort […]"
28.06.2021	Pie charts and description at the beginning of Section 3.4 updated after the removal of Portaal from the consortium.	
28.06.2021	Total number of partners in consortium corrected to 35 after Portaals exit	
28.06.2021	Minor adjustments to layout and illustration sizes	Small editorial changes to fit chapters and/or paragraphs onto pages
30.06.2021	Numbering of beneficiaries updated to match the numbering in Annex 2	Double-checked and updated on Agency's suggestion
30.06.2021	Shortened table in Section 4.2 concerning subcontracting for IBAVI and BOEX to make visible the standard text in the end	As requested by the Agency.
30.06.2021	Table 3.4b updated with budget for CFS costs for Mitros	As requested by the Agency.

Contents

1. Excellence

The energy and building sectors are vital to Europe's environment and energy policies, since buildings are responsible for 40% of total EU energy use and 36% of greenhouse gas emissions[1]. However, fast and disruptive changes are challenging to achieve, given the conservative nature of the industry, and the multitude of stakeholders and end-users that need to be addressed. In particular, the required deep energy renovation of the existing building stock, remains a major challenge[2]. Investment costs are a significant barrier, since the willingness and ability to pay for energy/climate measures are generally low, and due to the structural mismatch between risks and economic rewards. Moreover, energy poverty is becoming a pressing issue, with more than 30 million Europeans unable to keep their homes adequately warm[3]. Finally, the renewal of the construction and energy sectors are hampered by highly path-dependent characteristics with high sunk costs and extensive network/coordination effects.

Thus, we are faced with the challenge to find **attractive, resilient, and affordable solutions** that will **significantly speed up** the deep energy renovations and the deployment of energy and climate measures in the construction and energy industries.

The technologies and knowledge to make these changes happen, do exist. The ARV consortium has experience from several decades of R&D projects on low energy buildings, zero emission buildings (ZEB), plus energy buildings, and zero emission neighbourhoods (ZEN), ref. Table 1.5. The partners been involved in developing and testing a wide range of promising solutions for such buildings and neighbourhoods and have supervised real life pilot demonstrations of ZEBs and ZENs. Thus, we know that it is possible, the challenge is to make these solutions exploitable and scalable.

The ARV project will answer to these challenges by employing a novel concept relying on a combination of 3 conceptual pillars, 6 demonstration projects, and 9 thematic focus areas.

Working with innovation clusters ARV will provide ground-breaking innovations that will answer to the EU climate ambitions and the Renovation Wave and fulfil the **ARV** vision of a rapid and wide scale implementation of **Climate Positive Circular Communities (CPCC)** where people can thrive and prosper for generations to come.

The pillars, the demonstration projects, and the thematic focus areas are introduced in the following sections.

6 Demonstration Projects of Climate Positive Circular Communities[4] across Europe

[1] COM (2020): Stepping up Europe's 2030 climate ambition. Investing in a climate-neutral future for the benefit of our people. 562 final, Brussels 17.9.2020.
[2] COM (2020): A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives. 662 final, Brussels 14.10.2020
[3] Data from 2018, Eurostat SILC. Commission Recommendation of 14.10.2020 on Energy Poverty.
[4] The definition of CPCC is outlined on page 6

The core of the ARV projects relies on **6 large-scale demonstration projects, with 35 ARV partners representing the whole value chain of the building and energy sectors, and an extensive network of innovation clusters**. In order to ensure replicability and scalability, the ARV demonstration projects have been carefully selected to represent the climates and context of Europe and with ambitions to contribute with outstanding innovations in all the needed thematic areas of CPCCs. **They are urban transformation/regeneration projects that include different types of buildings** (residential, public, educational, and health care), including **133,400 m^2 of renovation** and **25,700 m^2 of new construction**. The projects are carefully selected to address all of the thematic focus areas of the call. They are also selected to complement each other, i.e. each of them has particularly outstanding innovations in selected focus areas to be 'leading stars' for other projects. For example, the Dutch demo has particularly outstanding innovations in thematic focus area no 5) Resource efficient (re)construction and renovation workflows. However, all of the demos address all of the focus areas. The demo projects and related innovations and clusters are further described in sections 1.4.2 and 2.1.1.

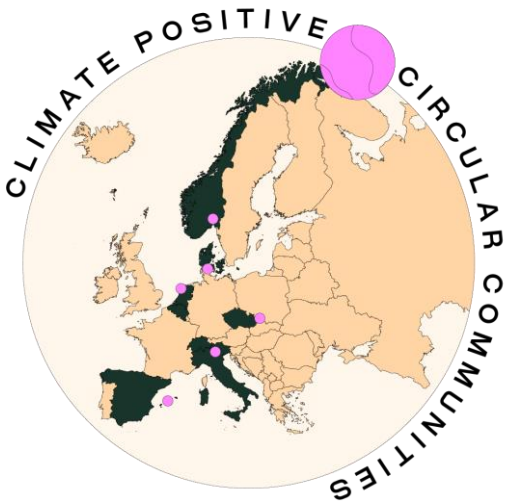


Figure 1.1 Map with demo projects and ARV countries.

The 3 conceptual pillars: Integration, Circularity, and Simplicity

The successful innovations of Climate Positive Circular Communities will rely on the application of 3 conceptual pillars as follows:

1) Integration means that we have to address several aspects in combination. It is not sufficient to make a very energy efficient building if nobody can afford it or if the indoor environment is not good. **Architectural quality, affordability, and people's well-being** are therefore vital aspects to address. In the ARV project, we address this by focusing on 3 different levels in combination: **1) people, 2) buildings, and 3) community energy systems** (see Figure 1.2). By focusing on people, we address the multitude of values of different stakeholders in the value chain, from end-users to manufacturers and financing institutions. ARV will engage **community platforms for awareness raising, occupant engagement, and co-creation**. When we demonstrate solutions for energy-efficient building designs, we show at the same time how the ARV buildings are integrated into its cultural and social environment in line with the **New Bauhaus vision**[5]. Finally, the users and buildings are **smartly linked up to community energy systems and materials hubs** for effective energy and resource management within and beyond the neighbourhood. The concept of integration involves the integration of different stakeholders and expertise along the value chain of CPCC, and **the use of novel ICT solutions** to facilitate the integration between the different systems, the stakeholders, and the people in the community. This is further described in section 3.

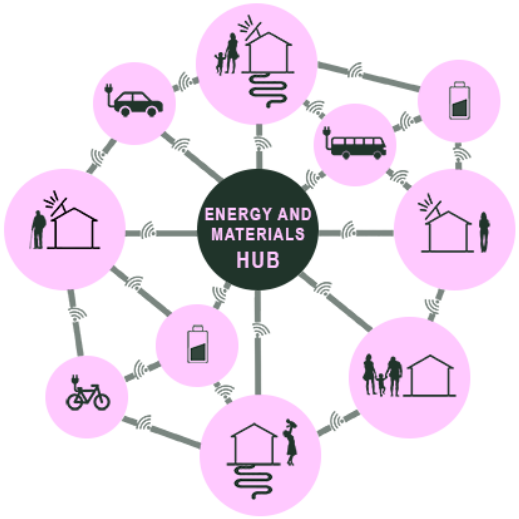
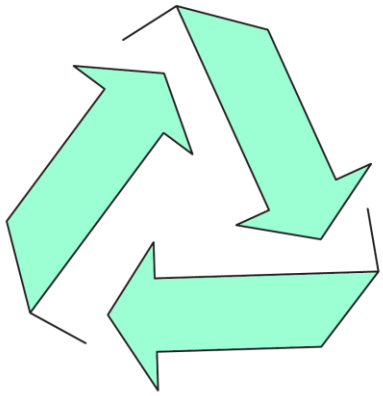


Figure 1.2 The integration between people, buildings, and the energy systems in a CPCC.

[5] https://ec.europa.eu/commission/presscorner/detail/en/AC_20_1916

2) Circularity has only recently begun to gain momentum in the construction sector, but is vital to sustainable development, as global consumption of materials is expected to double in the next forty years[6]. As emphasized by the new EU Circular Economy Action Plan[7], the construction sector requires vast amounts of resources and accounts for about 50% of all extracted materials. The sector is also responsible for over 35% of the EU's total waste generation. In ARV, we will address this challenge in a practical way, by **focusing on efficient renovation and construction of buildings** and by systematically applying the **EU Circular Economy Principles for Buildings Design**[8]. This means that ARV will apply the key principles of circular economy, i.e. *engaging all actors along the value chain* in circular economy, *exploit financial incentives and total life cycle costs*, create viable *business models* considering the distribution of burdens and costs, enhance and apply *appropriate tools and skills*, and target *durability, flexibility, adaptability, reuse, and recycling*. **Deep renovation** of existing buildings is especially targeted (WP5). The use of **digital tools** is vital to achieving the cost, time, and simplicity targets (WP2-9). ARV will also boost the development and deployment of **digital material banks/logbooks** (WP4, WP8) that track material use in existing and new buildings and their potential for reuse, coupled with cost and environmental indicators for embodied energy and emissions.



3) Simplicity. Addressing simplicity in the processes of planning, design, construction and use of CPPCs, is very powerful in untangling the challenges towards their fast and widespread use. This is because simple solutions have several important advantages: 1) they are more robust, 2) they are easier to produce, 3) they have lower costs due to less materials use and simpler production processes, 4) they are easier to understand, use and operate, 5) they have lower life cycle energy use and emissions (if designed intelligently), and 6) they have lower risks. To be able to produce simple solutions, ARV will address several challenges experienced by the different stakeholders, from investors, public authorities, construction companies, and end-users. Complexity management is a key **to producing simple solutions.** ARV will manage this by **the use of intelligence (digitalisation)** in integrated planning, design, construction, and operation/use, as well as by showcasing resource efficient integrated construction and renovation workflows by employing **intelligent industrialization and prefabrication**.

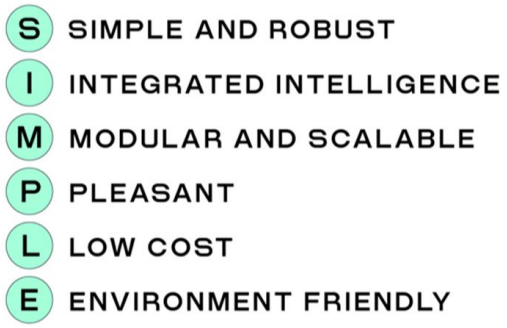


Figure 1.3 The Simplicity concept of ARV.

The 9 thematic focus areas are selected to address the specific challenges in the call. They are mapped into 9 work packages described in Section 2, and answer to the objectives as described in Section 1.1 below. The thematic focus areas are 1) Framework for CPCC planning and implementation, 2) Community engagement, environment and well-being, 3) Sustainable building (re)design, 4) Resource efficient manufacturing and construction workflows, 5) Integrated renewable and storage systems, 6) Efficient energy management and flexibility, 7) Validation by monitoring, evaluation, and impact assessment, 8) Business models, financial instruments, policy and exploitation, and 9) Communication, dissemination and stakeholder outreach. The 9 thematic areas are further described in Section 1.3(b) and in the work plan (Section 3).

[6] OECD (2018), Global Material Resources Outlook to 2060.
[7] COM (2020), A New Circular Economy Action Plan. For a cleaner and more competitive Europe.
[8] COM (2020), Circular Economy Principles of Buildings Design.

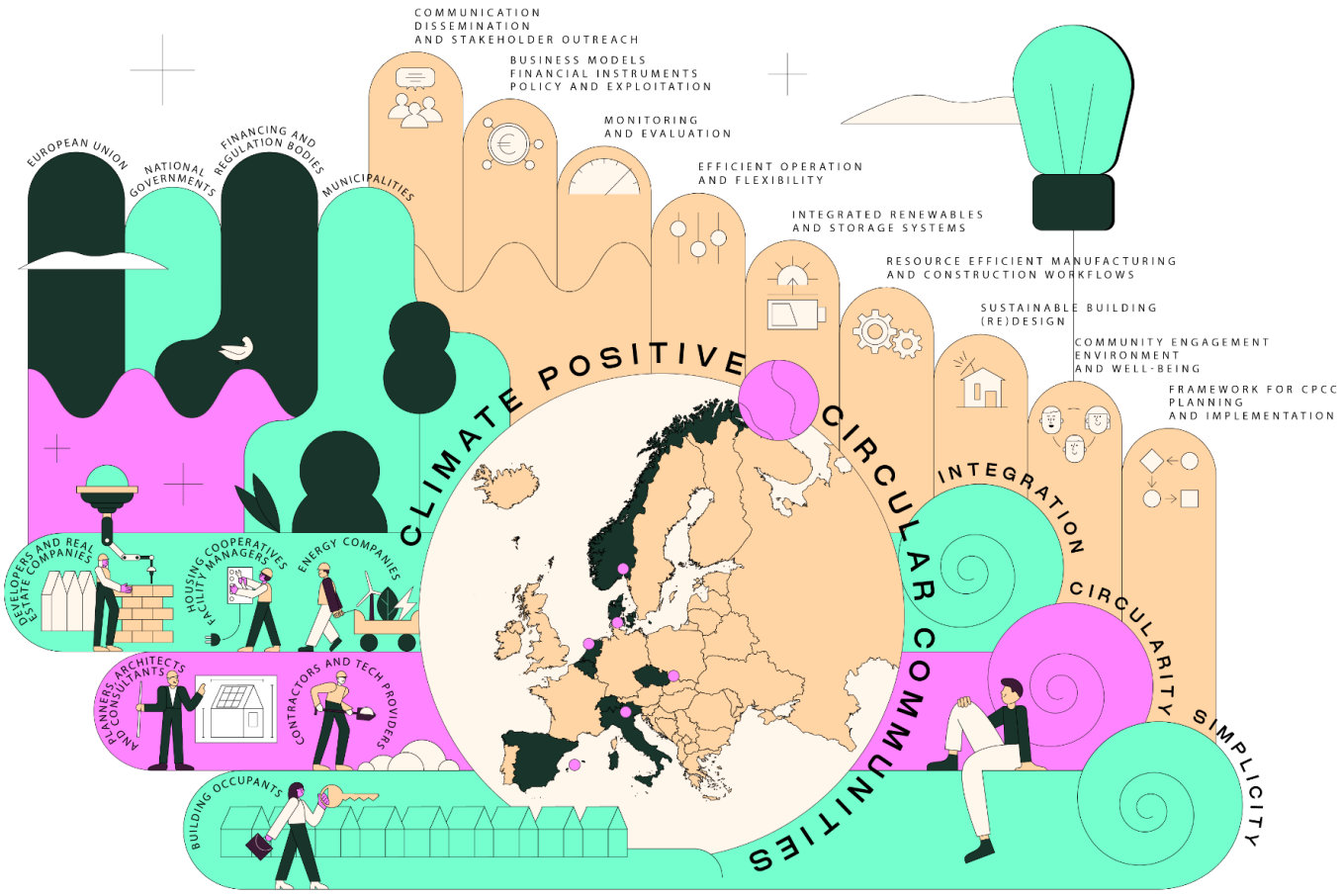


Figure 1.4 The concept of ARV with the **6** demonstration projects of Climate Positive Circular Communities riding on the renovation wave (**3** waves containing the pillars of integration, circularity, and simplicity) supported by the different stakeholders working together to make innovations in **9** thematic focus areas.

1.1 Objectives

The overall aim of the ARV project is to **boost the building renovation rate and to enable rapid and wide-scale deployment of CPCCs** around Europe. ARV will facilitate a **fast market uptake and cost-efficient replication** of the CPCC concept, and thus significantly contribute to the full decarbonisation of Europe by 2050. The specific objectives of ARV are aligned with the overall objectives of the call and are designed to reach the target values shown in Table 1.1:

Objective 1: Deliver a blueprint for effective planning, design, construction, operation and use of CPCCs (involves all WPs and demo projects, managed and delivered through WP10).

Objective 2: Demonstrate a replicable planning framework for efficient design and successful implementation of CPCC (WP2).

Objective 3: Demonstrate community engagement platforms for awareness raising, occupant insight and well-being, and co-creation (WP3).

Objective 4: Design and demonstrate integrated circular buildings for high energy performance, low emissions, low cost, good indoor climate and high architectural quality (WP4).

Objective 5: Demonstrate seamless construction/renovation processes for quick, simple, and efficient workflows (WP5).

Objective 6: Demonstrate innovative on-site energy generation and storage for renewable, local, and clean energy supply (WP6).

Objective 7: Demonstrate smart and flexible operation of buildings and energy systems for secure, user-oriented, and cost-efficient energy performance (WP7).

Objective 8: Monitor and validate the ARV solutions through secure and continuous measurements and evaluations of the demonstration activities (WP8).

Objective 9: Facilitate speedy scale up of ARV innovations by addressing key policy incentives and regulations, and creating innovative and effective financing mechanisms, and business models (WP9).

Objective 10: Communicate and disseminate activities carried out in ARV and engage stakeholders and accelerate the exploitation of the ARV solutions (WP9, WP10).

Table 1.1 Overview of target values for new and renovated buildings in ARV CPCCs**.**

Assessment criteria	New construction	Renovated buildings
Energy	**At least 50% reduction in energy needs** compared to current country building code. **Positive energy** level based on primary energy	**At least 50% reduction in energy needs** compared to pre-renovation levels. At least **nZEB** standard.
IEQ	High levels of indoor environment quality according to EU norms.	**At least 30% improvement** compared to pre-retrofitting levels according to EN 16798-1:2019
Noise and dust levels	According to the EU health, safety, and environment standards.	**At least 30 % reduction** in occupant disruption during retrofitting compared to local current practice
Embodied emissions	**At least 50% reduction** compared to local current practice	
Construction/retrofitting time	**At least 30% reduction** compared to local current practice	
Life Cycle Costs	**At least 20% reduction** for the community compared to local current practice	
Construction/retrofitting costs	**At least 30% reduction** compared to local current practice	

Definition of Climate Positive Circular Communities (CPCC)

The working definition of CPCCs is as follows, but will be further refined based on lessons learnt from the ARV project and through interaction with other H2020 projects and EU policy initiatives.

A CPCC is aligned with the concepts of *Positive Energy District (PED)* as described in the SET Plan Action WG 3.2[9] and working groups within the IEA[10], the definition of *Sustainable Plus Energy Neighbourhoods (SPEN)* as defined by the synikia.eu project[11], the definition of *Zero Emission Neighbourhoods (ZEN)*[12] as defined by the research centre on Zero Emission Neighbourhoods in Smart Cities (www.fmezen.no), and the EU circular economy principles. Like in PEDs, **the CPCC concept focuses strongly on the interaction and integration between the buildings, the users, and the regional energy, mobility and ICT systems**. However, CPCCs go beyond that by also including **socio-environmental aspects and highlighting circularity as a key aspect**. A CPCC can be an urban area, a city district, and consists of several interconnected buildings with associated infrastructure like grids and technologies for generation, storage, and exchange of electricity and heat.

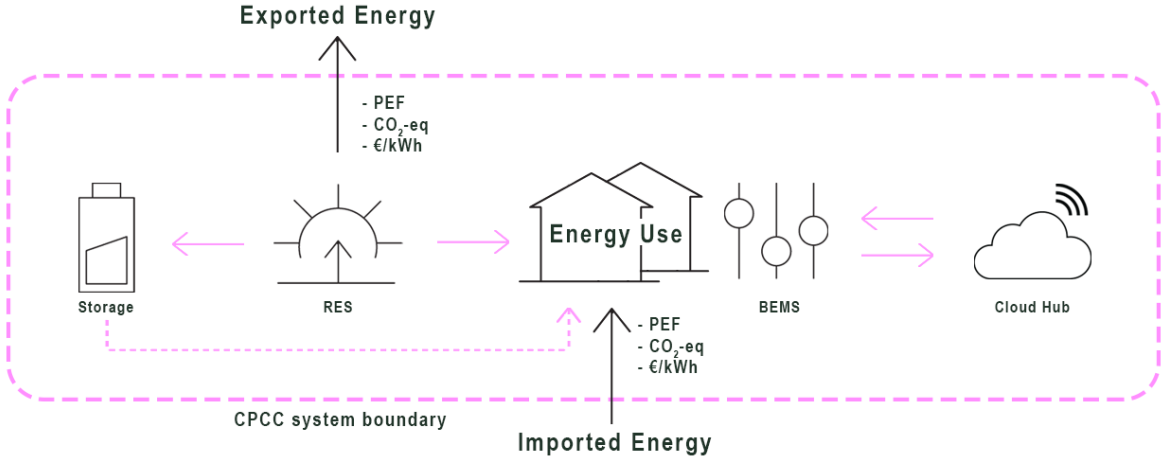


Figure 1.5 Illustration showing the main elements of a CPCC (storage, energy generation, energy use, energy management), and the energy flows within and in/out of the CPCC, managed by the ARV digital cloud hub.

A CPCC focuses on three core topics, (1) **Energy and Emissions**, (2) **Circularity**, and (3) **Socio-environmental** issues as shown in Table 1.2.

Table 1.2 Working definition of CPCCs with main topics and related goals and KPIs. The topics and KPIs along with target values are further described in Section 2.1

Topic	No.	Description	KPIs
Energy and Emissions	1.1	A CPCC has annual **net zero energy and GHG emission balance,** working towards an annual local surplus of renewable energy production.	Imported, exported and generated energy in kWh/a and kWh/m²/a. GHG emissions from imported energy and avoided GHG emissions from renewable energy generation and export in $kgCO_{2e}/m^2/a$ and tCO_{2e}/a
	1.2	The **system boundary** for calculating the import/export balance of a CPCC is determined by the buildings and energy infrastructure that are connected through a common hub that manages and controls the overall energy performance.	Total floor area and site area in m²
	1.3	For calculating the energy and emission balances, all building operational **EPBD energy uses** are considered as well as **integration with associated electromobility.**	Energy use per type and energy carrier (EC) in kWh/a and kWh/m²/a. Greenhouse gas emissions in tCO_{2e}/a and $kgCO_{2e}/m^2/a$. Primary Energy Factors (PEF) per energy carrier
	1.4	A CPCC is **embedded within an urban and a regional grid** to ensure optimal use of locally produced renewable energy, **flexibility, consumption management, storage capacities** and at the same time guaranteeing security of supply.	Net load profile, duration curve, peak load, peak export and import, and daily net load profile in kW; Utilisation factor in %. Share of self-consumption and self-generation in %.

[9]SET-Plan Working Group: SET-Plan ACTION n°3.2 Implementation Plan, June 2018.
[10] IEA EBC Annex 83 on PED - https://annex83.iea-ebc.org/about, the JPI Urban Europe Working group on PED - https://jpi-urbaneurope.eu/ped/, and the COST Action 19126 on PED.
[11]Salom and Tamm (2020): syn.ikia deliverable 3.1 Methodology framework for plus energy buildings and neighbourhoods, 30.09.2020, synikia.eu.
[12] Wiik et al. (2018): Zero Emission Neighbourhoods in Smart Cities. Definition, key performance indicators and assessment criteria: Version 1.0. Bilingual version, ZEN Report No. 7, NTNU/SINTEF, Norway.

	1.5	A CPCC **highly energy efficient** and will make use of **smart** home services and controls, smart building components, and smart but simple systems for user interaction/involvement.	Reduction in total energy and power needs (kWh/m^2 and W/m^2). Smart Readiness Indicator (SRI)[13]
Circularity	2.1	A CPCC **supports the transition to a circular economy** by implementing regenerative systems in which resource input and waste, emissions, and energy leakage are minimised by slowing, closing, and narrowing material and energy loops.	Ref Level(s)[14] indicators (all)
	2.2	Building components are designed to be **long-lasting, easy to repair, reused, remanufactured, refurbished, and recycled.** Where possible, **local and second-hand materials** are used.	Ref Level(s) indicators 2.1, 2.2, 2.3 and 2.4
Socio-environmental	3.1	CPCCs **put people in focus**, i.e. their specific needs, interaction, and wellbeing, and will provide excellent indoor environmental conditions, spatial qualities and equal accessibility for persons with disabilities and senior citizens.	Ex-ante and ex-post evaluation of user satisfaction. Common definition of multiple criteria framework.
	3.2	A CPCC will **minimize the disruption for occupants** during the construction/renovation process, i.e. construction/renovation time, noise, dust, etc.	Time of construction/renovation compared to local current practice in %
	3.3	CPCCs organize frequent **awareness raising** activities linked to sustainable behaviour that foster social innovation and promote education as well as training for an environmentally friendly and respectful energy use.	Number and scope of activities per year
	3.4	With regard to the changing climate, CPCCs seek to provide **comfortable outdoor conditions** that invite people to stay outdoors and promote outdoor activities.	Solar access; shared space in % of site area; area of playgrounds and other places for activities in m² and % of site area

1.2 Relation to the work programme

The ARV project proposal addresses the specific challenges and scope of the Call as described in Tables 1.3 and 1.4 below.

Table 1.3 Relation to the challenges of the Call.

Challenges (text from Call)	How ARV addresses the challenges
Firstly, a transition in designing and constructing buildings to *reduce their embodied emissions and to increase the energy efficiency* of their operation; the same applies to retrofitting existing buildings to increase their efficiency.	ARV will employ methods of **integrated design and construction**, using **digital tools**, **life cycle analysis** to minimize the embodied energy and emissions. We will apply the principles of **circular economy** for the (re)design and (re)construction processes, focusing on local bio-based materials, reuse, recycling, durability, resiliency to achieve **at least 50% reduction in embodied emissions needs** compared to current country building standards (**WP4-5**).
Secondly, a transition to *energy-positive buildings* (producing electricity, covering their heating and cooling needs and contributing to the energy grid stability) with sustainable, renewable energy technologies.	All ARV demonstrations will contribute towards the goal of **net-positive energy balance** with optimized on-site RES and storage systems (**WP6**). The design and management of RES will be optimized (**WP7**) with respect to energy, GHG emissions, and life cycle costs.

Table 1.4 Relation to the scope of the Call

Scope (text from Call)	How ARV addresses the scope
Proposals are expected to deliver *at least two (residential and non-residential, new and/or retrofitted) large-scale, real-life demonstrations* of promising technology, process and social innovations, in different regions of Europe.	With **6 large-scale demos across Europe** covering new and retrofit residential, commercial, and institutional building types, ARV solutions will deploy and evaluate a range of building and energy system innovations as well as social innovations designed to radically reduce the cost and time of transitioning to CPCCs (**WP 2-9**).
Scalable design of green, positive energy neighbourhoods well embedded in the spatial, economic, technical, environmental, regulatory and social context of the demonstration sites.	ARV will develop a **framework** for efficient planning and implementation of CPCC and a **blueprint** for design, construction, operation, and use of CPCC in different contexts, cultures, climates, and markets in Europe (**WP 2-9**).
Energy and resource efficient, seamless industrial construction/renovation workflows from design to eventual offsite manufacturing, installation and post-construction monitoring	With a dedicated Work Package (**WP5**), ARV demos will ensure efficient workflows that **reduce the construction/renovation time and cost by at least 30%** The work includes zero-engineering during construction/renovation with 3D point cloud scanning and AI building typology identification.

[13] European Commission Directorate-General for Energy. Final Report on the Technical Support to the Development of a Smart Readiness Indicator for Buildings. Luxembourg: Publications Office of the European Union; 2019.
[14] European Commission: Level(s) – The European Framework for Sustainable Buildings

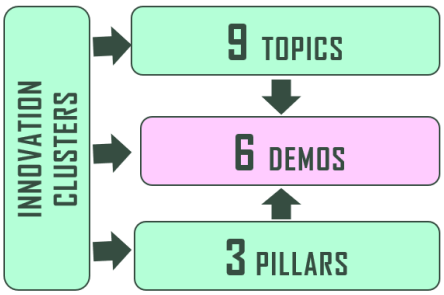
Recycling/reuse of construction materials (or industrial by-products) or reduction of the amount of materials and components used, in order to reduce the embodied energy of buildings	ARV will reduce waste with a "Just in Time" (JiT) design strategy (**WP4**) and enable future demountable parts using modular renovation/construction materials and circular design across all demos (**WP5**). **This will lead to at least 50% reduction in** embodied energy and life cycle greenhouse gas emissions compared to current practice.
Demonstrating high replicability, reduced maintenance costs and long-term performance, as well as socio-environmental performance (e.g. air quality/natural ventilation, natural lighting, etc.) and potential for adaptation, reuse or deconstruction in the future	All ARV demo projects will be systematically monitored and evaluated (**WP8**) for at least 1 year using a capturing ex-ante and ex-post cost and performance data across a range of indicators. Socio-environmental performance will be ensured by the **multiple benefits approach** of the project (**WP2, WP3 and WP8)**
Ensuring that proposed solutions do not influence negatively the fire and seismic safety of the buildings	All innovative solutions deployed within ARV will have been vetted and approved by the local authorities ensuring fire and seismic safety compliance prior to installation (**WP5**)
Minimizing disruption for building's occupants and the time spent on site	A central pillar of the ARV design framework includes protocols and standards for near-zero disruption of building occupants, in line with the Build4People partnership goal (**WP4, WP5**).
Delivering post-construction/renovation monitoring of both operational energy performance (minimizing design-built performance gap) and durability of the construction/renovation components.	Extensive post-construction monitoring and evaluation of all demos in ARV will ensure robust, comparable data sets across the project (**WP8**). The data will be made available to the ARV partners and EU communities through the Cloud Hub (**WP7**) and Data Warehouse (**WP8**). Lessons learned will be implemented in the Blueprint for CPPCs (**WP10**)
Digital and EGNSS-based methods of design and construction, smart monitoring and tracking of building and renovation processes (e.g. Building Information Modelling, digital twins and augmented reality, robotics, etc.)	A multitude of cutting-edge digital tools will be used in planning, designing and implementing the ARV solutions (**WP2-7**). ARV moves beyond the state-of-the-art in the **integration of the different tools including different stakeholders:** computer simulations, EGNSS, GIS, BIM, VR, digital logbooks, digital twins, 3D point cloud scanning, grey box models, AI, etc.
Innovative and more energy-efficient BIPV converting the building envelope into electricity-producing surfaces and aesthetic considerations.	ARV will integrate BIPV (**WP6**) in the building envelope that are architecturally pleasing (new Bauhaus) and easy to implement (**WP4-5**), such as a novel "Inside-Out" renovation method.
Renewable power generation and H&C systems (e.g. charging facilities) and heating-ventilation-air conditioning (HVAC) solutions.	ARV will demonstrate innovative on-site RES, including BIPV and efficient HVAC integrated with the building envelope and efficiently integrated with local daily (second life EV batteries + stationary batteries) and seasonal thermal storage and surrounding energy system (**WP4-7**).
HVAC solutions (e.g. reversible heat pumps with refrigerants that are not greenhouse gases, or less developed clean heating options such as hydrogen).	The ARV HVAC solutions will be designed using life cycle analysis to minimize their greenhouse gas emissions (**WP4-6**). Refrigerants with global warming potential will not be used.
Energy storage systems with bidirectional charging functionalities, that do not limit the use of living space (e.g. neighbourhood optimized storage including management systems for optimal integration, flexibility and interoperability with the grid).	ARV demos will deploy a range of storage systems for variable RES (**WP6**) including V2G/V2B and stationary batteries (1st gen and 2nd gen), low exergy on-site ground storage systems and novel seasonal thermal storage by utilizing urban tunnel infrastructures.
Highly energy-efficient building operation at reduced maintenance costs and long-term performance with the help of digital technologies to optimise energy generation, consumption, storage and flexibility at neighbourhood scale, as well as digital solutions to increase the usability, energy efficiency and secure operation of building systems and appliances, ensuring optimal comfort for users and a healthier living environment. Optimal dynamic matching of on-site renewable energy generation and building or neighbourhood consumption; integrated demand-response, considering also non-energy benefits (e.g. occupant security; indoor/outdoor air quality, etc.)	ARV demos will deploy and evaluate energy system integration, including dynamic feed-in tariffs, hedonic pricing models, and AI-enabled load balancing across energy carriers (electricity, heating, cooling, liquid fuels, gas). ARV will deploy the centralized European digitalization hub (cloud level) connected to sub-hubs (fog level) at the individual demo sites, which again are connected to building and occupant systems or apps (edge level). By using a state-of-the-art data lake principle, the ARV cloud hub will provide storage for monitoring data and allow efficient use of data on various scales. It will also provide user interfaces for occupants, operators, building owners, and other stakeholders. This will enable exchange of data between people, buildings and energy systems to unlock the flexibility potential and ensure occupant comfort, safety, and minimize pollution. Models will be adapted for different climates and context across Europe through a Handbook for Smart Communities (**WP7**).
Smart home services, advanced automated controls, i.e., smart meters, smart water control, smart EV charging, smart elevators, smart security, etc.; based on inclusive design, understanding the occupants preferred usage of the building and harmonising the building - occupants interaction	ARV demos will apply smart home system controls for increased energy efficiency and occupant comfort and interaction, including heating, ventilation, lighting, electrical appliances, access control, and burglar alarms (**WP7**). The systems will be design through **co-creation** between end-users and professionals, ensuring that occupants needs are addressed (**WP3, 4, 5**) and evaluated by post-occupancy surveys (**WP8**), validating 30% improvement in user's satisfaction for the renovated buildings.
Integration between building energy management systems/building automation control systems, renewable electricity/energy generation, storage, urban service facilities and the grid.	Integration across building features is addressed through ARV integrated approach (**WPs 3, 4, 5, 6, 7, 8**)
Potential for local flexibility to be aggregated and bundled; possibility to trade and commoditise energy	ARV demos will design and apply novel scalable Local Energy and Flexibility Markets (LEFMs) to trade RES and flexibility across energy systems (electricity and district heating) along with new business models,

flexibility creating new services and revenue streams for building owners/tenants	financial mechanisms such as green digital bonds, and hedonic pricing mechanisms for CPCCs, and make them accessible to different stakeholders around Europe (real-estate, energy companies, financial institutions, policy makers) (**WP7, WP9, WP10**).
Citizen awareness raising activities linked to green neighbourhood living labs (led by 'green schools'), to facilitate social innovation, promote education and training for sustainability, conducive to competences and positive behaviour/good habits for a resource efficient and environmentally respectful energy use.	ARV demos will host living labs (**WP3**) where citizens and occupants are engaged in the transformation process of the ARV communities. Key activities include creating and hosting exhibition spaces for energy education, coaching of tenants in energy use through Home Energy Management Systems, and appointing "Green Ambassadors" among the tenants.
Coordination on standards and regulatory aspects to ensure operational efficiency of buildings and HVAC technologies also addressing the design-built performance gap.	ARV solutions will address the design-built performance gap by systematically monitoring and evaluation of the planning, design, construction, operation and use of the CPCC and crating systems for feed-back throughout the whole value chain. This will result in recommendations for improved tools and processes and give input to policy measures and revised codes and regulations (**WP2, WP8, WP9, WP10**).

1.3 Concept and methodology

(a) Concept

As described in Section 1.1 (and illustrated in Figure 1.4) the concept of ARV relies on the combination of **3 conceptual pillars** (integration, circularity and simplicity), **6 large scale demonstration projects** and **9 thematic focus areas** (as shown in the figure below), supported by **innovation clusters** from the whole value chain of CPCCs (ref Figure 2.10 in Section 2.2)



In this way, ARV will **boost the building renovation rate (scale & depth) and increase the overall energy efficiency, energy flexibility, social sustainability, and climate-resiliency of neighbourhoods in a holistic way**.

The ARV partners' experiences from other projects (see Table 1.5) have shown that real-life demonstration cases are effective arenas to successfully integrate solutions. Inter-disciplinary innovations are realised when end-users, researchers and industry work together as active participants in the entire process, from the definition, design, construction, to the final evaluation[15,16]. Close cooperation and the exchange of knowledge between the project stakeholders will create innovation hubs for co-creation in the demo cases, serving as lighthouses for replication in the respective cities, countries, and the rest of Europe. This is ensured by the different climatic and geographical contexts of the demo cases, as well as the active engagement of **European wide innovation clusters**, as described in Section 2.2.

Thus, in short, the concept of the ARV is to simplify the adoption of increased energy performance of buildings to ensure wide-spread implementation with outstanding socio-economic performance. The ARV project aims to improve the uptake of already feasible and promising solutions (from TRL 5/6) towards their simplified integration in building and renovation projects (achieving TRL 7/8**). The demonstration sites will thus become living examples of the how the ARV solutions are seamlessly, affordably, and successfully adopted in Climate Positive Circular Communities.**

In this, ARV aligns and responds to a number of EU directives and policies calling for decarbonisation, sustainability, affordability, resource efficiency, and resilience in the built environment and beyond, including: 1) Revised Energy Performance of Buildings Directive EPBD[17]; 2) the Renovation Wave[18]; 3) SET-PLAN Action 3.2 Implementation

[15] Meistad, T. (2015). Sustainable building – From role model projects to industrial transformation, Doctoral Thesis, Norwegian University of Science and Technology, Trondheim, Norway.
[16] Berker and Bahrati (2012). Energy and Buildings Research: Challenges from the New Production of Knowledge, *Building Research & Information*, Vol. 40, pp. 473-80.
[17] Directive 2010/31/EU of the European Parliament and of the Council of 19 May 2010 on the energy performance of buildings (2010)
[18] European Commission (2020): A Renovation Wave for Europe - greening our buildings, creating jobs, improving lives. Brussels, Belgium.

Plan[19]; 4) Clean Energy for All Europeans[20]; 5) the Paris Agreement[21]; 6) Clean Energy Transition – Technologies and Innovations[22]; and UN Sustainable Development Goals[23] SDG7, 8, 9, 11, 12, 13, and 17. Furthermore, ARV fosters civic engagement and supports occupants in CPCCs to take an active role in shaping their communities (WP3). The ARV demonstration projects will be organized to allow efficient exchange between occupants/tenants and different stakeholders in the project. With digital platforms and frequent workshops, ARV will seek the active involvement, ideas, and feedback of the citizens in CPCCs. In line with the European Commission's Digital Strategy[24,25], ARV will integrate a smart urban infrastructure and easy-to-use digital solutions to improve and simplify people's daily lives while at the same time valuing privacy and guaranteeing excellent cybersecurity (WP6-7).

Relevant ongoing research projects

The ARV project includes actions to facilitate cooperation with other projects, and the project will build upon and interact with many projects where the ARV partners are participating, including national, European, and international projects. An overview of the projects and their relevance to ARV is presented in the table below.

Table 1.5 Overview of relevant national-, EU- and international projects where ARV partners are involved.

ARV partner	Relevant projects on national-, European- and international level	Relevance to ARV and joint activities/synergies
NTNU (lead) *SINTEF, DTU, IREC, HE, ENFOR*	**syn.ikia:** Sustainable Plus Energy Neighbourhoods (H2020)	Demonstration of four sustainable plus energy neighbourhoods, energy efficiency, flexibility, integration of RES, innovation management, business models, social sustainability, communication and stakeholder outreach.
NTNU (lead) *SINTEF*	**FME ZEN:** Research Centre on Zero Emission Neighbourhoods in Smart Cities (Research Council Norway & Industry)	Demonstration of 9 real-life large-scale pilot projects in different locations in Norway, flexible components, RES, dissemination, innovation management, business models
NTNU (lead)	**+CityxChange:**Smart Cities and CommunitiesH2020	Innovation, demonstration, IT, RES, knowledge exchange
NTNU (lead)	**ECHOES:** Energy CHOices supporting the Energy union and the Set-plan (H2020)	Synergies in consumer/prosumer energy behaviours and SET-plan
NTNU	**INVADE:** INtegrated EVs and batteries to empower mobile, Distributed and centralised Energy storage in the distribution grid (H2020)	Technology development Cloud-based flexibility management system to increase share of RES
NTNU, DTU	**openENTRANCE**: open ENergy TRansition ANalyses for a low-Carbon Economy (H2020)	Analysis of the impact of multiple future paths and policies, and the development of stakeholder dialogue
NTNU (lead)	**SMARTEES:** Socio-economic perspectives in realizing the Energy Union (H2020)	Social innovation and socio-economic perspectives
NTNU (lead)	**FME NTRANS:** Norwegian Energy Transition Studies (Research Council Norway & Industry)	Dissemination and citizen awareness
NTNU (lead)	**BEYOND:** Blockchain based electricity trading for the integration of national and decentralized local markets (H2020)	Energy trading platforms and concepts
NTNU	**Solar Energy in Urban Planning:**IEA SHC Task51	Solar technologies; Planning strategies
NTNU	**IEA Annex 63:** Implementation of energy strategies in communities	Planning strategies; Stakeholder engagement
NTNU (lead)	**EIP SCC:** "From Planning to Implementation", including Smart City Guidance Package	Smart city solutions, dissemination
NTNU (lead) *SINTEF, DTU, CTU, IREC, EURAC*	**EERA JP Smart Cities:** Developing action plans for smart cities	Contribute to SET-Plan of developing 100 Smart Positive Energy Districts
NTNU SINTEF, EURAC	**IEA EBC Annex 83:** Positive Energy Districts.	Framework and definition, Demo Projects
NTNU (lead)	**ChiNoZEN Project:** A collaborative project between Norway and China on low-carbon building and neighbourhoods	Technology development. Demonstration of combined cooling, heating and clean power generation for low-carbon neighbourhoods/buildings. Energy flexibility.
NTNU	**Iclima:** Open innovation Test Beds for materials and building envelopes (H2020)	Innovative materials and building envelopes. Testing and demonstration.
SINTEF (lead)	**FlexBuild:** The value of end-use flexibility in the future Norwegian energy system.	Energy flexibility in buildings

[19] European Commission Joint Research Centre (2018): SET-Plan ACTION no 3.2 Implementation Plan. Europe to become a global role model in integrated, innovative solutions for the planning, deployment, and replication of Positive Energy Districts. European Commission. Brussels, Belgium.
[20] European Commission Directorate-General for Energy (2019): Clean energy for all Europeans. Luxembourg: Publications Office of the European Union.
[21] United Nations Framework Convention on Climate Change (2015): Adoption of the Paris Agreement. Proposal by the President. Paris, France.
[22] International Energy Agency (IEA). Perspectives for the Clean Energy Transition: The Critical Role of Buildings. France; 2019.
[23] https://sdgs.un.org/goals
[24] https://ec.europa.eu/digital-single-market/en/content/european-digital-strategy
[25] European Commission (2020): Shaping Europe's Digital Future. Luxembourg: Publications Office of the European Union.

NTNU, DTU		
DTU (lead)	**SmartNet**: Smart TSO-DSO interaction schemes, market architectures and ICT Solutions (H2020)	Synergies in demand side management and distributed generation.
DTU (lead)	**FLEXCoop:** Demand response for energy cooperatives democratising energy (H2020)	Demand response tools and novel business models.
DTU (lead) *ENFOR, PZ, DAN*	**CITIES**: Centre for IT – Intelligent Energy System in Cities (Danish Strategic Research Council)	Forecasting and optimisation techniques for wind, solar energy, and district heating
IREC (lead)	**INCITE:** Innovative controls for renewable source integration into smart energy systems (H2020)	Energy flexibility in buildings
IREC (lead)	**SABINA**: SmArt BI-directional multi eNergy gAteway (H2020)	Energy flexibility in buildings and districts
IREC	**GrowSmarter:** transforming cities for a smart, sustainable Europe (H2020)	Smart city solutions
IREC	**EFFICIENT BUILDINGS:** Interreg MEDFull Horizontal project.	MED hub for energy efficiency innovative and shared solutions in buildings
IREC	**TRI-HP**: Trigeneration heat pump systems with natural refrigerants and renewable sources (H2020)	Synergies in advanced controls development and use of heat pumps with natural refrigerants in apartment buildings
IREC	**WEDISTRICT:** Smart and local reneWable Energy DISTRICT heating and cooling solutions for sustainable living (H2020)	Integration of renewables and energy management in DHC networks
SINTEF (lead)	**DATABYGG:** Smart prediction of energy use in buildings (Norwegian Research Council)	Demand response energy use. Smart prediction models
SINTEF (lead)	**OPPTRE:** Energy upgrading wooden dwellings to nZEB level **(**Norwegian Research Council)	Concepts for energy upgrading of single-family housing, building envelope, architectural attractiveness
SINTEF	**REZBUILD:** Innovative refurbishment ecosystem for Near Zero Energy building in Europe (H2020)	Refurbishment decision making platform through advanced technologies for near Zero Energy Building Renovation
SINTEF (lead)	**KLIMA 2050:** Risk reduction through climate adaptation of buildings and infrastructure (Norwegian Research Council & partners)	Reduce the societal risks associated with climate change: enhanced precipitation and flood water exposure within the built environment.
ACE	**ABRACADABRA:** Assistant Building's addition to Retrofit, Adopt, Cure and Develop the Actual Buildings up to zeRO energy, Activating a market for deep renovation (H2020)	Integration of Renewable Energy Sources systems with new volume additions or new buildings' construction to go beyond the minimum energy performance and aim at achieving Nearly Zero Energy Buildings (nZEBs)
ACE	**RenoZEB:** Accelerating nearly zero energy renovation for buildings and neighbourhoods(H2020)	Plug and play facades for deep nZEB renovation
ACE,Housing Europe	**Triple A-Reno:** Attractive, Acceptable and Affordable deep renovation by a consumer orientated and performance evidence-based approach (H2020)	Occupant focused through new consumer and end-user centred business models and decision support tools, using evidence-based performances that facilitate decision-making
ACE	**Cultural-E:** Climate and culture-based design and market valuable technology solutions for PEB (H2020)	Design tools, smart technologies, methodologies and policy recommendations for Plus Energy Buildings
ACE,Housing Europe	**Drive0: D**ecarbonization of the EU building stock by enhancing a consumer centred renovation (H2020)	Circular building renovation with focus on end-users.
ACE	**DigiPLACE:** Towards a European Digital Platform for Construction (H2020)	A common European digital construction ecosystem of digital services supporting innovation, commerce, etc.
PZ (lead) *SAB*	**SmartEnCity:** Energy retrofitting measures in three housing associations in Sønderborg (H2020)	Design, implementation, and monitoring of integrated renewable energy systems in buildings.
DTU (lead)	**FED:** Flexible Energy Denmark (Innovation Fund Denmark)	Flexibility of buildings and districts, and link to the local energy communitive.
DTU	**ebalanceplus:** Smart Energy Flexibility for Distribution Grids (H2020)	Integration of renewable energy in local grid; markets and business models, economic and social aspects.
DTU	**SCA:** Smart City Accelerator (EU Interreg)	Optimize the energy efficiency and acceptance of smart energy solutions in smart cities
DTU, *DAN*	**HEAT 4.0** (Innovation Fund Denmark)	Digital solutions for district heating and local thermal grids
DTU	**REBUS:** Renovating Buildings Sustainably (Innovation Fund and Landowners Investment Fund)	Societal partnership for sustainable renovation. Strengthening the innovation force in renovation.
EURAC	**STARDUST:** Holistic and Integrated Urban Model for Smart Cities (H2020)	Low carbon, efficient, intelligent, and citizen-oriented cities with green solutions and innovative business models.
EURAC	**VARCITIES:** Visionary Nature Based Actions for Health, Wellbeing & Resilience in Cities (H2020)	Cities with the human community at the centre: Innovative ideas, sustainable models, and shared public spaces to improve health and well-being in diverse climatic conditions.
EURAC	**SINFONIA:** Smart INitiative of cities Fully cOmmitted to iNvest In Advanced large-scaled energy solutions (FP7)	Large-scale, integrated, and scalable energy solutions in mid-sized European cities: energy savings, RES, retrofit, electricity grid optimisation, and district heating and cooling
EURAC	**CA19126:** Positive Energy Districts (PEDs) European Network (COST Action)	Harmonising, sharing, and disseminating knowledge/breakthroughs on PEDs
EURAC, NTNU	**IEA SHC Task 63** – Solar Neighborhood Planning	Design of communities based on solar energy utilization

BOEX, HU, UU, BOS GROEP	**IRIS:** Co-creating smart and sustainable cities (H2020)	Applied innovation, planning with citizen participation, energy efficiency, intelligent ICT, business models.
BOEX, HU, UU, BOS GROEP	**TKI:** Henriëttedreef District of Overvecht in Utrecht (National innovation project)	Modular renovation system
HU	**Actions to Mitigate** Energy Poverty in the Private Rented Sector (H2020)	Address energy poverty in the private rented sector
HU, UU	**Smart Solar Charging** (Over EFRO)	Locally generated solar energy is stored in shared cars via a smart and dynamic system (V2G)
HU	**Energy Transition** in the Existing Building Stock	Affordable and user-friendly renovation concepts
HU	**Future Factory** (MMIP3 & 4)	Modules to make row housing sustainable on a large scale.
UU	**PVP4Grid**: PV-Prosumers4Grid (H2020)	Better power market integration of PV and prosumers
UU	**PARENT**: PARticipatory platform for sustainable ENergy management (ERA-NET)	Energy savings with a software-based solution that is extensible, reusable, socially acceptable, and marketable.
UU	**CESEPS:** Co-Evolution of Smart Energy Products and Services (ERA-NET)	Energy behaviour, local energy trading, demand side management, local RES, e-mobility, and forecasting
SAB	**HAPPI**: Housing Association's Energy Efficiency Process Planning and Investments (H2020)	Energy refurbishment of homes: Best technologies and methods to be used, and smart funding of major renovations.
PALMA (lead)	**EDUSI:** Litoral de Ponent - Integrated Sustainable Urban Development Strategies (FEDER)	Lasting and long-term improvement of the social, economic, and environmental conditions of an urban area.
PALMA	**INCIRCLE** European Regional Development Fund	Waste management
PALMA	**REGENERATE:** Unlocking the Market for Eco-Sustainable Renovation on Balearic Islands (H2020)	Business models and renovation financing
DAN	**REWARDHeat:** Smart networks, integrating renewable and waste energy sources (H2020)	Development and demonstration of ambient loop district heating substation for multi flat building.
DAN	**RE-INVEST:** Renewable Energy Investment Strategies (Innovation Fund Denmark)	Innovative research-based endeavour towards a 100% renewable energy system in Europe
HE	**HEART:** Holistic Energy and Architectural Retrofit Toolkit (H2020)	Multifunctional toolkit integrating components to transform existing buildings into energy efficient smart buildings.
HE	**HOUSEFUL:** Innovative circular solutions and services for the housing sector (H2020)	11 circular solutions co-created by stakeholders in current housing value chain.
CENTER DENMARK (lead), *DTU, DAN*	**Center Denmark:** Intelligent Energy (European Commission and Innovation Fund Denmark)	To unify and embed results from digitalization of energy systems, data intelligence for disposal for commercial use
DTTN	**Build-in-wood** (H2020)	Drastically increasing the proportion of timber construction

(b) Methodology

The main methodology of the ARV project will be to **co-create, implement, operate and evaluate 6 urban regeneraton projects** to demonstrate how promising innovations towards Climate Positive Circular Communities (CPCCs) can become wide-spread.

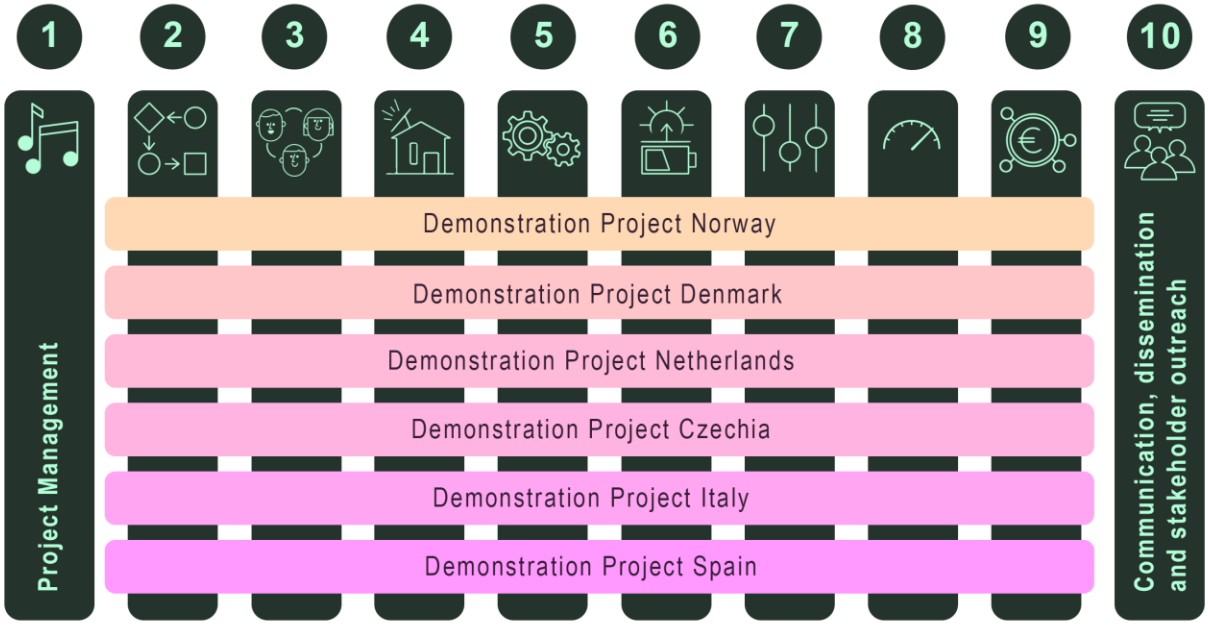


Figure 1.6 The integration of the thematic work packages (1-10) and the ARV demo projects.

The demonstration projects have been carefully selected to adress the main thematic areas of the call, and will be explored in a matrix structure that integrates the thematic areas (Work Packages) with the implementation of the regeneration projects (Demos), as shown in Figure 1.6. This matrix structure enhances knowledge exchange and co-creation between thematic expertise (in the WP) and the practical implementaiton (in the demo projects). As mentioned in the introduction, each of the demos are chosen to be 'leading stars' in one or more of the thematic focus areas. **The matrix structure ensures replication and scaling by trialing similar demo elements in different planning, socio-economics, financial, and social contexts.** It avoids each demo and thematic work areas being isolated silos, and ensures that the relative strenghts and weaknesses of the different partners are covered in a coherent and complementary fashion. Regional, cultural, and lingusitic homophily is a significant driver of knowledge transfer and has been explicitly included in chossing the demonstration sites to ensure a higher degree of scalability and replication.

The following is a summary of the composition and outstanding performance of the ARV demo projects:

- They are part of **urban transformation and regeneration projects** representative for different **climates and contexts** in Europe, spanning from north to south, and east to west.
- They include **innovation clusters** and stakeholders representing **the whole value chain needed to achieve a transformation to CPCC**, including municipalities, developers, owners, urban planners, architects, engineers, contractors, suppliers of materials, components and services, energy companies, facilities managers, occupants, NGOs, and research/educational institutes.
- They have a high emphasis on **efficient renovation processes**, including a large portion of **social housing to be upgraded to NZEB standard or better**. Moreover, the demonstration projects also include the construction of new buildings that demonstrates the ambition of **positive energy performance.**
- They have **high ambitions** with respect to energy performance, energy/power flexibility, utilization of RES, minimisation of greenhouse gas emissions, low investment and operational costs, circular economy, high architectural qualities, while achieving high levels of safety, security, and well-being of the occupants and users.
- They include **substantial innovations** that addresses all the focus areas in the call (ref Table 1.7). Moreover, each of the demonstration projects have particularly outstanding innovations in at least one of the 9 thematic focus areas: The Spanish Demo has outstanding innovations in focus areas no. 2) Framework and tools for effective implementation of CPCCs and 3) Community engagement. The Norwegian demo has outstanding innovations in focus area 4) Sustainable building (re)design. The Dutch demo has outstanding innovations in thematic focus area no. 5) Resource efficient (re)construction and renovation workflows. The Italian and the Czechian demos have outstanding innovations in focus area no. 6) Integration of renewable and storage systems. The Danish demo has outstanding innovations in focus area 7) Efficient operation and flexibility. Finally, they all contribute to the integrated approaches in focus areas 8) Measurement and evaluation and 9) Business models, financial instruments, policy and exploitation.
- They host **Living Labs** where citizens and occupants are engaged in the transformation process of the ARV communities. They aim to become smarter by addressing the citizens, businesses, workforce/commuters, entrepreneurs, academia, public authorities, and non-profit organizations and actively engage in bottom-up co-creation to identify, develop and implement suitable solutions.

In sum, the ARV demos will deliver innovations with a **large potential for replication and scaling up** throughout Europe.

The **main methods and tools** and the **workflow** to be applied in the project, are as follows:

A **number of different methods and tools** will be used, including the following:
Innovation management (WP1), inter-disciplinary workshops and co-creation (all WPs), demo site visits (all WPs), living labs (WP3,10), integrated design (WP4-7), AR/VR (WP2,3), EGNSS/GIS/BIM/digital twins (WP2, 4-6), digital logbooks and material databases (WP4,5,8), parametric design (WP4,5), LCA (WP4,5,8), Industry 4.0/Zero engineering/file-to-factory and lean low carbon construction (WP5), multiple benefit analysis (WP2,8), computer simulation of energy and indoor/outdoor environment (WP2, 4, 5, 6), grey box models (WP7), forecasting (WP7), digital cloud hub (WP7), APIs (WP8), Blockchain observatory (WP9), STO (WP9), social media (WP10), games

(WP10), web-platforms (WP10), etc. The application of the methods and tools is further described in the work plan (Section 3).

Workflow: The ten work packages will be regularly interacting with each other and the demos to produce integrated, circular, and simple solutions for CPCCs. WP1 focuses on project and innovation management and coordination. WP2 will be dedicated to establishing an easy-to-use planning framework for the CPCC implementation. Engaging and interacting with occupants will be the focus of WP3, which will connect especially with planning (WP2), design (WP4), execution (WP5), and smart energy operation (WP7) of the CPCCs. To demonstrate efficient building design and construction workflows, ARV will have dedicated WPs for sustainable building (re)design (WP4) and resource efficient manufacturing and construction processes (WP5). WP 6 focuses on the integration of renewable on-site energy generation and storage on the neighbourhood level, with links to EV charging. As the community comes into operation, smart monitoring (WP8) will connect people, buildings and energy systems to enable smart and cost-efficient operation and use with special focus on flexibility and energy exchange (WP7). To trigger fast and efficient replication of the CPCC solutions, WP9 will focus on financial mechanisms, business models, policy and exploitation. Finally, WP10 focuses on stakeholder outreach and dissemination, with the construction of an e-marketplace for the ARV solutions and the production of a blueprint for planning, (re)design, (re)construction, operation and use of CPCCs.

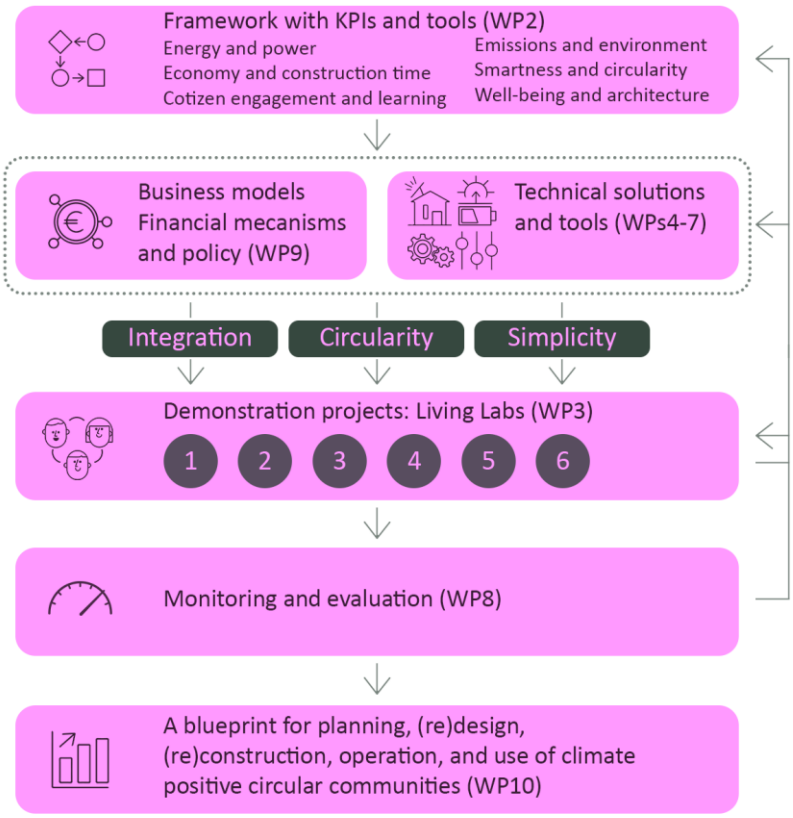


Figure 1.7 Illustration of the workflow in ARV.

Gender Analysis

The integration of gender and diversity considerations in the project is addressed using a framework for **stakeholder engagement** (e.g. by including best practices in leveraging inclusive engagement), and guidance for **Open Data Management** (e.g. by including sex-segregated data whenever possible and identifying gender bias in available data). Integrating gender considerations at all stages of the project is therefore important for achieving optimal performance, as well as successful market uptake and replication.

The deployment of Circular Climate Positive Communities will play a key role in shaping the solutions to be implemented and understanding their impact. Their success depends on the ability of local partners to involve citizens to overcome popular perceptions as something relevant only to technical experts and engineers. To this end, gender and diversity considerations will be included in all stages of implementation, from shaping the innovations to monitoring the effect of the demonstration projects. Special focus will be on ensuring **fair and diverse representation** in all participatory processes implemented in the framework of the ARV project.

With a focus on the development of market uptake and replication strategies, gender considerations will be included in the start-up promotion activities. Cross-project interaction, communication and dissemination will to the largest extent possible use **gender-impartial language and settings** to encourage gender mainstreaming, i.e. all genders can participate in, benefit from, and influence the ARV activities. Adapting ARV solutions to different geographic and cultural contexts will include awareness raising activities, emphasizing the importance of **inclusive integrated energy and sustainable planning**.

ARV will pay attention to **language and visual representation** used in all project materials, in order to help remove unconscious gender assumptions and create an appealing and empowering vision of an inclusive neighbourhood model striving for gender balance in project-related events and other representative functions. If necessary, additional expertise will be mobilised using existing networks, e.g. via the European Centre for Women and Technology and other resources.

The ARV project will have a female Project Coordinator, 5 out of 10 WP leaders are women, and 50% of the staff registered in the Participant portal are female. The General Assembly and Executive Board will also have a balanced gender representation. In addition, the Project Coordinator is committed to ensure a gender balance in project and administrative positions by offering dedicated support programs (http://www.ntnu.edu/genderbalance).

1.4 Ambition

1.4.1 State-of-the-art and ARV ambitions beyond state-of-the-art

Table 1.6 shows an overview of the current state-of-the-art and ARVs ambitions beyond state-of-the-art, organized to address the topics of the call and the related innovations in ARV. A further description of the ARV innovations is given in Section 3 with respect to the work plan, and in Section 1.4.2 with respect to the ARV demos.

Table 1.6 Overview of the state-of-the-art and ARV ambitions beyond state-of-the-art.

Topic	State-of-the-Art	ARVs ambition beyond State-of-the-Art
Zero and Plus Energy Buildings	Some net zero energy buildings and even plus energy buildings have been realized. Also, some net zero emission buildings have been realized. However, they are far from mainstream, and suffer from high investment costs, and complicated operation and use, resulting in higher energy use and/or lower environmental quality than predicted.	ARV goes beyond the state-of-the-art by taking a life cycle perspective on both energy and emissions, as well as a strong focus on people's well-being and awareness, cost-effectiveness, and architectural qualities. An ARV CPCC is designed to avoid sub-optimizing and overcoming the performance gap.
Topic	**State-of-the-Art**	**ARVs ambition beyond State-of-the-Art**
Planning and design	There is a wide range of tools available for performance prediction of energy and indoor environment. A few tools are designed to model neighbourhoods and districts. However, the tools are complicated and time-consuming to use, and do not address all performance indicators of a CPPC in an integrated way. There is also a lack of tools that give reliable performance predictions of life cycle emissions in the early planning phase, and tools that can model flexibility throughout the life cycle.	ARV will develop and demonstrate a framework with tools for effective planning and evaluation of CPCC. This will build on existing tools for ZEBs and PEDs, but will be expanded to take into account **circularity and flexibility topics and the human perspective**. Life cycle costs and trade-offs between different measures (such as investing in building renovations vs new energy systems) will be addressed. It will be designed to be integrated with digital tools such as EGNSS, GIS, BIM, to better assess all qualities of the neighbourhood and make it comprehensible for all stakeholders including occupants.
Topic	**State-of-the-Art**	**ARVs ambition beyond State-of-the-Art**
Construction/ renovation workflows	Europe's building stock is unique and heterogeneous, but it is largely old and inefficient, and changes are slow. Across the EU, deep renovations that reduce energy use significantly are carried out only in 0.2% of the building stock per year. The reasons are manifold, high investment costs, lack of specialized workforce, disruptions and nuisances to the occupants, etc. A few deep energy renovation projects have been carried out, but most do not meet all criteria needed to become widespread (costs, disruption, architectural quality).	ARV will develop, demonstrate and validate new workflows in an **industry 4.0 approach** for resource efficient manufacturing and construction for deep energy renovations. It applies advanced tools such as **digital data harvesting, automation, and zero-engineering** techniques. This will result in **prefabricated elements** that include energy efficient services and low carbon building materials that can be seamlessly installed without disruptions and nuisance for occupants. The ARV elements will be cost-efficient, reduce waste and transport, and ensure high architectural quality. The process is replicable to a wide range of buildings throughout Europe.
Topic	**State-of-the-Art**	**ARVs ambition beyond State-of-the-Art**
Operation and use	Efficient operation and use of buildings require technical solutions that are seamlessly integrated, and that addresses occupant behaviour and needs. Several studies show that ignoring the occupants result in the so-called design-built performance gap. At the same time, new digital technologies such as smart home systems and AI enabled EV charging offer opportunities for customized control and optimization of energy, costs and environmental performance while providing occupant comfort. In a plus energy neighbourhood perspective, there are added benefits to gained by load/generation forecasting, balancing, and energy flexibility management. These challenges require a multi-disciplinary and integrated approach to design and operation of buildings and neighbourhoods. The multiple benefits and strategies for unlocking all potentials remains to be fully understood and demonstrated.	ARV will engage and demonstrate solutions for **active citizen engagement** in the design, operation and use of CPCCs. **Living Labs** will be developed and tested in the demonstration projects to enhance engagement, awareness raising, and learning, **bridging the gap between the technical and social contexts**. Tools such as co-creation workshops, AR/VR, green ambassadors and change agents, energy and circularity coaching, and serious games, involving a wide range of stakeholders. A special focus will be put on young citizens (linked to schools) as future citizens and ambassadors of the CPCCs. Thee feedback and learning from the ARV demonstration projects will be used to provide replicable approaches. ARV will develop and demonstrate **digital, data-driven solutions and infrastructure to unlock the flexibility potential** of the CPCCs and optimize for self-consumption, minimizing CO_2-emissions and costs, without sacrificing safety or well-being of the citizens. This includes tailored Smart Readiness Indicators and Flexibility Functions for different types of buildings in CPCCs around Europe. ARV will also deliver a centralized data warehouse ensuring a common data framework for CPCCs.
Topic	**State-of-the-Art**	**ARVs ambition beyond State-of-the-Art**
Passive and bioclimatic building design	Passive building design / bioclimatic design have long traditions across Europe. Still, the potential of this powerful approach is not being fully harvested in current practice. This is despite the fact that modern passive design has an even higher potential, by using new knowledge of environmental issues such as	ARV will develop and demonstrate a new paradigm of '**integrated circular design** of CPCCs', by taking a **multi-disciplinary** approach to (re)design buildings with maximize energy efficiency, minimize life cycle greenhouse gas emission and costs, optimizing occupant well-being and ensure high architectural qualities. This will be accomplished by using

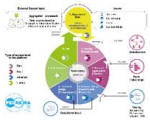
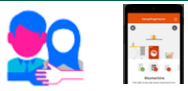
	greenhouse gas emissions and low carbon materials, as well as the use of modern digital tools. The reasons to this are primarily the time and resource limitations in the early design stages, and the interdisciplinary skills needed. Thus, an efficient and integrated design approach is needed from the early design stage, involving modern digital tools and a systematic holistic design process.	modern **digital tools** (BIM, Digital Twins) in a multi-stakeholder cooperation to design for: • Integration of active/passive solutions (solar, natural/hybrid ventilation, thermal storage, effective heat/cool distribution) • Industrialization, modularity and standardization • Plug-and-play integration • Material data storage (digital logbooks and passports) • Architectural diversity (design to context) • Flexibility, longevity, and low maintenance • Reduction, reuse, and recycling • Fire and seismic safety
Topic	**State-of-the-Art**	**ARVs ambition beyond State-of-the-Art**
RES and Storage	A range of renewable and storage systems for different uses exist on the market. Their continuous decline in costs, along with increased digitalization and the growth of EVs, offer an opportunity to accelerate, over the next two decades, a profound transformation of our energy system and its structure. The main innovation potential lies in the efficient integration of the different energy systems, as well as the integration with the buildings and the users. This has the potential to minimise the costs of transition towards climate neutrality and opens new opportunities for reducing consumers energy bills and their active participation in new markets.	*ARV innovation lies in the **smart*** **integration** of the most efficient RES and storage systems for different building types, uses, climates and context, given **the new paradigm of flexibility and trading**. ARV will focus on the most promising technologies such as ground source heat pumps, building integrated photovoltaics, electric batteries (stationary and in EVs), seasonal thermal storage (using natural reservoirs), and efficient utilisation of district heating. Integration of the technologies in a CPCC perspective will be realised by optimizing costs, emissions, and occupant well-being. Optimisation will be done using state-of-the-art methods and **digital tools** including forecasting, skyimaging, grey box models, and parametric design.
Topic	**State-of-the-Art**	**ARVs ambition beyond State-of-the-Art**
Financial instruments and business models	Financing sustainable development is one of the greatest challenges of our time. Meeting this challenge will require the mobilization and redeployment of substantial resources. Yet despite its overhaul following the financial crisis, today's global financial system is not fit for this purpose. Today, too little capital flows to meet the financing needs of the sustainable development goals, and too much capital continues to finance unsustainable development. The current era of low interest rates limits the ability to offer discounts on green loans and Energy Efficient Mortgages (EEMs), which acts as a disincentive to scale marked-based energy efficiency finance. Integration of flexible energy solutions in real-estate portfolios offers a new pathway to address this barrier by offering tools to strengthen returns on energy retrofit financing, whereby offering an innovative pathway to scale. Digital finance, which includes a broad range of technologies such as big data, artificial intelligence, blockchain and the Internet of Things (IoT), offers innovative solutions to scale up sustainable finance, and the prospect of a more efficient, accessible and less vulnerable financial system.	ARV aims to leverage the benefits of energy positive neighbourhoods to create new incentives for citizens and financial service institutions to invest in energy efficiency. The benefits go beyond energy/cost reductions and direct CO_2 savings, but also **enable energy flexibility to be commoditized and traded** by the citizens as prosumers. ARV will apply smart flexible energy solutions to accelerate the scaling of existing market-based financing, such as **Energy Efficient Mortgages (EEMs)**, as well as to design entirely new financing mechanisms based on the citizen as prosumer**.** Focus will be on creating **incentives for large scale retrofit** including modes of demand aggregation. ARV innovations include: **Product-Service combinations** (e.g., lease models) in the field of energy, safety, comfort, and renovation. **Energy performance contracting** based on the KPIs and Building Energy Management monitoring system as well as new ways to overcome the split incentive problem in rented real estate. It also includes the application of the **one-stop-shop** concept linked to innovative financing incentives to **engage a critical mass to advance deep energy refurbishments on a district scale**. Results will be captured in business model blueprints as modules for replication in across the EU.
Topic	**State-of-the-Art**	**ARVs ambition beyond State-of-the-Art**
Policy, codes and regulations	Building codes currently only focus on energy performance, although several countries are planning to implement requirements with regards to GHG emissions in the coming years. However, methods for how to document and assess this, are still under development. The European Electricity Regulation and Directive provide the basis for an ambitious European Green Deal and Green Recovery[26]. Many articles in both the Electricity Regulation and Directive are crucial in removing existing regulatory barriers to demand-side flexibility, and for enabling active participation of energy consumers in order to increase efficiency and in the transition to clean energy.	ARV will apply LCA approach and material logbooks and banks to assess and document life cycle emissions of the demos. This will provide basis for benchmarks and target values for policy and regulations. ARV aim at releasing the barriers for demand side efficiency and flexibility by sustainable design, data-driven renovation, and a hierarchy of digitalization setups in order to enable customers and local communities to act as active customers without being subject to disproportionate technical requirements, administrative requirements, procedures and charges. ARV aim at demonstrating how to remove existing regulatory barriers to demand-side flexibility, to enable an active participation of all energy consumers in the clean energy transition and increase efficiency at all levels.

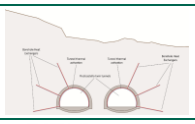
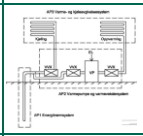
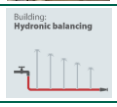
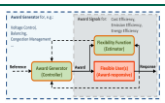
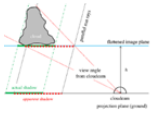
[26] SmartEn - Smart Energy Europe, Nov. 2020: The implementation of the electricity market design to drive demand-side flexibility.

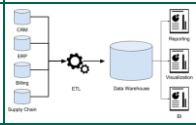
1.4.2 ARV Innovations

An overview of key ARV innovations is given in Table 1.7, providing a short description of each innovation, the current Technology Readiness Levels (TRL) and the targeted TRL's, the key stakeholders, and the expected impacts. More detailed descriptions (as well as more innovations) are given in Sections 1.4.2 and 3.

Table 1.7 Overview of the ARV innovations (a detailed description is given in Section 1.4.2)

	Key innovation	TRL	Main impacts/ goals	Illustration
WP2: Framework and tools for CPCC	Modelling & Assessment Tool for Planning CPCC	5/6→8/9	Connect and integrate the solutions in a CPCC allowing a simplified and scalable design. Connect stakeholders in a construction/renovation process facilitating the co-creation of CPCCs. The framework will be simple to use and highly replicable at different demonstration sites.	
	VR/AR Empowered Environments	5→7	Citizens empowerment; Increased understanding and acceptance of energy retrofitting solutions; Smoother dialogue between residents and professional stakeholders.	
WP3: Community engagement, environment, and well-being	CPCC Living Labs and citizen engagement tools.	6→ 8	Community engagement for social renovation, energy transition and circularity, involving green ambassadors and energy coaching.	
	One-stop-shop platform for CPCC refurbishments	6→ 8	Co-creation approach enabling diffusion of design technology and replicability of solutions; fire and seismic resistance co-benefits of timber-based construction/refurbishment.	
	Centre for Energy Transition TE21	5/6→7/8	Increased citizen awareness, engagement and knowledge about energy performance and energy transition in urban environments.	
	Citizen Energy Communities (CECs)	5/6→7/8	Crowd-funding mechanism for increased renewable generation using PV in the district and guideline for replicability	
	Human Capital program BouwisWouw	7→8	Jobs & internships created in the local building and renovation sector.	
	Social renovation with housing tenants	7→8	Citizen empowerment and improvement of social and physical living environment	
	Energy coaching of residents to reduce energy poverty	4/5→7	Citizen empowerment and satisfaction, lower energy consumption and lower energy costs for tenants	
WP4: Sustainable Building (re) Design	Positive Energy Building Social Housing with local materials	6/7→8/9	Increased use of local materials with low embodied energy and emissions. Replicable design solutions for PEB in the Mediterranean climate	
	Use of recycled materials in green roofs	6→7	Reducing embodied energy and heat islands, improved rainwater management.	
	Architectural and aesthetic plug-and-play BIPV/BAPV solutions	6→8	Citizen satisfaction with building design; Increase in RES production (BI/BAPV) at building level.	
	Deep energy retrofitting of heritage buildings	6/7→8/9	Process for deep energy retrofit while conserving cultural heritage values and improving indoor comfort. Architectural integration of PV.	
	Digital Logbook for CPCC and Material Hub	6→8	Documenting Integrated Circular Design solutions for building refurbishment with 50% of energy reduction and positive energy new construction, inform Industry 4.0 via digital surveys, comfort improvement.	
	HeMuBo retrofitting (NZEB) with Inside-Out system design components for high-rise social housing retrofit to PEB	6→8	Shortened retrofitting time and cost; Increased energy ambitions from the NZEB HeMuBo approach towards the ZEB and PEB approach of Inside-Out. Goal is to create a future-proof concept and higher comfort levels for tenants.	

WP5: Resource Efficient (Pre)Manufacturing and Construction Workflows	Swappable energy façade	4/5→6	Enabling easy application of PV/PV-T/solar thermal/façade heat exchangers for possible coupling with heat pumps	
	Timber/bio-based plug-and play modules	6→8	Reduction of CO_2 -emissions in materials use and on-site, longer service lifetimes, shorter construction times, and reduced on-site noise and pollution.	
	Inside-Out system design for high-rise social housing retrofit to PEB.	6→8	Shortened retrofitting time and cost; Increased energy ambitions achieving net-zero to positive energy values.	
	Pre-recognition of façade-typologies	4/5→7	Shortened retrofitting time and cost; Improved flexibility for tailor-made retrofitting system; High potential for replication in existing building stock.	
	Zero-engineering of manufacturing process	4/5→7	Shortened retrofitting time and cost; Improved flexibility for retrofitting systems; Increased potential for replication for existing building stock	
	Circular hub for optimized construction	4/5→7/8	Upcycling of demolition material decrease tCO2 and embodied energy of retrofitted building; Decrease in air pollution and retrofitting costs due to optimized logistics.	
	One-piece flow optimized construction workflow	4/5→7/8	Reduction of nuisance (dust, noise, emissions) for residents during retrofitting; Decrease in air pollution and retrofitting costs due to optimized logistics.	
WP6: Innovative RES + storage	Integration of second-life battery storage system and V2G	5→8	Repurposing car battery saves materials; building energy flexibility, load-shifting, and peak shaving, cost reduction.	
	Urban Energy Geostructure in highway tunnels	6→8	To provide seasonal thermal storage to the CPCC using existing (abandoned) infrastructure. Reducing power needs, costs and emissions.	
	LowEx System	6/7→8/9	Extremely low temperature heating and high temperature cooling distribution using thermal mass, and optimized ground source heat pump with SCOPs heating 6-7 and SCOP cooling >30. Increased thermal comfort, higher architectural quality, lower energy/power need	
	Circulation Booster for Domestic Hot Water in District Heating (DH)	4/5→7	DH temperature reduction from 45 to 25 °C causing higher utilization of energy for final heating purposes and better comfort	
	Return Temperature Optimizing	6/7→8/9	DH temperature reduction from 45 to 30 °C causing higher utilization of energy for final heating purposes and better comfort	
WP7: Efficient operation and flexibility	CPCC Cloud HUB	6/7→8/9	Digital Hub for data storage and control of energy performance, unlocking the flexibility potential at the neighbourhood level. Will also be hosting the Data Warehouse (see WP8).	
	CPCC SRI	5/6→7/8	Smart Readiness Indicators adapted for buildings in CPCC in different climates and contexts, for improved energy management	
	Flexibility Functions for CPCCs	5→7	Flexibility functions to unlock the flexibility potential of CPCC in different climates and contexts, reducing power needs, CO_2, and costs.	
	nZEB Multifamily buildings centralized systems	5/6→7/8	Optimal operation and monitoring for increased performance of centralized systems in nZEBs by means of energy flexibility.	
	Automated energy performance analyses for PEB retrofitting	4/5→7	Improved building RES self-consumption, through reduction in primary energy savings. and increase in RES production (BI/BAPV) at building level	
	Deployment of solutions for forecasting (city weather, solar, load)	4/5→7	Increase in self-consumption through optimization of RES generation, storage, and use	

	Smart building control optimisation	4/5→7	Increased self-consumption; Improved indoor environment quality; Enhanced citizen awareness and engagement through user-interfacing	
	Smart community optimisation and market interfacing	4/5→7	Primary energy savings by district and city scale exchange of energy; Triggering of further investments in sustainable energy due to revenues from market trading.	
WP8: Monitoring, evaluation, and impact	Post-Occupancy Evaluation for CPCCs	6/7→8/9	More holistic and long-lasting solutions ensuring that occupant quality is not compromised by energy performance	CPCC-POE 
	CPCC Data Warehouse	6→8	Systemized data architecture and storage for tracking, validating and dissemination of energy, emissions, materials, comfort, pollution, user behaviour, and micro-climate. Contribute to overcoming design-built performance gaps.	
	Multiple Benefit Framework	6→8	Framework for integrated assessment of CPCCs toward UN sustainable development goals.	
WP9: Financing and buisiness models	Bankable business models for CPCCs	6/7→8/9	Successful working business models for different real-estate ownership structures: social housing, rental and privately owned. Scalable and including for profit and non-for-profit.	
	Scalable financing instruments for green real estate	6/7→8/9	Innovative financing solutions that accelerate the transition to energy positive real-estate while being affordable and effective for building owners and users.	
	Green Security Token Offering (STO)	6/7→8/9	The use of green digital bonds to exploit the potential of STO for flexible energy and retrofits. Awareness raising among European Financial Institute to accelerate interest in EE financing.	
	One-Stop-Shop mechanism for the large-scale renovation of urban areas	6/7→8/9	Decreased barrier for renovation projects, increased the involvement of end-users for long-lasting solutions	

1.4.2 ARV Demonstration Projects of CPCCs

The Spanish demo case is the *Llevant Innovation District* in Palma de Mallorca in a neighbourhood with approx. 2500 inhabitants. It encompasses a mixed used development area including residential, tertiary, and educational buildings, with both new construction and renovation activities. The set of actions that will be undertaken by the ARV project will encompass resource efficient renovation processes and district energy analysis and operation, highlighting social, educational, and digital aspects to enhance citizens involvement. Key actions in the district can

be summarized with by following numbers:

1) Large Scale retrofitting action in La Soledat Sud of 250 private dwellings (26 800 m^2) by means of a novel Public Private Partnership mechanism. Total built area is 191 000 m^2;
2) New Positive Energy Social Housing Building promoted by IBAVI: 36 apartments; 1750 m^2;
3) New high efficiency Residential Multifamily Buildings. Demo project involves 2 buildings; 114 + 88 apartments 14 400 m^2;
4) Energy Renovation of a flagship heritage protected building from the 70's modern movement: 16 600 m^2;
5) The creation of a Citizen Energy Community (CEC), a private crowd-funded, innovative mechanism to facilitate the deployment of renewable energy using available public and private roofs in the area.

Key data:

Size (floor area): 936 935 m^2	**Building/renovation timeline:** 2021-2025
Investment cost: € 104 million	**Project developers:** City council (Ajuntament de Palma de Mallorca) with the collaboration of Regional Government and University

Key innovations:

WP	Innovations
WP2	The adaptation, testing, and use of a **District Energy Simulation Tool** to analyse, design, and study energy flows in the neighbourhood. This will serve to optimize the interaction with the surrounding energy infrastructure, define pathways for energy transition in the District and assess the impact of actions. Subsequently, link to 3D twin district models using Virtual Reality by establishing connection to the Digitalization Hub in the area.
WP3	**Centre for Energy Transition TE21** will act as a demo and exhibition space and a hub for citizen engagement towards energy transition in urban spaces and new sustainable technologies. Linked to local energy communities around schools, TE21 will engage a set of training actions and awareness increasing campaigns with special attention for the education of younger generations actions. Activities will combine use of digital tools, VR visualization, testing of prototype solutions and open visits **Adaption and evaluation POE for assessment of occupant satisfaction**. **The creation of a Citizen Energy Community (CEC) platform**: a private crowd-funded, innovative mechanism to generate renewable energy using available public and private roofs in the area. The CEC platform will be developed with special focus on educational aspect and replicability.
WP4	Design, construction, and monitoring of 36 apartments multifamily building with the ambition level of being a Positive Energy Buildings in 2023 by a Public Social Housing promoter. Strong focus on the use of **innovative local materials and resilience against climate change.** **Cost-optimal solutions for retrofitting** of buildings in large-scale renovation process (200-300 dwellings) aiming to achieve a 50% reduction in the energy demand and a significant improvement in the thermal comfort conditions **Energy Renovation of a flagship heritage protected office building** (Antic Edifici GESA) along with testing and monitoring of several BIPV solutions regarding aesthetics aspects and energy production.
WP5	Showcase the **reduction of execution time** and costs in a large-scale renovation process (200-300 dwellings; several building) in an integrated process with one Project Manager in comparison with a process that goes one building by one building. Testing solutions based on the **recovery of eco-friendly local artisan industries** which are in danger of extinction, along with the use and improvement of a Catalogue of Sustainable Local Materials.
WP7	**Advanced control and monitoring** of shared HVAC assets in multifamily dwellings Data aggregation in a hierarchical setting using cloud, fog and edge computing. **European digitalization Hub** (CENTER DENMARK) are established to ensure low-cost operations in different climate zones. **Flexible operation of a Citizen Energy Community (CEC)** to generate renewable energy using available public and private roofs in the area.
WP9	**Private Public Partnership one-stop shop mechanism** for the large-scale renovation of urban areas providing the instrument to facilitate large scale renovation initiatives **The creation of a Citizen Energy Community (CEC)** by means of **private crowd-funded, innovative mechanism** to generate renewable energy using available public and private roofs in the area. The CEC model will be developed with special focus on educational aspect and replicability -

The Italian demo case is called *Piedicastello Destra Adige* and located in the Northern Italian city of Trento. The demo case consists of four areas:

Area 1, the former Italcementi industrial site, will host an entirely new mixed-use district of Trento, containing residential and tertiary buildings. The aim is to develop the district as self-sufficient, by using the very high geothermal potential in the area and its excellent orientation to the southeast for PV production to power the geothermal heat pumps.

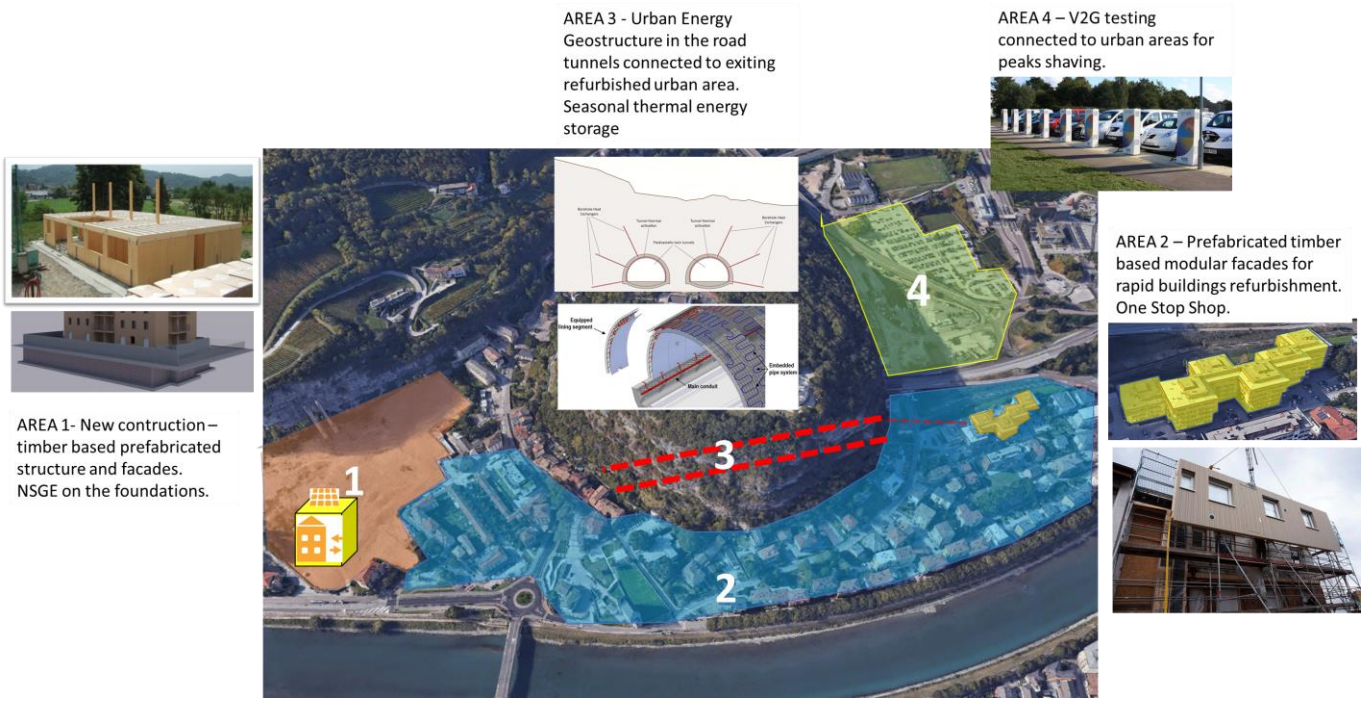
Area 2 is an urbanization from the 50s–70s. Most of the buildings are close to or have already reached the end of their life cycle. The area was developed with a strong focus on social housing and is largely still owned by the Trentino Institute for Social Housing. These residences are to be renovated by using standardized prefabricated timber-based façade elements, implementing the so-called "One-Stop-Shop" which provides technical support at all stages of design and realization, also the private owners of the area are invited to associate themselves in the redevelopment process, thus guaranteeing a high degree of replicability also for other areas of Trento.

Area 3 includes the former Piedicastello highway tunnels encompassing two 250-m holes in the Dos Trento mountain which are currently used as an art and exhibition gallery. This geostructure is intended to supply and store energy for the new city district in areas 1 and 2.

Area 4 which is currently used as a parking lot, will be redeveloped with a service HUB for the district and city. It will connect commuter flows to commercial services and will host an energy storage system, following the V2G approach, simultaneously promoting the market penetration of electric mobility.

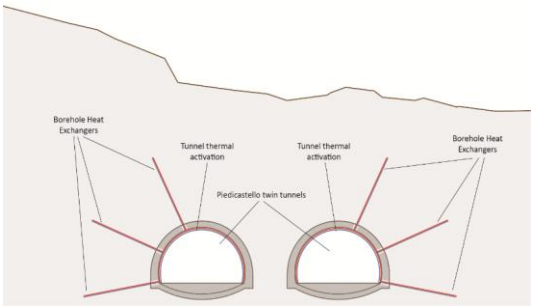
Key data:

Size: Total built surface in Area 2 to be renovated - 40.000 m^2, Financed within ARV: 6000 m^2 New built surface in Area 1 to be built – 10.000 m^2, Financed by ARV: 550 m^2	**Building/renovation timeline:** 2021-2025
Investment costs: Potential investment cost in Area 2: 16M€ - direct investment cost during ARV 2.7M€ Potential investment cost in Area 1: 10M€. Direct investment costs during ARV 1.1M€ Potential investments costs in Area 3: 2.5M€ Direct investment costs during ARV: 350k€	**Project developers:** Province of Trento, Private landowners, Trento Municipality, ITEA, Dolomiti Energia



Key innovations:

WP	Innovations
WP3	• One-stop-shop platform for refurbishment, to invite private owners in the area to associate themselves in the renovation activities i.e. by providing technical support at all stages of design and execution. Co-creation approach enabling diffusion of design technology and replicability of solutions; fire and seismic resistance co-benefits of timber-based construction/refurbishment. • Development of a local energy community approach linked to NSGE and district heating services, local RES production and sharing. • Involvement of local stakeholders in the co-design phase considering multiple impact of the CPCC being developed.
WP4	Both new construction and refurbishment of urbanization of the 60s and 70s (Social Housing and private) is foreseen with an Industry 4.0 spill-over approach where the integration between the 2 sectors will create new opportunities for companies and economy of scale in the solutions. The main objective is to make the urban expansion energy self-sufficient. The innovation proposed are: • A catalogue of **Integrated Circular Design solutions** for building refurbishment with 50% of energy reduction and positive energy new construction, mainly acting on: building envelopes with active (BAPV/BIPV) and passive elements, nature-based solutions integration, inform Industry 4.0 via digital surveys, comfort improvement (psychological, physiological). • **Timber based (new) construction, refurbishment and superelevation scenarios** (local and circular value chain); simplified Life Cycle Inventory; circular economy-based design process; land uses reduction via superelevation (scenario development) for new constructions; renovation of existing buildings; additional (new) volumes on existing buildings. • **Natural and mechanical ventilation concept**s for climate responsive buildings. • Heat pumps integration for H&C (connection to NSGE – tunnels, building foundations, roads); passive heating systems integrated in buildings envelopes; active thermal mass, heat storage; active/passive systems integration via Building Automation Systems.

	• Analysis of existing models for scenarios elaboration[27] to inform **hybrid Energy/Nature-based solutions** on building/urban surfaces; innovative materials (new and waste/by-products). • Architectural and aesthetic integration of **BIPV/BAPV/PVT** solutions; materials selection; integration between PV, Solar Thermal and CMV systems.
WP5	• Timber and bio-based on-site construction/renovation (modular – plug&play) during building operation will be piloted in Trento at installation of climate change adaptive measures that include summer cooling by heat pumps and green roof sample for cooling of heat islands and local rainwater management (rain gardens, greenery). Installation of swappable façade-integrated BAS controlled RES (flexible solution enabling easy application of PV/PV-T/solar thermal/façade heat exchangers for possible coupling with heat pumps). Passive/Active solutions for improved comfort linked to psychological and physiological aspects. Carbon credit scheme linked to carbon stock in timber-based solutions. • Identification of off-site production methodologies for MMC (Modern Methods of Construction) in dry tech, based on the main system used for panels production: CLT and/or framed wall • Definition of standard modules (shape and dimension) with some flexibility (dimension, materials, layers) for easy adaptation to existing buildings (fabric and systems) • Identification of BIM procedures for the panels design, to be fully compatible with production and control software, directly linked to client order handling, inventory management etc. • Definition of possible layers and materials (bio-based and/or recycled): outer finishing (including green solutions, nano-based materials, reflective finishes, PV panels), ventilated façade, insulation, system/facilities passage (within the module or intra modules), inner finishing (including PCM and massive solutions) • System integration: passage for pipes and electrical system (plug and play: correlation with existing systems), BAPV and BIPV, mini MV machine near windows • Fixing system of the panel to existing wall to be simple, fast, safe, reversible (wood/wood, wood/steel, steel/steel joints) considering installation and adjustment: particular attention will be paid to out-of-square walls and non-standard elements (corner, ground and roof joints, balconies etc)
WP6	• Using **second-life batteries and V2G technology** at a commuter parking lot. • **Urban Energy Geostructure in former 2x250-m highway tunnels as seasonal storage** to supply a new city district with heating and cooling energy. A new prototype of energy tunnel in the existing Piedicastello tunnel, currently used as an exhibition hall after having been dismissed from transportation purposes. The innovation will comprise: 1) Installation of radial borehole heat exchangers, 30 m length, at the contour of the crown. 2) Installation of a circuit of pipes at the intrados of the tunnel crown, 3) Pipes for connection to a heat pump system located at the portal. 4) Secondary system used for heating and cooling in the exhibition hall. 5) Measurement plan including temperature sensors in the ground, in the tunnel, heat flow, etc.  • **Energy geostructures for the new building for area 1 t**o support the project scope of the creation of a nearly zero energy buildings in the area 1 (former Ex-Italcementi area), energy geostructures will be adopted. The following solutions are planned: 1) thermal activation of the foundation thanks to the installation of a circuit of pipes in the foundation slab, 2) thermal activation of the retaining walls by means of the GeothermSkin elements (patent priority n°. 102016000020821).
WP7	• Establishment of an Energy Community management and its standardization for the refurbishment process.
WP8	• One-stop-shop platform business model connected to Italian national incentives for refurbishment, to invite private owners in the area to engage in the renovation activities, i.e. by providing technical support at all stages of design and execution.

The Dutch demo case consists of two clusters of residential buildings in the *Overvecht-Noord district* and the *Kanaleneiland-Zuid district* in the city of Utrecht. Both districts were built in the 1960s and 1970s to account for the quick rise in urban population and are in general of low-quality. Both districts share the characteristics of lively multi-cultural districts, with high share of social housing, schools and shops. The residential areas are densely populated district, home to a majority of low-income households. Both districts have a triple energy infrastructure: a district heating network, gas infrastructure for home-boilers and an electricity grid.

[27] CUSP.UO Observatory

In Overvecht-Noord the district stakeholders have ambitions to become fossil-free by 2030, which is supported by the National Government. Two social housing corporations Mitros and Bo-Ex together with their partners and other housing corporations are faced with the challenge of renovating approximately 5,000 social housing units in the coming years, while at the same time increasing the public space, quality of life, safety, mobility and culture in the area. Similar challenges are urgent in the Kanaleneiland Zuid district in Utrecht. The majority of homes are 1960s and 1970s system-build high-rise flats, of which there are approximately 15 000 to 20 000 in North-Western Europe offering a huge market potential for a systematic approach. It is a major challenge to renovate these apartment buildings to Nearly Zero or Positive Energy Buildings in a cost-efficient way Important obstacles are the lack of integrated, generically applicable, affordable solutions, the limited possibilities for renewable energy generation in and around the high-rise flats, the extra space required in the homes and public space, the organization of innovation and collaboration with the construction value chain partners, the required renovation time, inconvenience for residents and limited confidence of residents in long-term (energy) performance.

The demonstration actions that will be undertaken by the ARV project are the resource efficient, systematic retrofitting of: a) 6 apartment buildings to Nearly Zero Energy Buildings (with the ambition to improve the energy performance to Positive Energy Building through the tailor making of ARV innovations); b) 4 residential apartment buildings from the 1960s into Positive Energy Buildings embedded in a green neighbourhood. Positive Energy Buildings is the ambition put forward, but in case that this ambition is not feasible to achieve due to outside developments (such as the 100% sustainability of the District Heating network operated by external organisations) the buildings will be retrofitted in a Positive Energy-ready way, meaning that the retrofitted building will become positive energy buildings once the external heating sources are 100% renewable. In both districts, an interconnected smart grid will be demonstrated with (BI)PV, battery storage and V2G storage assets in connection to the DSO grid will be created including the 8 mid-rise residential buildings and 2 high-rise Intervam-10 story residential buildings.

Figure 1.8 The first retrofitted high-rise Positive Energy Building in Europe completed in Overvecht-Noord Utrecht in 2020.

Key data:

Total size (floor area):	63 600 m^2	**Building/renovation timeline:**	2021-2024
Investment cost:	€ 85 million	**Project developers:**	Bo-Ex & Mitros (ARV partners)

Owner	District	Type	Ambition	Planning	Retrofit	Dwellings	M2
Bo-Ex	Kanaleneiland	Bredero-4	PEB	2022	2023	65	5500
Bo-Ex	Kanaleneiland	Bredero-4	PEB	2022	2023	65	5500
Bo-Ex	Kanaleneiland	Bredero-4	PEB	2023	2024	65	5500
Bo-Ex	Kanaleneiland	Bredero-4	PEB	2023	2024	65	5500
Bo-Ex	Kanaleneiland	Intervam-4	NZEB to PEB	2022	2023	48	4900
Bo-Ex	Kanaleneiland	Intervam-4	NZEB to PEB	2022	2022	48	4900
Bo-Ex	Kanaleneiland	Intervam-4	NZEB to PEB	2022	2023	48	4900
Bo-Ex	Kanaleneiland	Intervam-4	NZEB to PEB	2022	2024	48	4900

Mitros	Overvecht	Intervam-10	NZEB to PEB	2023	2024	125	11000
Mitros	Overvecht	Intervam-10	NZEB to PEB	2023	2024	125	11000

Key innovations:

WP	Innovation
WP3	**Social renovation with housing tenants:** before the actual renovation the housing corporation will engage with tenants to explore social challenges and opportunities of the tenants, and support tenants in dealing with these social topics. The key innovation of ARV includes also the post-renovation coaching to improve tenant's long-term resilience for social challenges and opportunities. In addition, the application of a technical and social voucher system for tenant home improvement flexibility will be analysed and reviewed. **Human Capital program Bouw=Wouw!:** key innovation is connecting the innovative ARV demonstrators to the training of youngsters in the district in the installation and maintenance of smart solutions. The new approach offers both social opportunities for district residents and answers to required capacities for scale-up and replication of energy renovations in the Utrecht region. **Energy coaching of residents to reduce energy poverty**: Innovation includes both digital and social innovation. Through smart the visualization of monitoring data from the monitoring systems installed in buildings (see also WP7 innovation) through a Home Energy Management System (HEMS)-device or website personalized energy data is prepared. Coaching will be done by local energy change agents and tenants will be coached to understand the energy performance by adjusting their behavior and/or better using demand response technologies. **Physical Hub in district**: in 2021 the construction of a circular pavilion in the district is expected. This circular pavilion will support community engagement and development with training, promotion and dissemination of the district energy transition and renovation programs. As part of this ARV subtask this hub will be used as the location in the district where the co-creation activities related to social renovation, Bouw=Wouw! and energy coaching will take place.
WP4	**Inside-Out system design for retrofitting of mid/high-rise social housing to Positive Energy Buildings:** the innovative design elements of the integrated and modular building components are: • Rooftop: integrates the collective heat pumps, buffer vessels, (BA/BI)PV panels, insulation system. • Facades: integrates heat recovery for LT heating and ventilation, DC-ready cabling and (BA/BI)PV panels • Panels will be modular and adaptable to different building typologies, connecting to different façade and balcony sections. • Identifying the needed diversity of the renovation concept to create the architectural appearance which can be adapted and applied to the context. • Standardization and flexibility of the interface connecting above modules that offer a higher adaptation potential in full life cycle and create less waste trough net assembly. **Architectural and aesthetic plug-and-play BIPV/BAPV solutions:** innovative elements are included in the plug-n-play integration of PV components in façade roof, balcony, railing and balustrade building components generating solutions for connecting cabling of PV-panels and monitoring equipment and optimizing the yield of electricity production. • HeMuBo NZEB retrofitting: the innovative elements are: • NZEB retrofitting including energy system shift from heating by gas boilers to (low/mid temp) district heating • Universal façade retrofitting system: timber frame construction and innovative thermal bridge solutions; • NZEB to PEB through application of Inside-Out modular components. Exploration to possible integration of modular façade solutions (Inside Out 2.0: energy and HVAC installations facades using sandwich panels) produced off-site and installed plug-and-play on-site and the application of additional BIPV / BAPV*.
WP5	**Pre-recognition of façade-typologies**: innovative elements include the pre-recognition of façade-typologies through 3D point cloud scanning (by drones, Lidar, etc) and automated identification of building typologies through AI-algorithms. **Automated energy performance analyses for Positive Energy Building retrofitting**: AI-based prediction of the amount of RES (PV, heat sources) to achieve net-zero or positive energy balance. **Zero-engineering of construction process**: Parametric design tools the reconstruction components can be designed and fed to industrial production facility saving engineering cost and time. **Circular hub for optimized construction**: Optimization of construction, material and worker flows of all contractors and subcontractors through integrated BIM and circular construction hubs. Integrate local production facilities into the hubs allowing new (sustainable) and harvested materials processed into new (integral) building components. **One-piece flow optimized construction workflow**: application of data-driven approach to just-enough and just-in-time operational and logistics workflows reducing waste, space, costs and nuisance on construction site.
WP6	**Design and implementation of RES and storage solutions for buildings/neighbourhoods' thermal needs**: Implementation and demonstration of a cost-effective, one-size fits all, modular heating ventilation and cooling infrastructure for high-rise buildings, compatible for multiple heating sources. **Design and implementation of RES and storage solutions for buildings/neighbourhoods' electricity needs**: BIPV/BAPV for maximizing solar energy harvesting combined with local and district electricity storage providing support to the grid as well as EV-V2G. Direct usage of DC power outage of BIPV/BAPVI
WP7 and WP8	**Deployment of solutions for forecasting (city weather, solar, load):** Forecasting PV energy production with cloud detection cameras and weather station together with a fast network of sensors that measures irradiation and temperature of BAPV/BIPV-panels and energy usage **Smart building control optimisation**: Use of model predictive controllers (MPCs) to integrate weather and load forecasts and controllers for district and BEMS, BIPV and BAPV systems taking into account app- and web-based user feedback. **Smart communities' optimisation and market interfacing**: Integrating modelling, forecasting, and control solutions for smart energy buildings and communities. A hierarchical and distributed control framework will enable local communities and energy networks optimal use of local renewable energy generation including EV/V2G charging algorithms. Linking of conventional

	markets with aggregated flexibility for buildings and districts. Interface to balancing and flexibility markets. Guidelines on new business models for energy communities. The innovation is the distributed control approach of decentralised assets, coordinated by an aggregator, without violating the user's privacy.
WP9	**Innovative business models**: Product-Service combinations (e.g. lease models) in the field of energy, safety, comfort and renovation (WP4, WP5). Energy performance contracting based on the KPIs and Building Energy Management monitoring system (WP7). Business models and FI related to optimized self-consumption and/or energy trading of renewable electricity at the building level and/or district level and/or country level (WP6 & WP7)

* The building owners (Bo-Ex and Mitros) intent to lift performance of the HeMuBo approach (applied by parties external to the ARV consortium) from NZEB to PEB. The decision to implement changes will depend on outcomes of WP4 / WP6 and external factors, such as existing contractual agreements between Bo-Ex, Mitros and their contractors (not part of the ARV consortium) and required investment for achieving the higher energy performance. .

The Czech demo case encompasses the *Karviná Mizerov Health Centre* in the city of Karviná. It is a 5-storey building that was built in late 80s. It is owned by the Municipality of Karviná and partly rented to private practices that specialize in a variety of different medical professions, i.e. immunology, dentistry, dermatology, radio diagnostics etc. The use of RES and building envelope retrofitting will ensure to reach the ZEB standard after renovation. For that, a combination of heat pumps, PV, as well as hybrid PVT solar panels and waste heat and energy storages will be utilized. An advanced building energy monitoring system (BEMS) and the monitoring of the IAEQ will ensure the effectivity of the measures. EV charging facilities both, for private and company cars as well as the ambulances promote the market penetration of electro mobility in the area.

Key data:

Size (floor area): 11 130 m^2	**Building/renovation timeline:** 2022-2024
Investment cost: € 2.06 million	**Project developer:** City of Karviná

Key innovations:

WP	Innovation
WP3	**Energy transition**: Karviná Mizerov Health Centre as a living lab for the City of Karviná and other municipalities within Czech Republic. The LL will educate citizens such as students in an effective way, creating energy and resource efficient neighbourhoods that increase citizen and stakeholder awareness and engagement. Promote user-friendly innovative and sustainable building solution through education and other communicational channels, implement user-centred design of building systems. Support a creation of long-term stakeholder ecosystems concerned with energetic transformation and the role of individual projects in driving broader organizational and procedural changes. **Community engagement** actions with young people in the school (14-19 years), exploring co-creation methods. Change agents promoting sustainability to their peers, parents, and the community.
WP4	The Czech demo case encompasses the renovation of Karviná Mizerov Health Centre in the city of Karviná. The following will be of focus for the Demo project in Karviná: • Become positive energy building, achieved by passive house standard and renewable energy generation. • Digital design and 3D simulations (digital twins) for solar irradiation potential and design of optimum shading devices. • Small-scale pilots of climate change resilient solutions – use of heat pumps for summer cooling. • LCA of HVAC systems with focus on carbon footprint. • BIPV BAPV PV-T, solar thermal, heat pumps, active shading systems with weather forecast, innovative cooling solutions. BIPV integrated into ventilated facade. • Green roof sample for reducing heat islands, rainwater management (rain gardens, greenery).
WP5	On-site construction during building operation will be piloted in Karviná at installation of **climate change adaptive measures** that include summer cooling by heat pumps and green roof sample for cooling of heat islands and local rainwater management (rain gardens, greenery). Installation of **swappable façade-integrated RES** (flexible solution enabling easy application of PV/PV-T/solar thermal/façade heat exchangers for possible coupling with heat pumps).
WP6	**Electricity**: Implementation of innovative PV system combining BIPV and BAPV will be considered in the demo Karvina. The PV system will provide high performance and contribute in improving indoor environment by supplying energy to drive external shading elements blocking the excess of sunlight to the interior, while keeping architectural aesthetics of the BIPV at top level. A central second-life energy storage will be designed adequately in order to operate the demo as a local microgrid which supports various functionalities related to building energy flexibility, load-shifting and peak shaving. Additionally, EV charging stations and the implementation of V2G/V2H services are also considered. Finally, local sensors for solar irradiance and temperature as well as skyimager solution will be installed for accurate predictions of the PV generation and operation of the whole system.

	Thermal: Implementation of innovative heat pump system for building refurbishment providing heating and cooling energy. The system will combine heat pump with PVT and use of waste heat. Additionally, a thermal storage design will be considered for balancing the heat pumps, providing potential for heating demand flexibility in building and provides necessary heating energy in winter and cooling during summer and to target positive energy district requirements. Local weather station will be implemented with indoor temperature measurements for effective operation of the HVAC systems.
WP7	• BEMS with cooperation with forecasting and smart metering will ensure the efficient operation and management of RES, storage systems and actual energy demand. • PV forecasting for modelling the operation of BAPV/BIPV and battery storage in building • Forecasting of local PV generation and Sky-imaging solution for very short-term solar irradiance forecasting for building energy system operation • Forecasting of electricity and heat load profiles • Forecasting of energy generation for BIPV and BAPV sites • Control of battery systems • Optimal operation of interconnected battery storage and EVs • Connecting the various BEMS platforms for aggregating flexibility and enabling flexibility at district scale
WP8	IAQ monitoring platform: Sensors to inform users, directly control technology (AHU, HVAC), or provide necessary data to a superior system
WP9	The experiences from Karviná Mizerov Health Centre will serve as a living lab for Karviná and will act as a role model for other municipalities within the Czech Republic.

The Danish demo case is called *SAB Department 22: Kløvermarken/Hvedemarken* and is located in the central part of the City of Sønderborg. It includes 19 apartment blocks of 3 floors, in total 432 apartments with a floor area of 32,000 m^2. The apartment blocks were constructed in 1970-1973. In 2010, the buildings were renovated with more insulation, new low-energy windows, new radiator systems and new district heating substations with heating controls connected to Danfoss Portal. There are 9 substations covering the 19 apartment blocks. In 2017, more than 3,000 m^2 solar PV panels were integrated in the roofs of all 19 apartment buildings. The solar PV system can produce 460 kW solar electricity corresponding to 408,000 kWh per year covering 37 % of the total electricity consumption in the 432 apartments. At the same time new LED outdoor lamps were implemented in the area around the 19 apartment blocks and in the corridors and basement.

Key data:

Size (floor area): 35 600 m^2	**Building/renovation timeline:** 2021-2022
Investment cost: € 0.4 million	**Project developer:** Sønderborg Andelsboligforening (Sonderborg Housing Association)

Key innovations:

WP	Innovation
WP3	Involvement of tenants and citizens: The energy saving results of the planned innovative energy technologies depend significantly on the daily energy performance of the tenants in the demo buildings. Therefore, a number of information and training activities are planned to secure, that the tenants and the maintenance staff learn the new smart control systems and learn to operate the new energy saving appliances. Green Ambassadors will be appointed among the tenants, one ambassador for each of the 19 buildings, to be trained to assist their neighbours and colleagues saving energy.
WP4	Innovative design of heating automatic systems reducing district heating return temperature from radiators in the apartment. Innovative design of heat pump systems in local internal domestic hot water circuits in order to reduce the return temperature for the district heating system. Focusing on low carbon intensive materials used in the buildings. Focusing on indoor climate challenges in combination with new heating automatic reducing the return heat temperature. Demonstration and monitoring existing building integrated PV panels in combination with battery solutions.

WP6	Neighbourhood scale smart battery system: The existing solar PV system in the DEMO project has performed very well during the last 3 years, and it planned to install battery systems together with the solar PV panels in each block. In the beginning of 2021, batteries with a capacity of 15 kWh/4 kW each will be implemented in each of the 19 blocks. Installation of the 19 batteries means, that extra 60.000 kWh solar electricity can potentially be used in the buildings per year instead of exporting the solar electricity to the grid. Monitoring and evaluation of the integrated PV+battery system will be a part of this project.
WP7	Leanheat intelligent heating control system: Sensors installed in the apartments enable Leanheat`s artificial intelligence to register the building`s thermodynamic behaviour and to optimally control the heating system in the buildings. Leanheat also reduces the necessary maximum power usage. The artificial intelligence learns the domestic hot water consumption profile in the apartments and adjust the heating to charge and discharge energy accordingly. The load-shifting system is designed to move consumption of energy to periods, when it is most economic to use. The performance of the Leanheat intelligent control system in SAB Department 22 will be monitored and reported in the ARV project. Reduction of district heating return temperature from the buildings: Focusing on the heat radiator system and the domestic hot water system. Lower district heating return temperatures result in higher efficiency of the heat production plant. Furthermore, a higher share of renewable low-grade sources will be available and can be utilized. Danfoss Solo system will be implemented as demonstration in 2 buildings with 50 apartments in SAB 22. Solo system can control the temperature difference over the radiator for system optimization. At the same time the hydronic balance of the radiator is better, the flow being dictated by real heat demand. Domestic hot water boosted by heat pump: Normally the district heating return temperature is too high due to a necessary high temperature in the domestic hot water circulation system. The district heating return temperature can be lowered by implementing a small heat pump (3-5 kW) in the system. The heat pump extracts heat from the circulation pipe circuit, and thereby reduces the return temperature. The business case for this system is the tradeoff between an economic bonus due to reduced district heating return temperature and electricity consumption of the heat pump. Depending on actual electricity costs and value of district heating return bonus, the operation of the heat pump can be optimized (on/off) resulting in fuel shift option between district heating and electricity. The performance of this new system will be monitored, evaluated and reported in the project. Intelligent and flexible management of the electricity/district heating network (building on CITIES project): The temperature in the local district heating network is often unnecessary high resulting in a high heat loss, because the operator has no secure forecast of the actual heat demand in the buildings and therefore need to distribute the district heat with a relative high temperature, again resulting in a high return temperature. To lower the flow and the return temperature in the network, a method for a data-intelligent prediction of the local heat demand in the buildings and a prediction of the heat loss in the network will be introduced. The method is based on intelligent data from the digitized heat meters in the apartments combined with weather forecast, predicted heat demand, temperatures in critical positions in the network etc. With this method the district heating network can function as a heat storage facility. Furthermore, the methods can be used to operate with a with temperature zones within a city and local adaption of heat pumps and use of heat from e.g., supermarket cooling, could be optimized. The digitization of the system is also very important for the future electrification of the district heating. Flexible configuration and operation of heat pumps (building on CITIES project): Today the focus is on integrating heat pump at the user level. However, the above-mentioned digital operation of DH systems implies that methods for integration of heat pumps on various levels in the DH system should be analysed. Integrating larger heat pumps on district level will increase the flexibility of integrated power2heat system, and consequently the options for demand response solutions will be enlarged. The zonal operation of DH systems facilitated by digitalization will pave the way for using the existing DH system as a part of a local energy cooperative, where also excess heat from industry and/or supermarket cooling can be integrated. Local Energy/Flexibility Market: High level controllers in ARV will be able to generate forecasts of the available flexibility on aggregated level. This flexibility is used directly for providing grid services, but in addition the flexibility can be bid into relevant markets by balance responsible parties (BRPs). In ARV specialized smart home aggregators will be developed to trade and commodities energy flexibility at building or district level. Smart electricity and lighting control in homes: A new developed smart home control system will be demonstrated in the buildings and apartments. The smart home system controls the heating, ventilation, lighting, electrical appliances, access control, burglar alarms etc.
WP9	Design of innovative financing models for implementation of energy retrofitting measures in social housing associations

The Norwegian demo case is the *Voldsløkka School and Cultural area*. The project includes the construction of a secondary school for 810 students, a new culture hall, a dance hall, and rehearsal space. The project includes the construction of new buildings and the **renovation of an existing listed building**, in total about 14.000 m^2 floor area. The area has high environmental ambitions and will be built as Oslo's first plus energy school, with a surplus of energy generated, covering all energy needs included appliances/plug-loads. The total area of the PV-installation is 1556m^2 and a yearly estimated production of 192 MWh. The new school facility will be **integrated as part of the surrounding local area**, which complements the area with new functions and activities and strengthens the area's green structure. The set of actions that will be undertake by the ARV project will encompass **resource efficient renovation processes and district energy analysis and operation**, highlighting **social, educational, and digital aspects** to **enhance citizens involvement** and generating **Citizen Energy Communities**.

Key data:

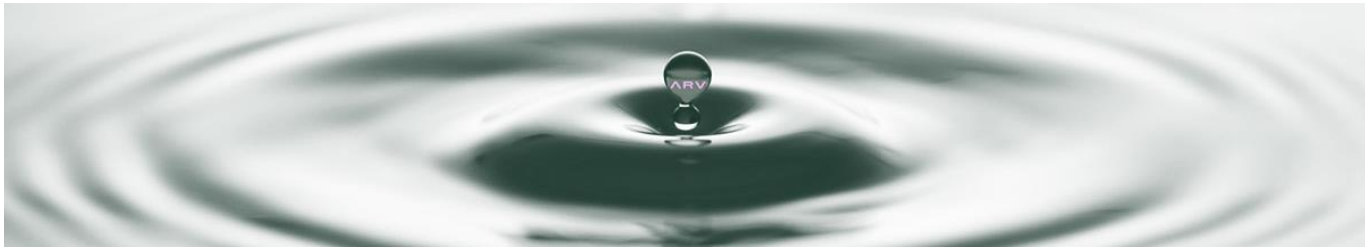
Size (floor area):	14 000 m^2	**Building/renovation timeline**	2021-2024
Investment cost	€ 88.2 million	**Project developer**	OsloBygg KF

Key innovations:

WP	Innovation
WP3	**Implementation of AR/VR tools and platform in decision-making process**. Various 3D and/or visualization techniques of Virtual Reality (VR) and/or Augmented Reality (AR) are used during the renovation and development of the demonstration district to better communicate results of different scenarios analysis to different types of stakeholders, to facilitate citizen engagement, promote education and training for sustainability. The development of VR and AR applications are targeted toward several distinct stakeholders (city planners and policy makers) and citizen user group types (school children, common public, inhabitants and infrastructure users, service personnel). **Raising climate awareness through education** and **local community engagement.** Making use of physical educational facilities for sustainability teaching of students. **Social Renovation** will focus on engaging the community before renovation, whereas Energy Transition will establish a physical space and focus on new solutions regarding energy transition and circularity, testing of innovative and prototype solutions, and energy coaching of occupants. A demo-space **for citizen's and children's education** will be implemented with a focus on new technologies like storage, electrical vehicles, renewables, etc. The project includes multi-use meeting areas for engaging the local community more actively in the use of the buildings.
WP4	**Climate adapted design** using an innovative open surface water solution. This is the starting point for the design of the school project. The concept is a green and different schoolyard where vegetation and surface water management are used as a resource to create good and varied outdoor spaces. **Effective application of low-carbon concrete** with 40% lower embodied emissions than standard. **Digital design for optimum life cycle performance**. BIM and Digital Twins will be used to optimize the performance of the building development from the environmental and economic perspective. A comprehensive evaluation of the buildings will be made by considering their lifecycle environmental impact, cost, and energy use, the inclusivity of the local community, the use of indoor and outdoor space, water management, noise and pollution, and aesthetic. **Climate adapted design** by an innovative open surface water solution. The design of the outdoor green area will ensure the use of vegetation to optimize the water management and at the same time create a varied and appealing outdoor environment. The use of pollutant-absorbing plants is planned. **Circular renovation design strategies** will be developed by mapping of locally available building materials and components from existing and going-to-be demolished buildings. Specifically, most of the walls and windows in the old factory will be reused and upgraded to new energy performance standards to save embodied GHG emissions from building material use. This is part of the energy renovation design of cultural heritage building using a circular renovation strategy. Design strategies for the (re)use of building materials and components will be defined in relation to technical, functional, and aesthetical constraints.
WP5	Implementing a **Carbon neutral construction process.** Electric- and bio-based fuels construction machinery will be used in the construction phase to reduce GHG emissions, air pollutants, and noise. These will be linked to systems for electric heating of the construction site. To optimize the construction site management from an environmental perspective and maximizing the use of electric vehicles, materials HUBs are to be established outside the construction site, where large vehicles can de-load goods, which will be transported to the site by smaller electric vehicles.
WP6	Local Renewable energy generation using innovative **BIPV and BAPV**

	Local energy storage: In the preliminary project, space has been set aside for a separate battery room for a possible separate installation of this. ARV will seek to design and construct an innovative system using recycled batteries. **Local Renewable energy generation using building integrated photovoltaics (BIPV) and building applied photovoltaics (BAPV).** Coloured PV panels will be installed on the roof and façade of the buildings allowing for a higher degree of flexibility in terms of architectural expression and integration. The challenge is to balance an optimal energy production with aesthetical requirements. Design solutions with angular modules will be tested too. A mounting system that ensures an easy installation and replacement of components (panel-to-panel and panel-to-building) will be tested. **Local energy storage.** A battery storage room is planned in the renovation process. As part of the general strategy of reusing building materials and components, recycled car batteries will be used. It is expected to reduce 50% of GHG emissions across the battery production process and 20% of their environmental impact, and at lower cost. **Low-temperature thermal heating and high temperature thermal cooling (LowEx) HVAC system.** A novel heating/cooling system which delivers low-temperature thermal heating and high temperature thermal cooling by using the same infrastructure coupled with the ground source heat pump. Low energy needs the order of 3 to 10 kWh/m^2 year and greatly reduced power peak. By reducing the energy need for heating/cooling, the local renewable energy production can be used for addressing other buildings end-uses (lighting, ventilation, appliances) which are less dependent on the seasonal need, thus reducing the yearly mismatch between PV production and buildings' energy use. The LowEx system is integrated by using the existing infrastructure, thus saving cost and embodied energies from the material use.
WP7	WP7 focuses on the optimal performance of the operation of the demonstration buildings. Within WP7, the models for energy generation forecasting and control of the LowEx system are tested.
WP8	**Climate awareness and citizens engagement:** Multiple benefits approach for evaluating the intervention **Carbon neutral construction process:** Energy and materials mass flows during the construction phase and monitoring phase, Usage schedule and power consumption of electric machinery and appliances during the construction phase, Construction time (on-site monitoring with devices and/or evaluations based on visits/reports) and dust and noise production, Building site environmental quality (PM10, PM2.5, Noise level) **Climate adapted design:** Outdoor and Indoor environmental quality (temperature, relative humidity, CO2 concentration, PM10, PM2.5, Noise level). **Circular renovation design strategies:** Energy and materials mass flows during the construction phase and monitoring phase. **Local Renewable energy generation and LowEx system:** Energy production (on-site monitoring) e.g. Energy from PV, HP (geothermal - electric kWh absorbed by the HP and thermal kWh produced), Energy consumption (on-site monitoring). Final energy consumption due to space heating, cooling, and DHW. Final electric consumption of the buildings.
WP9	Establishment of an Energy Community management and its standardization for the refurbishment process.

2. Impact



The key project outcome is the establishment and systematisation of streamlined processes and services for a simple and integrative approach towards more sustainable buildings in Europe. In Section 2, we demonstrate how the activities and expected outcome of ARV project will directly address all the Expected Impacts from the Call – **EICs** and other relevant impacts not mentioned in the call text (cf. Section 2.1.2). In Section 2.1.3 we identify the potential barriers that may hinder achieving such impacts and present measures to overcome those barriers. In Section 2.2. we provide a draft plan for the Dissemination, Exploitation and Communication strategies (cf. Sections 2.2.1, 2.2.2 and 2.2.5, respectively) that will realise the expected impacts of the project. We particularly highlight the involvement of key stakeholders across the value chain at local level and the participation of the relevant communities for the development of active and living neighbourhoods.

2.1 Expected Impacts

2.1.1 Expected impacts of the call

Table 2.1 gives an overview of ARV's expected impacts. The sub-sections below provide a comprehensive and detailed explanation of how each impact have been calculated, including baselines, methods, calculations, and target values.

Table 2.1 – Alignment of the project with the expected impacts dictated in the LC-GD-4-1-2020 call text.

EXPECTED IMPACT of the CALL	SUMMARY OF ARV PROJECT'S IMPACTS
EIC1 - Primary energy savings triggered by the project	Total accumulated savings of 846 GWh in 5 years after project (year 2029).
EIC2 - Investments in sustainable energy triggered by the project	Accumulated investments 1080 M€ 5 years after the project (year 20209)
EIC3 - Demonstration sites that go beyond nearly-zero energy building performance and **EIC4** - High energy performance (nearly zero-energy level within the meaning of Directive 2010/31/EU for retrofitted / positive-energy level buildings for new constructions);	All the demonstrations within the ARV project are defined as "high energy performance" being either at least 'nearly zero-energy level' (renovations) or 'positive-energy level' (new construction).
EIC5 - Reduction of greenhouse gas emissions towards zero (in tCO2-eq/year) for the total life cycle compared to current situation shown through cradle-to-cradle LCA	Total accumulated savings of about 235 000 tCO_{2eq} in 5 years after project (year 2029).
EIC6 - Reduction of the embodied energy in buildings by 50 % without concessions with respect to energy consumption and comfort;	50-55% reduction compared to baseline, ref table 2.2 and associated explanation.
EIC7 - Reduction of air pollutants towards zero (in kg/year) for the total life cycle compared to current situation shown through cradle-to-cradle LCA	Total accumulated reduction of pollutants of 4 544 500 kg in 5 years after the project (year 2029)
EIC8 - Demonstration of high potential for replicability using new or existing innovation clusters incorporating the whole value chain	From the foreseen 8580 ARV projects, we estimate that the Innovation Clusters will be directly responsible for the commission of 4760 projects (55 %).
EIC9 - Shortened construction/retrofitting time and cost by at least 30%, in order to allow market uptake and social affordability	Key strategies will be employed to enable achieving a 34 % reduction in time and 32 % reduction in cost.
EIC10 - Improved final indoor environment quality by at least 30% and reduction of dust and noise during retrofitting by at least 30%, leading to higher rate of users' satisfaction, demonstrated according to the relevant CEN standard (or equivalent).	Key strategies will be employed to enable achieving a 30% reduction in dust and noise during retrofitting.

In the following, we detail how the ARV project will address the expected impacts of the call (**EICs**). In addition, for each EIC, we estimate the global impacts beyond this project within a 5-year period, based on the assumption that the ARV concept and outcomes will be adopted in 8580 projects and cover a total area of 12 417 000 m^2 (cf. Table 2.12 in Section 2.2.2.1). The rationale and data behind this assumption is further detailed in Section 2.2.2.

EIC1) Primary energy savings triggered by the project

ARV will deliver highly efficient buildings (WP4-5), significantly exceeding the respective countries' building regulations (in new construction) and pre-renovation levels (in renovated buildings). Figure 2.1 shows the calculated primary energy need of the new buildings in ARV compared to the respective countries' building regulations (baseline). The results show that on average, the newly constructed ARV demo buildings use 67 % less primary energy than required in the building codes.

Figure 2.2 shows the calculated primary energy need of the renovated buildings within ARV. A significant improvement compared to the pre-renovation situation (44 % on average) can be achieved here as well. The rather small improvement of the Danish demo in Sønderborg where no upgrade of the building envelope is foreseen, is achieved by efficiency measures in the building energy system and management only. Such measures have a high potential for replicability and can be implemented very fast and cost-efficient.

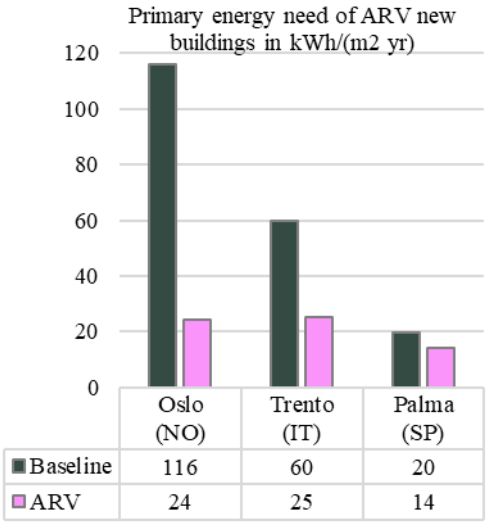


Figure 2.1 Primary energy need of new buildings in ARV compared to reference values from similar buildings according to the specific countries' building codes and local primary energy factors**.**

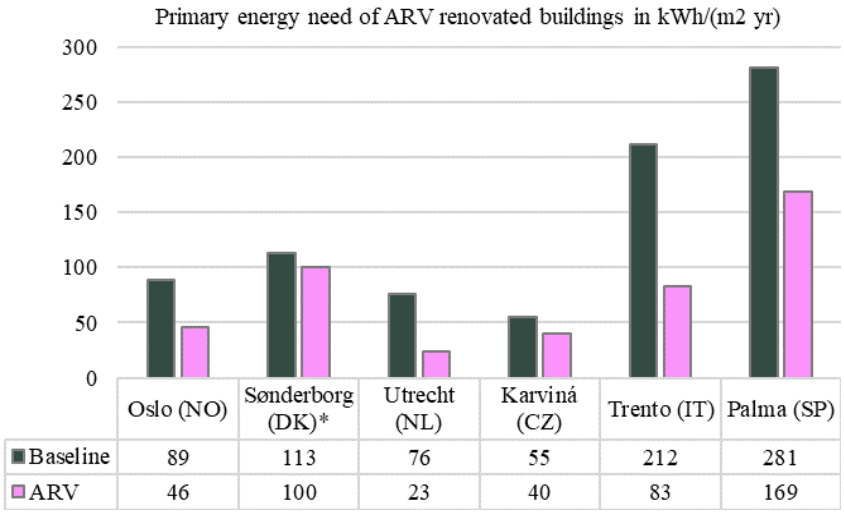


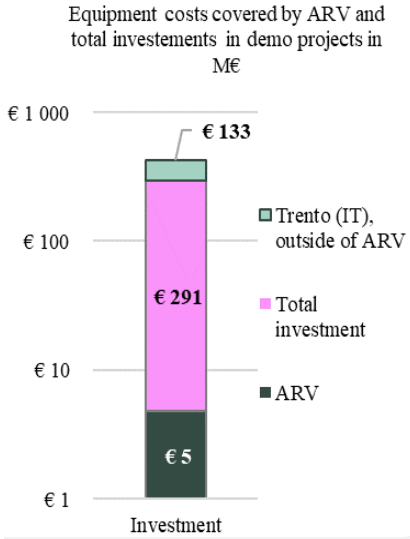
Figure 2.2 Primary energy need of renovated buildings in ARV compared to the situation before the renovation according to local primary energy factors. *Only from efficiency measures.

Thus, as a direct result of the ARV demonstration projects, 9.2 GWh of primary energy are avoided per year. Scaling up the impact of ARV considering building renovation, construction and demolition rates as an average of the countries reported Sandberg et al.'s work on dynamic building stock modelling in Europe[28], a total of 402 TWh of primary energy use can be avoided until 2030, and 1326 TWh until 2050.

The ARV project will provide a very significant contribution towards the EU aim of a 30 % cut in its annual primary energy consumption by 2030. The 6 demonstrations in the project are expected to contribute with total savings of about ***9.2 GWh/year.*** *Considering the market penetration/adoption detailed in Section 2.2.2, the ARV concept is expected to contribute with a total of* ***846 GWh in total accumulated energy savings in the first 5 years post project****.*

[28] Simplified projection, assuming the EU building stock is developing as an average of the countries in Sandberg, Nina Holck; Sartori, Igor; Heidrich, Oliver; Dawson, Richard; Dascalaki, Elena; Dimitriou, Stella et al. (2016): Dynamic building stock modelling: Application to 11 European countries to support the energy efficiency and retrofit ambitions of the EU. In Energy and Buildings 132, pp. 26–38. DOI: 10.1016/j.enbuild.2016.05.100.

EIC2) Investments in sustainable energy triggered by the project (in million Euro)



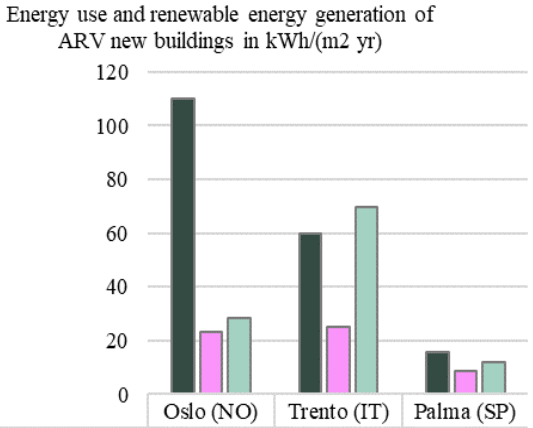
ARV will greatly contribute to increase investments in sustainable energy (considering energy system efficiency, and new renewable energy generation), with investments of 1.9 M€ (NO), 0.1 M€ (DK), 5.8 M€ (NL), 0.2 M€ (CZ), 1.2 M€ (IT), and 4.6 M€ (SP), in total of 13.8 M€. Considering that our demonstrations cover an area of 159,000 m^2, this equals an investment of 87 €/m^2. The total installation capacity in the ARV demo areas will be 3.3 MW. However, total investments in the demo projects triggered by ARV will be much higher. With investing about 5 M€ in equipment costs through ARV, a total of 291 M€ will be invested in the ARV demos by the partners. Including the part of the Trento (IT) demo which is not directly part of ARV but will still benefit from it, additional 133 M€ will be invested (see Figure 2.3).

Figure 2.3 Determined equipment costs covered by ARV and total investments in all demo projects by the partners.

Through dissemination, communication, and exploitation activities (during and after project) the ARV consortium will demonstrate the socio-economic and environmental benefits of using different sustainable energy technologies in residential and non-residential buildings. Therefore, based on the different technologies used, their current market maturity the level of penetration that we expect for the ARV concept, and with an estimated target area of about 12 417 000 m^2 within 5 years, ***the expected impact of ARV on investments in sustainable energy triggered by the project is 1080 M€****. The ARV concept is not based on a single sustainable energy source, which will maximize the potential for investments in sustainable energies.*

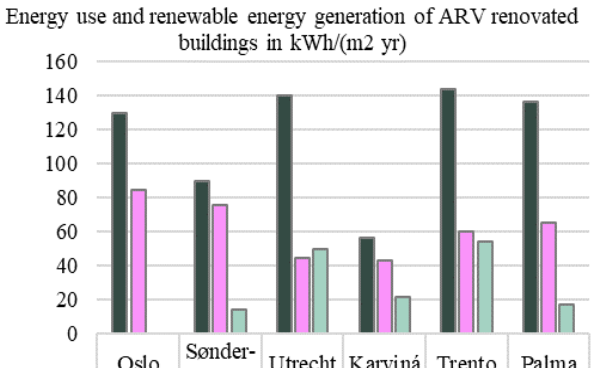
EIC3) Demonstration sites that go beyond nearly-zero energy building performance and

EIC4) High energy performance - nearly zero-energy level within the meaning of Directive 2010/31/EU for retrofitted and positive-energy level buildings for new constructions.



	Oslo (NO)	Trento (IT)	Palma (SP)
Baseline energy use	110	60	16
ARV energy use	23	25	8
ARV on-site generation	28	70	12

Figure 2.4 Calculated yearly energy use and renewable energy generation of new buildings in ARV compared to the baseline energy use taken as the minimum requirement from the respective national building codes.



	Oslo (NO)*	Sønder-borg (DK)**	Utrecht (NL)	Karviná (CZ)	Trento (IT)	Palma (SP)
Baseline energy use	130	90	140	57	144	137
ARV energy use	84	76	45	43	60	66
ARV on-site generation	0	14	50	22	55	17

Figure 2.5 Calculated yearly energy use and renewable energy generation of the renovated buildings in ARV compared to the baseline pre-renovation energy use. *Protected as historic monument, no PV possible. **Through the installation of a battery storage system, annual self-consumption will be increased by 60,000 kWh/year.

ARV will showcase high-performance buildings, both new constructed and renovated. The high level of energy efficiency and the implementation of smart energy management systems, renewable energy sources and passive design measures enables the three new constructions in Oslo (NO), Trento (IT) and Palma (SP) to become plus energy buildings (see Figure 2.4). Not only is the minimum building codes' requirements for energy use (baseline energy

use) expected to be reduced by an average of 61 %, but on-site renewable energy generation will exceed the obtained energy use in ARV by on average 80 % on an annual basis, corresponding to an annual surplus of renewable energy generation of 53 kWh/m^2 or in total 1.4 MWh.

In addition, the buildings to be renovated within ARV exhibit an excellent energy performance, reducing the baseline energy use (pre-renovation level) by an average of 42 % and generating 49 % of the obtained energy demand on-site from renewable energy sources (see Figure 2.5).

Scaling up the potential impact of ARV to a European scale, considering building renovation, construction and demolition rates as an average of the countries reported in Sandberg et al.'s work on dynamic building stock modelling in Europe[28], a total of 389 TWh of delivered energy can be saved until 2030, and 1281 TWh until 2050. Furthermore, renewable on-site energy generation across Europe would be increased by 177 and 580 TWh until 2030 and 2050, respectively. In the six ARV countries alone, the savings amount to 130 and 433 TWh, and the renewable on-site energy generation to 60 and 196 TWh until 2030 and 2050 respectively.

EIC5) Reduction of greenhouse gas emissions (in tCO_2-eq/year) for the total life cycle compared to current situation shown through cradle-to-cradle Life Cycle Assessment

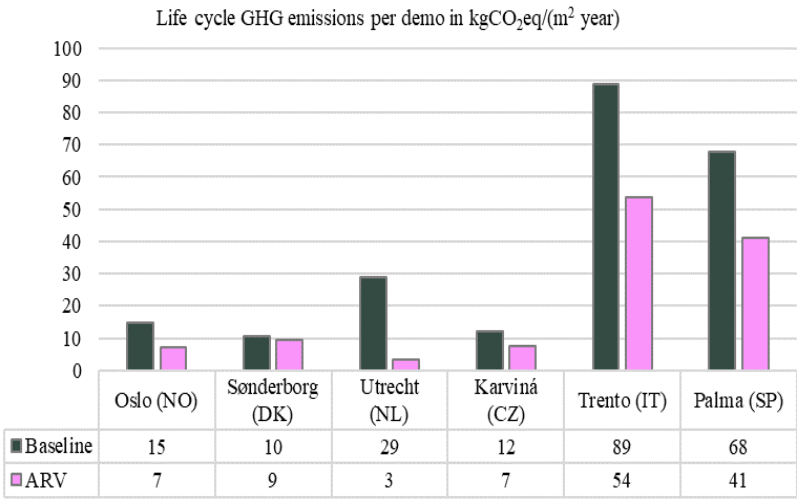


Figure 2.6 Calculated annualized life cycle GHG emissions in kgCO_2eq/(m^2 year) for the six ARV demos. For the baseline, the operational GHG emissions for new buildings are calculated from the minimum requirements for energy use according to national building codes for new buildings and typical national average values. For the renovated buildings, the situation pre-renovation was used as a baseline.

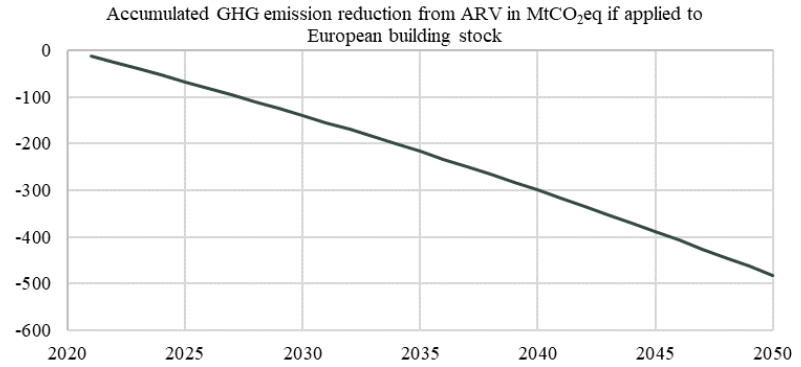


Figure 2.7 Accumulated GHG emission reduction from ARV in $MtCO_2$eq, using building renovation, construction and demolition rates as an average of the countries reported in Sandberg et al.'s work on dynamic building stock modelling

The data depicted in the following was obtained through a preliminary LCA analyses based on a simplified approach, since a comprehensive set of detailed data is needed to make a full cradle-to-cradle LCA. More detailed LCAs will be carried out in the ARV project, to fully assess and compare ex-ante and ex-post performances (WPs 4-8).

Figure 2.6 shows the project-averaged savings in kgCO_2eq/(m^2 year) for new construction and renovation. In ARV, the overall life cycle GHG emissions compared to the baseline are expected to be reduced by 48% or 2979 CO_2eq/(m^2 year). Scaling up these numbers, considering building renovation, construction and demolition rates as an average of the countries reported in Sandberg et al.'s work on dynamic building stock modelling in Europe[28], a total emission of 153 $MtCO_2$eq can be avoided until 2030 and 496 $MtCO_2$eq until 2050 (see Figure 2.7).

Considering the average of all energy renovations across EU28 that took place between 2012 and 2016, the relative annual GHG reduction per residential renovation is estimated to be roughly 9%, which represents an average reduced emission of roughly 11$MtCO_2$eq per year during this period[29]. ARV will enable an annual reduction of GHG in the demonstration sites of about 2979 tCO_2eq per year, which corresponds to an average of about 50% compared to the baseline emissions. Considering the average of the savings normalized to the area of each demonstration and considering the progressive implementation of the ARV concept within a total of about 12 417 000 m^2 in 5 years, we estimate ***total accumulated savings of about 235 400 tCO_2eq in 5 years****. We are therefore in the positive direction to achieve the EU goals of building related GHG emissions by 2050.*

[29] Comprehensive study of building energy renovation activities and the uptake of nearly zero-energy buildings in the EU. Final Report. EC. November 2019.

EIC6) Reduction of the embodied energy in buildings by 50 % without concessions with respect to energy consumption and comfort

Table 2.2 below highlights several ARV strategies to reduce the embodied energy (GJ/m^2) and embodied emissions ($kgCO_2eq/m^2$) of buildings, as well as the reduction achieved compared to the baseline, that will enable effective reduction of building materials' contribution to climate change. For Oslo (NO), Sønderborg (DK) and Trento (IT), the embodied emissions were used as a baseline, as the availability of data did allow for determining a representative baseline value for embodied energy in these countries. The baseline value used for the Oslo (NO) demo is an average of 39 school buildings in Norway[30]. For Sønderborg (DK) and Trento (IT), average embodied emissions from 34 residential buildings in Denmark[31] and 28 residential buildings in Italy[32] with a 50-year life span were used. For the Czech Republic and Spain, neither representative country-specific values for embodied energy nor emissions could be obtained, so average European embodied energy values from IEA Annex 57[33] for refurbishments (in case of Czech Republic) and an average of refurbishment and new construction (in case of Spain) was used. For the Dutch baseline, Koezjakov et al.'s reported value of 4.7 GJ/m^2 in their publication on embodied energy in the Dutch building stock was used[34]. The expected reduction of these baseline values is between 50 and 55% in the ARV demos.

The fact that reliable, representative data on embodied energy and embodied emissions for existing or even new buildings is so difficult to obtain, highlights ARV's exceptional importance in contributing to a better understanding of the building stock in Europe. During the course of the project, ARV will explore methods and report reliable data on embodied energy and emissions.

Table 2.2 Expected impact of ARV on reduction of embodied energy (*) and/or embodied emissions (**).

Demonstration	Baseline	Reduction	Examples of strategies triggering reduction of embodied energy
Oslo (NO)**	4.5	50 %	Application of low-carbon concrete with 40% lower embodied emissions than standard. Carbon neutral construction process. Wood based façade construction. Reuse of building parts and recycled materials
Sønderborg (DK)**	7.2	50 %	Renovation of existing building – reuse of building parts and reduced waste
Utrecht (NL)*	4.7	50 %	Reduce waste by Just Enough & JiT design strategy. Plug and play design: demountable parts. Circular hub for harvesting materials from demolition waste and processing for reuse in (integral) building components
Karviná (CZ)*	4.4	50 %	Components designed for easy mounting, removal, and recycling. Prefabricated wood-based elements.
Trento (IT)**	4.6	50 %	Prefabricated wood-based elements. Reuse of urban dismissed geostructure. Renovation with reuse of building parts.
P. de Mallorca (SP)*	5.3	55 %	Integrated design process & catalogue of solutions for refurbishment of buildings with 50% of energy reduction. Local bio-based materials. Renovation with reuse of building parts.

The ARV project will provide a significant contribution towards the EU aim of reducing the embodied energy in buildings by 50-55 % without concessions with respect to energy consumption and comfort.

[30] Wiik MK, Selvig E, Fuglseth M et al. Klimagasskrav til materialbruk i bygninger: ZEN Report No. 24, 2020

[31] Zimmermann, R. K., Andersen, C. M. E., Kanafani, K., & Birgisdottir, H. (2020). Klimapåvirkning fra 60 bygninger: Muligheder for udformning af referenceværdier til LCA for bygninger. Polyteknisk Boghandel og Forlag. Forskning i det byggede miljø, SBi Bind 2020:04 https://sbi.dk/Pages/Klimapaavirkning-fra-60- bygninger.aspx

[32] Freja Nygaard Rasmussen, Sara Ganassali, Regitze Kjær Zimmermann, Monica Lavagna, Andrea Campioli & Harpa Birgisdóttir (2019) LCA benchmarks for residential buildings in Northern Italy and Denmark – learnings from comparing two different contexts, Building Research & Information, 47:7, 833-849, DOI: 10.1080/09613218.2019.1613883

[33] Birgisdóttir, H.; Houlihan-Wiberg, A.; Malmqvist, T.; Moncaster, A.; Rasmussen, F. N. (2016): Evaluation of Embodied Energy and CO2eq for Building Construction (Annex 57). Available at: http://www.iea-ebc.org/Data/publications/EBC_Annex_57_ST4_Case_Studies_Recommendations.pdf

[34] Koezjakov, A.; Urge-Vorsatz, D.; Crijns-Graus, W.; van den Broek, M. (2018): The relationship between operational energy demand and embodied energy in Dutch residential buildings. In Energy Build. 165, pp. 233–245. DOI: 10.1016/j.enbuild.2018.01.036.

EIC7) Reduction of air pollutants towards zero (in kg/year) for the total life cycle compared to current situation shown through cradle-to-cradle Life Cycle Assessment

The data depicted in Table 2.3 was obtained from Eurostat from the source sector 'Residential: stationary'[35] unless marked otherwise. As in EIC6, finding reliable and representative data for all the air pollutants in all the demos is a challenging task and will be carried out during the project.

Table 2.3 Expected impact of ARV in the reduction of air pollutants for the total life cycle. *Baseline reported by partners.

	PM2.5					
	NO	DK	NL	CZ	IT	SP
Baseline air pollutants (in kg/year)	12.2	811.6	66.9	15.8	201.9	1258.2
Estimated air pollutants (in kg/year)	6.1	730.5	13.4	11.1	121.1	622.8
Reduction in air pollutants (in kg/year)	6.1	81.2	53.5	4.8	80.8	635.4
Savings air pollutants normalized to demo area	0.001	0.002	0.001	0.0004	0.0154	0.011
Savings potential in 5 years	11 500	60 175	35 925	11 272	387 758	284 717
Total accumulated savings in 5 years (kg)	**791 183**					
	PM10					
	NO	DK	NL	CZ	IT	SP
Baseline air pollutants (in kg/year)	14.0	826.5	69.9	20.6	204.5	452.4
Estimated air pollutants (in kg/year)	7.0	743.8	14.0	14.4	122.7	223.9
Reduction in air pollutants (in kg/year)	7.0	82.6	55.9	6.2	81.8	228.5
Savings air pollutants normalized to demo area (kg/m²)	0.001	0.002	0.001	0.0006	0.015	0.004
Savings potential in 5 years	13 197	61 277	37 574	14 653	392 557	102 370
Total accumulated savings in 5 years (kg)	**621 705**					
	NOx					
	NO	DK	NL	CZ	IT	SP
Baseline air pollutants (in kg/year)	25.8	777.5*	275.4	903.7	510.2	1556.2*
Estimated air pollutants (in kg/year)	12.9	701.4	55.1	632.6	306.1	770.3
Reduction in air pollutants (in kg/year)	12.9	76.1	220.3	271.1	204.1	785.9
Savings air pollutants normalized to demo area (kg/m²)	0.001	0.002	0.006	0.024	0.037	0.013
Savings potential in 5 years	24 321	56 409	147 969	642 953	979 474	352 156
Total accumulated savings in 5 years (kg)	**2 203 233**					
	Sox					
	NO	DK	NL	CZ	IT	SP
Baseline air pollutants (in kg/year)	12.1	67.2*	14.8	390.7	63.9	1888.8*
Estimated air pollutants (in kg/year)	6.1	60.5	3.0	273.5	38.4	934.9
Reduction in air pollutants (in kg/year)	6.1	6.7	11.9	117.2	25.5	953.9
Savings air pollutants normalized to demo area (kg/m²)	0.001	0.0002	0.0003	0.011	0.005	0.016
Savings potential in 5 years	11 406	4 980	277 940	267158.5	122 374	427 435
Total accumulated savings in 5 years (kg)	**851 950**					
	CO					
	NO	DK	NL	CZ	IT	SP
Baseline air pollutants (in kg/year)	0.5	14.8	52.8	27.2	9.1	43.5
Estimated air pollutants (in kg/year)	0.3	13.3	10.6	19.0	5.5	21.5
Reduction in air pollutants (in kg/year)	0.3	1.5	42.2	8.2	3.6	22.0
Savings air pollutants normalized to demo area (kg/m²)	2.1E-05	4.2E-05	0.001	0.0007	0.001	3.7E-04
Savings potential in 5 years	471	1096	28 360	19 348	17 276	9 840
Total accumulated savings in 5 years (kg)	**76 412**					
TOTAL ACCUMULATED SAVINGS in 5 years after project (kg)				**4 544 483**		

*Taking into account the average of the savings normalized to the area of each distribution and considering the implementation of the ARV concept within a total of 12 417 000 m² in 5 years, the ARV concept is expected to contribute with **total accumulated savings in pollutants of 4 544 483 kg** within the 5 years after project. The 6 demonstrations in the project, are expected to contribute with total savings of **4093 kg/year**.*

[35] https://ec.europa.eu/eurostat/databrowser/view/ENV_AIR_EMIS__custom_355943/default/table?lang=en

EIC8) Demonstration of high potential for replicability using new or existing innovation clusters incorporating the whole value chain

Even though the activities and demonstrations within this project target specific buildings and sites, they are representative of climates, regions, and architectural styles found across Europe. ARV will demonstrate simple and integrative strategies that can be applicable with minimal constraints to other regions. Ensuring actual replicability requires the commitment of established **Innovation Clusters as part of the exploitation strategy** (cf. Section 2.2.2), where the knowledge and strategies will be concentrated and disseminated within the local value chain, and will play a significant role in the Exploitation, Dissemination, and Communication activities. Specifically, each demo site will engage with the corresponding municipalities, housing associations, and scientific & technological partners, creating a convergency point for easier exchanges amongst local partners, but also with higher level partnerships with European coverage, e.g., at the level of technology distributing companies, that will enable cross-links amongst the Innovation Clusters. It will facilitate solution sharing e.g., for the distribution of prefabricated components or the dissemination of novel innovative energy management solutions.

By establishing highly replicable and simple/integrative approaches, with direct links to local Innovation Clusters and aggregated with the e-market area, we ensure that not only the knowledge and experience is maintained, but also that the network and resources amongst relevant local stakeholders are strengthened. This is a key step into ensuring that new projects will arise beyond the timeframe of this project. We anticipate that in the first year of commercialization 100% of the projects will be commissioned directly to the Innovation Clusters (469 projects), this percentage will decrease gradually over the years when the e-market ramps up. ***In total, from the foreseen 8580 ARV projects, we estimate that 4760 will be commissioned via the Innovation Clusters.*** *A detailed overview of the projects commissioned via Innovation Clusters is further detailed in Section 2.2.2.*

EIC9) Shortened construction/retrofitting time and cost by at least 30%, in order to allow market uptake and social affordability

Building owners have highlighted construction times and costs to be important decision factors when considering constructing or retrofitting buildings. A stakeholder consultation on the renovation wave initiative showed that **92%** of respondents indicate **lack of or limited resources** to finance building renovations as a barrier to do building renovations, as well as the **complex and lengthy processes** and capacity of construction contractors to deliver[36]. Therefore, it is expected that reducing time and cost of sustainable construction strategies would have a tremendous impact in boosting building renovation rates and depth, thus increasing demand that would benefit all relevant stakeholders, including constructors, tenants, and building owners.

ARV cost reductions result from several measures related to the various ARV demos: NO: implementation of the circular renovation strategy, optimizing the construction site (Circular Hub and Material Hub), use of electric construction machineries; DK: cost reductions for design, manufacturing and construction of the Circulation Booster equipment. NL: early engagement of the tenants at start of renovation (social renovation), and use of pre-fabricated and modular Inside-Out building elements; CZ: using digital construction solutions during the construction value chain, off-site prefabrication, use of just-in-time-concept, maximizing use of skilled workforces that can multitask, and minimize construction reworks; IT: off-site standardized prefabrication, more precise survey techniques that reduces errors and inform off-site prefabrication, and reduced on-site construction time; SP: off-site prefabrication and integrated design since the beginning of the project.

ARV time reductions are a result of: NO: early engagement and better communication of planning (use of AR/VR environments) to the local community in the planning process, implementation of the integrated circular design strategy in the early design phase, using pre-fabricated and modular solutions, and optimization of the construction site management; DK: more efficient installation of automatic equipment and more efficient use of simulation/software; NL: using zero-engineering, and prefabricated and modular Inside-Out building elements; CZ: using digital construction solutions during the construction value chain, close collaboration in the project design phase and engagement of all stakeholders involved in the processes, education of workforce that can multitask, and minimize construction reworks; IT: use lean construction; SP: implementation a Public Private Partnership between the city council and a main company to manage the process entirely while also implementing a participative strategy that involves end-users (i.e. district residents) in the project.

[36] Stakeholder consultation on the renovation wave initiative. Synthesis Report. European Commission, Directorate-General for Energy. October 2020.

The estimated current times of construction are in the range of 12-72 months, depending on the extent of the construction/renovation and the complexity of the project. Average reductions in both time and cost for all the six demonstration sites in ARV are given in Table 2.5. The numbers are obtained by comparison of time and cost estimations for ARV processes and solutions to average construction/retrofitting times and costs for traditional construction processes and solutions achieving the same energy performance. Further reductions are expected when the procedures and solutions are implemented in other projects after ARV, because of more experience and larger volumes. For some of the demos these reductions are included in the table.

Table 2.5 Expected impacts of ARV in the reduction of construction/retrofitting time and cost. The table shows expected reductions during the ARV project period and after the ARV project has completed (in parenthesis), where this has been estimated, i.e. when the solutions have been scaled up and fully integrated in the market.

Demonstration	Time reduction	Cost reduction
Oslo (NO)	33%	30%
Sønderborg (DK)	38%	35% (up to 40%)
Utrecht (NL)	40%	35%
Karviná (CZ)	33% (38%)	31% (34%)
Trento (IT)	35% (up to 50%)	30% (35-40%)
Palma (SP)	25%* (35-38%)	32% (40%)
AVERAGE REDUCTION OF TIME & COST (%)	**34 & 32**	

Making cost-effective and time-effective construction and renovations to result in social affordability and market uptake is in the core of ARV concept. In average, the adoption of ARV concept, is expected ***to reduce time and costs by 34% and 32%*** *(on average within ARV project), respectively.* *For the demo in Spain the renovation time reduction is 35% and newbuilt time reduction is 15% (i.e., an average of 25%). The new built time reduction of 15% will increase to 30% when the innovative solutions are standardised in the market.

EIC10) Improved final indoor environment quality by at least 30% and reduction of dust and noise during retrofitting by at least 30%, leading to higher rate of users' satisfaction, demonstrated according to the relevant CEN standard (or equivalent).

Indoor Environmental Quality (IEQ) is a fundamental component in the construction and renovation process and leads to healthy and comfortable environments. Building designs that accommodate appropriate ventilation systems, with environmentally friendly materials, and that take into consideration air pollution (see EIC 7) are very important to establish a good IEQ. The six demonstration sites have employed diverse strategies to **achieve at least 30% reduction of dust and noise during retrofitting, leading to an improvement of IEQ of at least 30%**. Such strategies include clever designed connections will help to reduce noise and dust levels over a shorter period, optimized HVAC, industrial produced components mounted on the outer façade to avoid inside construction activities, and architecturally integrated noise reducing façade elements for natural ventilation. New buildings will at least reach IEQ_I, refurbished buildings at least IEQ_{II} according to ISO 17772-1:2017. Pre- and post-occupancy evaluations will be carried out in all ARV renovation demos to **ensure at least 30 % improvement in IEQ**, where the pre-occupancy IEQ was evaluated as IEQ_{II} or worse.

2.1.2 Other expected impacts beyond the 10 EICs specified in the call

Table 2.6. Summary of ARV key impacts that go beyond the 10 EICs specified in the call text.

Impact category	How ARV will contribute to achieving the impacts	Targets	KPIs
1) Circular Economy and Resiliency	Maximizing reuse of buildings by lean renovation applying life cycle analyses (WP5, 8), minimize waste and pollution by prefabrication and industrialization (WP5), design for long-lasting, easy to repair, reuse and recycling of building components (WP4, 5). Use of local bio-based materials (WP4, 5). Design for flexibility of building use (WP4), and flexible and secure energy systems and storage (WP6,7).	50% reduction in life cycle GHG emissions compared to ex-ante condition or current practice. Apply all relevant *Level(s)*[37] *CEIs.*	kg CO_2-eq/m^2 over 60-100-year lifetime. # of Level(s) CEIs applied.
2) Social-environmental qualities	Design for well-being and good indoor environment qualities including good daylight and visual qualities, indoor air quality, thermal comfort, acoustics, and accessibility for persons with disabilities and senior citizens (WP4-5). Included in multiple benefit analysis (WP3 and WP8)	At least 30% improvement compared to ex-ante condition	% of users moving up the satisfaction scale

[37] https://ec.europa.eu/environment/topics/circular-economy/levels_en

	Design for comfortable outdoor conditions, i.e. solar and daylight access, visual qualities, and shielding from wind and noise (WP4-5).	At least 30% improvement compared to ex-ante condition	% of users moving up the satisfaction scale.
	Minimize disruption to occupants during renovation by off-site prefabrication and minimizing the time spent on site (WP5).	30% reduced construction time. Close to zero disruption	Construction time and intervention
	Awareness raising, engagement and education by arranging Living Labs with co-creation, (WP3), creation of Citizen Energy Communities (WP2)	At least 12 activities per year involving at 1000 people.	Number and scope of activities per year
3) Smartness	Design for high energy efficiency and make use of smart home services and controls, smart building components, and smart but simple systems for user interaction/involvement (WP4-7).	Average impact score more than 70%.	Smart Readiness Indicator (SRI)
4) Energy flexibility and security of supply	Design for high energy efficiency and make use of smart home services and controls, smart building components, and smart but simple systems for user interaction/involvement. Exchange of data between buildings, energy systems and people through community digital hub. Automated algorithms for weather and performance forecasting. (WP4-7)	At least 30% improvement compared to ex-ante performance	Daily net load profile in kW; utilisation factor in %, share of self-consumption / self-generation in %.
5) Affordability and alleviation of energy poverty	ARV will demonstrate scalable solutions for renovation of social housing and public buildings that will give significant reductions in construction and operation costs, while provide good indoor climate and architectural qualities (WPs 2-9).	30% reduction in construction costs and at least 50% reduction in energy/power bills.	Reduction in Euro compared to current standards.
6) Job creation, innovation capacity and industrial competitiveness	All stakeholders: reinforce or establish new collaborations in the value chain of CPCC, PPPs, increased understanding of customer needs (all WPs). Increased health and well-being of citizens (WP2-8), value creation from reduced energy and power use (WP3,4,5), use of on-site RES and storage + EVs (WP6), and increased flexibility (WP7, 9), human capital program for job creation (WP3), standardization and industry 4.0 processes (WP5),	At least 20% increase in value creation of ARV partners and the creation of about 12-20 000 new jobs per year[38] (based on the investment of the ARV developers 2022-2024).	Revenue in Euros, # of jobs created
7) Standards and regulations	ARV will contribute to revised building and energy regulations, in particular on benchmarks and documentation needs for GHG accounting and for revised energy/power performance codes, and to the SRI. For financing ARV will contribute to a new standard for green digital bonds (green STOs).	Provide input to national and EU level through at least 20 meetings and publications	# of publications and meetings with regulation bodies
8) Knowledge creation	ARV will contribute to knowledge creation among all stakeholders in the consortium, to the group of associated innovation clusters, to the occupants in the demo projects through Living Labs (WP3), Energy Communities (WP2), and to a wider audience through communication and dissemination activities (WP10)	Ref dissemination and communication plan (section 2.2.1)	Number and scope of events (section 2.2.2)
9) Contribution to key EU policy goals	The renovation wave[39]: ARV will demonstrate a streamlined, efficient and replicable workflow for resource efficient renovation of social housing and cultural heritage public buildings (WP5).	133 400 m^2 of buildings renovated to nZEB standard or better	# of m^2 buildings and energy
	Climate targets: ARV will contribute to the targets of 50-55% reduction of GHG emission by 2030 and 90-95% by 2050, by demonstrating and validating scalable CPCCs.	50% reduction in life cycle GHG emissions compared to ex-ante condition/current practice.	kg CO_2-eq/m^2 over 60 years lifetime.

Specific impacts for the participating partners

The ARV project will advance the innovation in the construction and renovation sector through a comprehensive portfolio of strategies suitable for different climatic conditions, in different cultural context targeting social housing and public buildings. Fig. 2.8 outlines the positioning of the industrial partners and their respective contribution to the post-project exploitation of the project results from a value-chain perspective. As shown in the figure, the consortium partners cover the entire value chain from material providers to final customer and building users. The industrial partners will have a key role post-project for the successful market uptake of the developed solutions, not only creating new market opportunities but also strengthening competitiveness and the growth of the companies (cf. Section 2.2.2 for details on the Exploitation strategy). In the following, we briefly describe the expected impacts from the project for each of the industrial partners involved.

[38] 12-18 local jobs per million Euros invested in energy efficiency, IEA, Sustainable Recovery, June 2020.
[39] https://ec.europa.eu/energy/topics/energy-efficiency/energy-efficient-buildings/renovation-wave_en

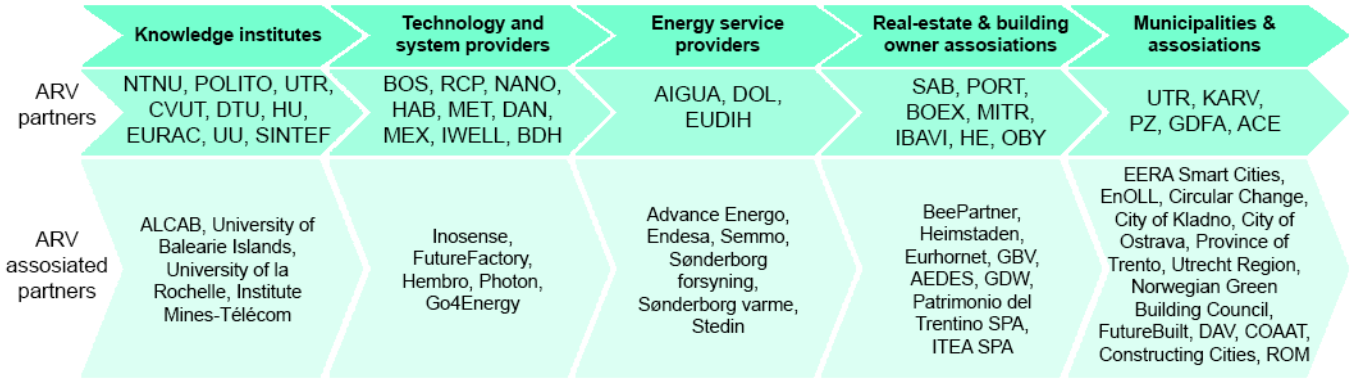


Figure 2.8 ARV value chain, highlighting the role of all consortium partners and the associated partners documented through Letters of Support.

Table 2.7 Expected benefits for the ARV **industrial** partners

Partner	Expected Impacts
ENFOR	*Direct benefits*: The improved forecasting model should help ENFOR double its sales within 3 years. ENFOR estimates hiring 1 new development engineer during the project, and the increase of revenue should bring 3-6 new employees in 5 years. The tools developed within this project will be sold globally through current sales distribution agreements and the foreseen exploitation strategy. *Indirect benefits*: The successful achievement of the project will enable ENFOR to consolidate customer relationships and continuously strengthen its position as leading provider of solutions for the energy sector. It will also enable exploring multiple new methods for improved energy forecasting with DTU.
Danfoss	*Direct benefits*: As part of the exploitation partnership, Danfoss will deliver a solution – Circulation Booster Concept – for smart efficient operations based on external signals from electricity and district heating production. Danfoss estimates 1-5 new jobs in product management, production, and services within 5 years post-project, which can increase depending on the added value of the solution trend. *Indirect benefits*: The successful achievement of the project and of the inclusion of Danfoss solutions in the demonstrations will strengthen the #1 position in smart and efficient solution for district heating systems and be at the forefront of combining district heating substation technology with heat pump.
Mex Architects	*Direct benefits:* The project will allow Mex Architects to directly participate in the construction of contemporary building components and building typologies, benefiting from the increased ARV efficient processes that enables taking up more projects without ramping up internal resources. *Indirect benefits:* The inclusion of efficient, sustainable and attractive renovations within this project in their portfolio will strengthen Mex Architects position in the field, generating further market demand.
iWell	*Direct benefits:* iWell will benefit from demonstrating the iWell Cube batteries, which if successful can quickly be scaled up to use in multiple flats and neighbourhoods as a flexibility service to the grid operators and housing corporations in a Flexibility as a Service (FaaS) model. iWell estimates doubling its current employment through the hire of maintenance employees and installers and software engineers. *Indirect benefits:* The successful project outcomes will contribute to one of the core iWell R&D pathways, and therefore has the potential to accelerate developments in this track considerably. It will also increase visibility and new strategic partnerships, such as with grid operators, housing corporations, provinces and municipalities.
BOS GROEP	*Direct benefits:* The participation in this project will enable BOS to further improve smart renovation solutions for high-rise buildings such as facades and integrated roof modules with collective infrastructures for multiple heating services. By improving the products design, materials, and industrialisation features, BOS expects lowering production costs and making them financially more attractive, thereby increasing revenues. The increase in projects will enable BOS to start an off-site production facility for prefabricated installation modules and to create new jobs. *Indirect benefits:* The successful project outcomes will impact the overall company innovation strategy and propel novel R&D innovation pathways.
RC Panels	*Direct benefits:* RC Panels will benefit from participating in ARV by increasing yearly renovations from 1000 homes to 4000 homes within 4 years, supported by increased industrialisation and prefabrication. The ARV project will also enable joint developments with housing associations (representative of future clients) and other innovative companies for high-rise solutions. *Indirect benefits*: Participation in this project will contribute to the generation of new technical solutions and associated knowledge for integrating installations in building parts. It will also greatly increase the visibility and client portfolio of RC Panels, which will contribute to future projects and growth.
Metro-vacesa	*Direct benefits:* The developments foreseen in this project of Integrated service for monitoring and control of centralized systems in multifamily buildings will be implemented in future MV Residential Developments based on the degree of customer satisfaction, considering the results of this project, which will improve client satisfaction and MV business. The project will directly result in contracting 2 employees during the project and the additional business will lead to the creation of 3 new jobs. *Indirect benefits:* Will gain exclusive access to strategies and partnerships that will be relevant for future real-estate applications and be integrated in post-sale evaluations for future developments.
Aiguasol	*Direct benefits:* Participating in the ARV project will enable improvement of automatization of HVAC systems design, digital twin development, and improvement of BIM integration of simulation tools and results leading to doubling Aiguasol capacity to 800 k€ projects yearly. This will have a direct effect of contracting 2 new development engineers during the project and 6 new engineers after the project.

	Indirect benefits: This project will enable novel research & development of tools for PV output sharing.
Dolomiti Energia	*Direct benefits:* The participation in the ARV project is a crucial enabler to continuing their efforts of promoting energy efficient services as an ESCO that protect the environment. *Indirect benefits*: Dolomiti Energia will strongly benefit from the partnerships and increased visibility obtained through the participation in this project, which may be highly relevant for the customer's decision-making process.
Nano-Power	*Direct benefits:* NanoPower will benefit from participating in ARV by directly supplying second life battery energy storage systems to the demonstration sites and gain experience on how to optimally integrate and operate them in CPCCs as part of the planned exploitation strategy. *Indirect benefits*: Participation in this project will greatly increase the visibility and client portfolio of NanoPower, which will contribute to future projects and growth.
Buro de Haan IT	*Direct benefits:* The participation in this project will enable further developments on various algorithms for the pre-recognition of façade geometries, enabling the analysis of a building in a better and flawlessly manner as well as streamlining the construction process by automating the necessary engineering calculations. (including construction calculations, environmental calculations, legislative tests. This would lead to several breakthroughs with a direct impact in the business. *Indirect benefits*: Given that this is a new market, we expect that the participation in this project will greatly increase the visibility and market awareness of our work, as well as more collaborative projects.

The remaining partners will also directly benefit from the collaborative effort in this project. Table 2.8 summarizes the impacts for these partners. For simplicity, some were grouped based on their profile.

Table 2.8: Expected benefits from ARV for the **non-industrial** partners

Partner profile	Partner	Expected Impacts
University and Research Institutes	Norwegian University of Science and Technology, Czech Technical University, Technical University of Denmark, EURAC Research, SINTEF, Catalonia Institute for Energy Research, University of Applied Sciences Utrecht, Utrecht University, Politecnico di Torino, University of Trento	*Direct benefits:* Participation in ARV will strongly advance the state-of-the-art knowledge in innovative methods, solutions, and technologies to create sustainable patterns of behaviour and contribute to all integrative aspects of Circular Climate Positive Communities. *Indirect benefits:* The generated knowledge and established strategic partnerships will be relevant to other research areas within the Universities and further advance scientific breakthroughs. In the longer term, Universities expect to contribute to standardisation (national and EU level, such as the Level(s), skills and education training as well as policy making in the development of sustainable neighbourhoods.
Municipalities	Municipality of Utrecht Municipality of Karvina Palma City Council	*Direct benefits:* Participation in ARV represents a step forward into creating more Circular Climate Positive Communities that make neighbourhoods and cities more sustainable. The results will serve as examples and best practices for adjacent district renovation projects in the cities. *Indirect benefits:* The successful outcome of the project and the strategic partnerships will be relevant to implement more solutions in the future.
Housing associations / Corporations	SAB Housing Association, Stichting Bo-Ex '91, Mitros, IBAVI, Housing Europe	*Direct benefits:* The ARV innovations will used in the building stock managed by these associations, increasing their reach to potential new users. *Indirect benefits:* The participation in ARV will increase the network and future partnerships of these associations, laying foundations for future successful projects.
OsloBygg	*Direct benefits*: The participation in this project will generate new knowledge and experience in the full life cycle of new sustainable buildings, their management operations and their integration in urban neighbourhoods. *Indirect benefits:* The inclusion of successful demonstration cases in OsloBygg portfolio will attract further partnerships and business, making it a reference for widespread sustainable public buildings.	
Habitech	*Direct benefits*: The increased collaboration and integrative approach gained from this project will enable better implementation of smart-efficiency projects on individual buildings and on urban scale, from the planning stage to the implementation and the management and the performance analysis. *Indirect benefits:* The access to the unique ARV business network will provide a framework to give Habitech members a more comprehensive approach and access to novel solutions.	
EU Digital Innovation Hub	*Direct benefits:* Participation in this project will directly contribute to advancing the state-of-the-art and enlarge the digital platform/hub with more partners and more services. *Indirect benefits:* The generated partnerships will be relevant for the commercial partners using the digital platform running their services, with more available choices.	
Project Zero	*Direct benefits*: The participation in ARV will encourage the establishment of partnerships and sharing solutions to establish a leading position for Sønderborg and Denmark in CO_2-neutral growth and sustainable cities, the main goal of Project Zero. *Indirect benefits*: The generated collaborations will enable a transition to sustainability cities around the world.	
The Green Digital Finance Alliance	*Direct benefits:* The adoption of innovative sustainable business models and financial mechanisms developed during the project would directly impact their standard mode of operations. *Indirect benefits:* This project will enable the creation of a network of stakeholders with high potential to collaborate and further promote sustainable digital finance practices at national and international levels.	
Architects Council of Europe (ACE)	*Direct benefits:* Through the participation in the ARV project, the ACE will have a strong voice and participation in the decision-making process in the architectural services foreseen, thereby ensuring a balanced and valuable legacy for the future that complies with ACE´s mission. It will also enable future guidance to architects on how to provide high quality architectural services to clients whilst working to ensure that the regulatory environment for architectural practice facilitates the achievement of this aim. *Indirect benefits:* The partnerships established will contribute to fostering cross-border cooperation and facilitating the European practice in the context of relevant EU directives and policies.	

2.1.3 Barriers and obstacles to achieve the expected impacts

There are several potential external barriers that may influence the outcome and impact of the project. We describe the barriers below, and present ways of overcoming these barriers.

- **Lack of trust that renovations are economically attractive,** coupled with **high costs of interventions**. There is also the idea that even comprehensive renovations may not reduce running costs, or that shallow renovations may already help reduce running costs and still increase the cost of buying and renting. Our project will provide proof of the applicability and advantages of undergoing deep renovations, and the benefits it brings to building owners and users by demonstrating the value of the proposed solutions (multiple benefits framework).
- **High (perceived) effort** that demotivates owners and occupants to undertake renovations, coupled with difficulties in decision-making processes in multiple ownership residential buildings. In addition, energy efficiency is not always the main reason to invest in such a project, and owners often prioritize high comfort levels, personalization, and aesthetics, which can make the alignment with energy interventions a challenge. It is also unclear how energy performance would influence real estate prices, which may be demotivating for owners. ARV will address this barrier by providing validated, accurate, and information that is easy to access and understand for all stakeholders (validated real-world demo projects, e-marketplace, one-stop-shop, guidelines/blueprint for planning, design, construction, operation and use of CPCCs).
- **Difficulty in accessing financial support**, not only in obtaining loans for renovations in residential buildings but also long payback periods, unpredictability of costs throughout renovations, and high upfront payments before receiving financing. Barriers to issuances of green digital bonds are currently being lifted in the EU via increasing regulatory clarity of crypto assets. However, there is no guide or standard for green digital bonds (green STOs). The ARV project will contribute to correcting this failure (WP9). Through the demonstration of the success of the solution in the demo projects, this provides investors and loan agencies with the confidence that they will see a return on their investment. Also, creating the capability to trade energy in a fair and efficient way, will provide an economic incentive to building owners.
- **Insufficient technical expertise** amongst local and regional authorities, along with shortage of skilled workforce, especially for large-scale renovation projects. This often constraints the applicability of certain technologies in specific cases and poses resistance to the installation of new techniques or energy efficiency measures due to concerns on their maintenance. The ARV project will deliver an e-marketplace with integrated technical expertise and validated suppliers so that the owner can buy tested and guaranteed services and respective training.
- **Complex and conservative nature of the constructive sector**, who often do not easily accept major changes in their way of working, particularly in cases where new skills and technical expertise is needed. The slow and long project commencements are also perceived as a major obstacle to start construction and renovation projects. The reduction in time and costs of construction and renovation activities, as well as the integrated, streamlined, digitalized, and simplified production processes to be delivered by ARV, will address these challenges.
- **Limited uptake of smart technologies and digitalisation** is a potentially significant barrier, one that is vitiated within the project by a combination of highly experienced project partners with a long track record of deploying smart building/smart energy systems innovation, a wide range of large enterprises and SMEs across the entire value chain, and a clear digital-first strategy to lower costs, simplify the renovation/construction process, and use technology in a more systematic fashion.
- **Uncertainty about the future use of the building**, such as changes in services, demography, rural exodus, which increases reluctance to renovate. In addition, a common so-called split incentive barrier, where the owner pays for the renovations, but the occupants benefit from it, is a barrier. ARV strategies to engage with occupants and the integrated approach of energy efficiency/RES/storage in the value chain of CPCCs (from planning to use), will contribute to increasing the uptake of ARV solutions.
- **Wide applicability of the technologies in multiple solutions may be impaired,** e.g., where there are specific architectural constraints or concerns on the maintenance and reliability of new installations. The ARV project will address this challenge by demonstrating and validating solutions in a wide range of contexts (cultural, climates, typologies) enhancing the flexibility and scalability of the solutions.
- **Lack of attractive financing products** is listed in the Renovation Wave as the most common barriers to efficient building renovation. ARV will work with some of the world's leading financial institutions (WP9) in collaboration with real estate investors, public authorities, and construction/building industry partners to deploy and evaluate novel financing instruments that will bridge the risk/reward gap for both public and private housing owners, building industry, property developers, and public authorities.
- **Regulation and policy barriers** exist in some European jurisdictions to scale platform-based prosumer business models. This risk is lowering the incentives for citizens to transition from consumers

to prosumers of energy. The European Electricity Regulation and Directive provide the basis for an ambitious European Green Deal and Green Recovery[40]. Many articles in both the Electricity Regulation and Directive are crucial in removing existing regulatory barriers to demand-side flexibility, and for enabling active participation of energy consumers in order to increase efficiency and in the transition to clean energy. While some of the provisions of the Regulation were immediately applicable with its publication in the Official Journal of the European Union in June 2019, several provisions are expected to be transposed into national legislation by December 2020. However, a comprehensive demand response aggregation framework is still missing in most countries. ARV aim at releasing the barriers for demand side efficiency and flexibility by sustainable design, data-driven renovation, and a hierarchy of digitalization setups in order to enable customers and local communities to act as active customers without being subject to disproportionate technical requirements, administrative requirements, procedures and charges. Thus, ARV aim at demonstrating how to remove existing regulatory barriers to demand-side flexibility, to enable an active participation of all energy consumers in the clean energy transition.

2.2 Measures to maximize impact

Dissemination and exploitation activities are key factors to the success of the ARV project, as they will engage stakeholders and contribute to knowledge exchange between actors from different sectors, maximizing its benefit to the European economy and society. The dissemination strategy will focus on promoting the project scientific and technical actions & results, including training; workshops and events to engage stakeholders in mutual learning activities. Moreover, the exploitation strategy will ensure the effectively use of ARV results through scientific, economic, political, and societal routes and will guarantee that the impact of the outcomes is maximized after the completion of the project activities. In the following subsections, we detail our strategies for effective dissemination, exploitation, and communication of project results for the successful delivery of ARV expected impacts.

2.2.1 Dissemination activities

A dedicated Work Package (WP10) has been designed to ensure the maximum impact of the research for the whole industry and research community as well as building/energy value chain and citizens, through high transparency and full dissemination of the research results. The dissemination strategy aims to engage relevant stakeholders in all the activities conducted during the four-year project, contributing to setting the foundations of a long-lasting relationships for the promotion of scalability and market update of the developed solutions at a wider level including industry, policy makers, governance, and civil society. ARV will also foster synergies at EU level, contributing to EC activities and priorities as the Green Deal initiative. To reach those purposes the project will implement a dissemination plan for ARV results (WP10), which considers the following aspects: ***(i)*** Project target stakeholders; ***(ii)*** Dissemination tools and channels; ***(iii)*** Message; and ***(iv)*** Monitoring and evaluation. The dissemination plan will be monitored, reviewed and regularly updated throughout the course of ARV project to ensure the maximum impact is achieved.

The Dissemination Plan for the four-year activities outlines the dissemination goals, target audiences, key messages, strategies and responsibilities, consortium benefits, and communication channels. The details of this plan shown below and will be consolidated into a detailed report with planning and timing of the activities to fit with the start date of the project and upcoming events. Additionally, contextualized Dissemination and Communication Strategies will pe prepared for each CPCC Living Lab demo, addressing the specific communities at neighbourhood & district level for each of the 6 kkCPCC LLs in Norway, Spain, Denmark, Czechia, Italy and the Netherlands.

ARV target stakeholders

Six primary stakeholder groups have been identified and clustered: 1) construction/building; 2) citizens/end-users; 3) policy makers/regulators; 4) research community; 5) investment/business community; and 6) media/civil society. Table 2.9 details the stakeholder groups that will benefit from ARV activities/results and contribute to its long-term scientific and innovation capacity. The project partners have strong contacts with a number of national and international stakeholders in the areas of construction and energy, which will be leveraged during the project implementation and after expected results are achieved. Each of the identified stakeholder groups will benefit from the project in different ways and will have different dissemination and exploitation tools and activities to reach them.

Table 2.9 Stakeholder groups targeted by ARV dissemination activities.

[40] https://smarten.eu/wp-content/uploads/2020/11/FINAL_smartEn-EMD-implementation-monitoring-report.pdf

Stakeholder groups	Types of organizations/individuals	How stakeholders benefit from ARV & How their involvement contributes to maximizing ARV impact
Construction / building sector (Potential E-market members)	Material providers and portfolio managers, Constructors, Architects, Service providers, Real-estate representatives	First-hand contact with the technology & proposed strategies will enable direct implementations of solutions at early phase, while at the same time ensure the replication of the ARV strategies and therefore the growth of the envisaged outcomes.
Citizens (End-users)	Building owners, Tenants, Landlords Associations (cooperatives), Municipalities	The effective end-users of the sustainable buildings will benefit from the use of strategies that contribute to a sustainable environment, with economic savings in their electricity bill.
Policy makers and regulators/ authorities	EU Commission, Policy makers, World Green Building Council	Be informed about the benefits of ARV for the future of a sustainable European economy growth. New regulations and policies for more efficient buildings. Standardized processes, services, & business models between the different stakeholders.
Research community and educational institutions	Universities and research institutes (non-profit and commercial) Associations/networks of researchers/ scientists	Engage in mutual learning actions with ARV partners, contributing to enhancing research and innovation competences in the area. Knowledge spill-over.
Investment Companies and Business Associations	Business Europe Association, European Small Business Alliance (ESBA), European Capital, European Investment Bank, Alternative Investment Management Association (AIMA), Association of Investment Companies (AIC)	Be conscious about the developments in a cutting-edge sector with great impact in Europe's economic development. Support the further development of the sector and the upscaling and large-scale sustainable hubs.
Media groups, journalists, communicators	Synergies with relevant networks and projects	Contribute to inform the civil society about the economic and environmental benefits of ARV. Contribute to aware citizens for sustainable actions.
Broad public / citizens / non-profit organizations	General Public	

Dissemination (and Communication) tools and channels

The dissemination & communication actions aim to make European stakeholders aware of ARV benefits, relevant to their own core interests (energy & construction actors; building owners, tenants, renters, etc; academics/education; technology/industry promotion). To address the multitude of stakeholders, appropriate tools and channels will be implemented. The dissemination & communication channels (e.g. BUILD UP[41], ECTP[42] etc) will include:

- The creation of an ARV project visual design identity and templates for documents and presentations
- The production of a brochure & poster with an introduction to the ARV project
- The development of the project's website, associated with ARVs social networks (LinkedIn, Twitter)
- Digital newsletters will be developed regularly, disseminated to relevant project stakeholders, and uploaded on the project website, to transmit the progress of the project and the outcomes of the activities to all actors that may be interested in the research and that may be eventually involved in future research activities
- Support packages with decision support tools, description of processes for mentoring of the **Living Labs** (LLs) managers, and training material for citizens (prepared in WP3) will be further disseminated as part of the tailor-made Dissemination and & Communication Strategies developed in WP10
- A series of programmes, incl. Open Days, interactive guided tours, talks, workshops &festivals will take place at local level, to make the experience of each CPCC Living Lab more engaging & accessible to citizens
- Conferences will be organised together with targeted events to engage with industry & civil society
- A project result booklet containing description of all the results achieved in ARV will be produced with the contributions of all partners involved in the 6 CPCC demos sites
- Short video series & podcasts focused on ARV results & the citizens' experience of the CPCC LLs activities.
- Other tools will be used to target particular types of stakeholders such as social media, Web 2.0 technologies including features in specialist publications to be accessed by different types of stakeholders, or project/external events
- The dissemination of scientific and technical achievements will be done by open tools like Google Scholar & Research Gate, while relevant scientific communications will be available in the project website;

The **e- marketplace area** will be set up and embedded on the website, as a **"one stop shop".** There, all project results will be merged, providing guidelines for end-users, links to different resources, information on product suppliers,

[41] https://www.buildup.eu/en
[42] http://www.ectp.org/

software, spreadsheets, and datasets. Training material and technical guidance will also be included. Information will be easily filtered by type, topic, scale, country, license, etc. This area will also serve as a contact point for all demo projects targeting Climate Positive Circular Communities, enabling virtual connectivity and collaboration. Another channel that will be implemented concerns attending and delivering presentations about the project and the R&D collaborations, national and internationally, at relevant scientific/technical events. Direct communication with individuals (face-to-face meetings, workshop, webinars and/or direct emailing), targeted emailing to relevant organizations identified, and publication of news on the websites/newsletters/social networks of organizations of the partners' networks will also be fostered (see WP10).

Key Messages

Our messages will be direct and easy-to-remember. They will drive the project's C&D activities by conveying **how ARV responds to key societal challenges** such as climate change, housing affordability, energy poverty, citizens' health and well-being, economic recovery, and **how the project's outcomes are relevant to our everyday lives**, by creating jobs, introducing novel technologies, and in making a positive impact on the planet and the quality of life. ARV messages will be **tailor made to the type of activity they relate to** (communication or dissemination) and will be updated over the course of the project. Nonetheless, the consortium has defined a few preliminary messages for the dissemination and communication of the project:

- Climate Positive Circular Communities, where people can thrive and prosper for generations to come
- Beautiful, sustainable, together in CPCC
- Renovation for recovery, resilience, and social inclusion
- Environmental-friendly, safe, healthy, affordable living places & communities for all
- CPCC will make renovation a win-win for climate neutrality and recovery
- Greener and resilient communities
- CPCC to reconcile climate and social goals.

Monitoring and evaluation

As soon as the project kicks off plans need to be implemented, monitored, and elaborated, a monitoring strategy is foreseen (WP1, WP8). The evaluation will be carried out on a regular basis to ensure an effective impact assessment and update or redefinition of dissemination and exploitation activities and safeguard the high quality of the dissemination and exploitation carried out. Evaluation criteria and monitoring activities are depicted below:

- Evaluation criteria: impact measurements indicators. Table 2.10 shows the qualitative and quantitative indicators to measure the impact and thus, for conducting the most accurate assessment of the dissemination activities.
- Monitoring procedures: reporting and feedback. To facilitate an accurate monitoring and assessment of the dissemination activities, and to understand the impact of the actions carried out, all partners will register their ARV activities. Moreover, all partners will prepare their dissemination and exploitation activities according to the action plan &report, at least every 6 months to the AEB; all partners will register the activities in the dissemination and exploitation-reporting document; and all partners will keep evidence of the activities conducted. The dissemination strategy will be implemented taking into consideration that all relevant IPR are protected. Hence, results will be made public only after due consideration of IPR issues and respective protection, under the supervision of the Innovation Management Board and ARV Exploitation Board.

Table 2.10 Impact measures and target values.

Indicators to measure impact	Measurement technique/source	Target value
Scientific and Technical Results	Papers published in scientific journals with high Impact (e.g. Building Research & Information, Energy Build, Int. J. Life Cycle Assess, Renewable and Sustainable Energy Reviews, Architectural science review); International invited/plenary/keynote communications and poster presentations.	> 4/year > 5/year
Number of total visits to Project´s website	Project website is registered in Google analytics that offers a free service that generates detailed statistics about the visitors to a website.	1000 / year
Number of distributed brochures	Analysis of the partners' individual dissemination plans and reports.	200 / year
Number of scientific events attended in which the project is disseminated	Scientific events.	8
Number of technical events attended in which the project is disseminated	Technical events.	8
Number of person-to-person meetings/ communications	Person-to-person meetings/communications.	25
Number of targeted emails	Targeted emails.	200/ year

Nº of news published in other networks' websites	Other networks' websites.	12
Number of LinkedIn and Twitter follows/members	LinkedIn and Twitter registry.	300

2.2.2 Exploitation of results

The ARV exploitation board will be established as a vehicle for scaling the business models and financing instruments. The Exploitation Board will be composed in part by strong innovation clusters as well as financial sector players that will spread the green building and renovation concepts to provide momentum to the 'renovation wave' that will be politically underpinned. The ARV exploitation methodology will be structured in T9.6 as a three-step process as shown in Figure 2.9.

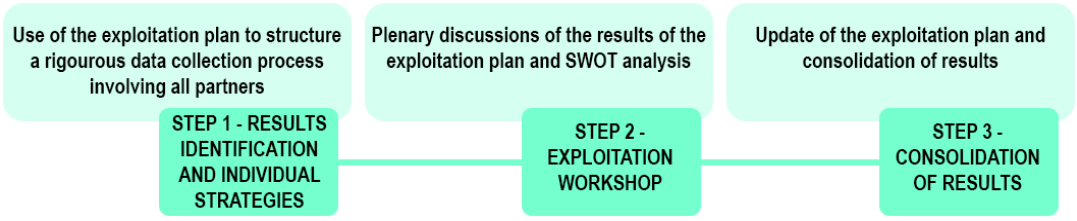


Figure 2.9 Exploitation methodology in ARV

2.2.2.1 Exploitation and Business Plan outline

The exploitation plan for the project innovations will be pursued with relation to **short-** and **long-term** objectives. The **short-term objectives**, within the four-year time frame and closely linked to WP1, WP8, WP9 and WP10, will be to:

1) Facilitate knowledge exchange with the ARV Exploitation Board to continuously identify commercially viable innovations and protect any further IP arising from the project,

2) Make recommendations for replication based on multiple benefit analyses (task 8.5, D8.8),

3) Develop business and financing models proven in other markets for adaptation in the EU to accelerate the renovation wave. (D9.2),

4) Design business model blueprints for energy positive retrofits for different asset classes as modules for replication across the EU (D9.3),

5) Design building-linked financing instruments for FI adoption in re-estate portfolios (D9.5),

6) Develop green digital bonds guide to scale prosumer flexible energy markets (D9.6)

7) Enable scaling across EU markets of energy positive renovation. (D9.7), and

8) Develop and expand the network of potential stakeholders in the value chain, including industrial partners, SMEs, and investors to further propel post-project activities (through ARV exploitation board and associated innovation clusters).

9) Establish an e-marketplace to merge project results with links to resources, product suppliers, etc. (D10.3)

The creation of an e-marketplace will enable the aggregation of all the project results, innovations, technology providers, and service providers. The e-market will include the necessary tools to streamline the process and deliver the necessary services and installations, and the financing mechanisms put in place will facilitate their uptake. In addition, **Innovation Clusters** (see Figure 2.10) that include ARV partners and other stakeholders from whom we received Letters of Support will be formed with the goal of serving as a local vehicle to facilitate the implementation of the envisioned solutions. They will include not only local stakeholders, but also larger international players, both academic and industrial, offering a broad yet still highly scalable solution.

The Innovation Clusters of ARV bring together key stakeholders from the whole value chain of CPCCs: knowledge institutes, tech and system providers, energy service providers, architects, real-estate and building owners, municipalities and regional authorities, financial institutes, and different organizations working to promote sustainable buildings and communities. In ARV, there are country specific clusters organized around the ARV demos and a common EU-wide cluster serving both the local clusters and acting as multipliers to the EU-wide market, see Figure 2.10.

The **long-term objectives** are closely linked to the potential uptake of ARV strategies and will be based on the growth of the solution as more end-users provide success stories. This growth is estimated in our market analysis, as depicted in the following section, and rely on the Innovation Clusters, the innovative Financial Mechanisms (WP9) and the success of the ***e-market area*** (i.e. increase the overall brand awareness of ARV solutions and innovations). Our goal is the establishment and systematization of streamlined processes and services towards the creation of more sustainable buildings in Europe. This will directly contribute to placing in the market **12 000 000 m² of renovated and new buildings** employing the ARV concept and strategies by 2029, as estimated by our Market Analysis below.

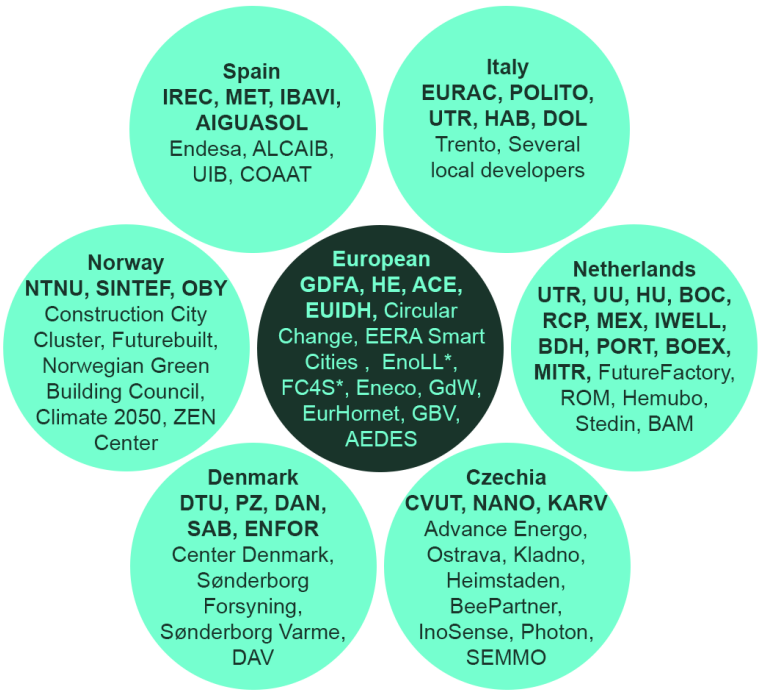


Figure 2.10 The innovation clusters of ARV: The country specific clusters and the common European cluster acting as incubators on the European scale market. Names in bold signify ARV partners, while the other names are associated partners confirmed through Letters of Support to ARV (attached) (*EnoLL: European Network of Living Labs, FC4S: Financial Centres for Sustainability (UN convened)).

Market analysis and Business case for ARV

ARV innovations have a huge market potential. The European building stock is aging and in need of replacement or renovation, which constitutes a considerable market potential, and therefore play a strong role in stabilizing the building sector, especially in a crisis period. The annual **turnover** in the construction sector (all activities) is in the region of €1,400 billion and that the **turnover** dedicated to **renovation** and maintenance activities is in the region of €370 billion[43]. The market for building energy efficiency products and services, including energy management technologies, water heating, and HVAC, was approximately €41 billion in 2015 and is expected to rise to €80.8 billion by 2023 (CAGR of 7.7%)[44]. The exploitable innovations envisaged in this project have a promising revenue potential.

Considering the known and predicted construction and renovation rates, we have estimated the overall market potential, which constitutes the total number of buildings in the EU expected to be constructed or renovated. From those, we have estimated the number of ARV projects that could be developed each year, and calculated the respective % market share, number of projects, and area. Following the principles of the proposed Renovation Wave, and considering the distribution of the ARV demonstration cases, we foresee more renovation projects than new constructions as the largest market. **Assumptions/input:** The market potential was calculated using data[45,46] on number and distribution of buildings as well as the forecasted construction and renovation rate, resulting in the following: EU building stock: 258 820 000; EU residential buildings: 219 685 150; EU non-residential buildings: 39 134 850; average area of residential building: 91,8 m²; average area of non-residential building: 6380,5m². The ARV's potential market penetration was based on estimations resulting from a feasibility study based on the input of ARV's partners with experience in launching new concepts and product in the construction market. The ARV potential is segmented by type of building (i.e., residential *vs* non-residential) and type of intervention (renovation *vs* new construction).

[43] https://www.renovate-europe.eu/category/news/, accessed January 2021.
[44] http://renovate-europe.eu/wp-content/uploads/2015/09/Final-pdf-version.pdf
[45] https://ec.europa.eu/energy/eu-buildings-factsheets_en
[46] Sandberg, Nina Holck; Sartori, Igor; Heidrich, et al. (2016): Dynamic building stock modelling: Application to 11 European countries to support the energy efficiency and retrofit ambitions of the EU. In Energy and Buildings 132, pp. 26–38. DOI: 10.1016/j.enbuild.2016.05.100

Table 2.11 – Overall market potential and ARV potential.

MARKET POTENTIAL		Year 1 (2025)	Year 2 (2026)	Year 3 (2027)	Year 4 (2028)	Year 5 (2029)	TOTAL in 5 years
	Construction Rate	**1.11 %**	**1.10 %**	**1.08 %**	**1.07 %**	**1.05 %**	
New	residential	2 443 165	2 409 880	2 376 594	2 343 308	2 310 023	**11 882 969**
	non-residential	435 227	429 297	423 368	417 438	411 509	**2 116 840**
	Renovation Rate	**1.26 %**	**1.26 %**	**1.27 %**	**1.27 %**	**1.28 %**	
Renovated	residential	2 762 707	2 773 359	2 784 010	2 794 661	2 805 313	**13 920 050**
	non-residential	492 150	494 048	495 945	497 843	499 740	**2 479 726**

ARV POTENTIAL		Year 1 (2025)	Year 2 (2026)	Year 3 (2027)	Year 4 (2028)	Year 5 (2029)	TOTAL in 5 years
New (#)	residential	122	241	594	820	1 155	2 932
	non-residential	44	64	127	188	247	670
Renovated (#)	residential	166	277	696	1 118	1 543	3 800
	non-residential	59	124	174	324	500	1 179
	TOTAL	391	706	1 591	2 449	3 445	**8 582**
% by Innovation Clusters		100 %	80 %	65 %	50 %	45 %	**4 764**
New (area, m2)	residential	11 219	22 132	54 565	75 322	106 074	269 312
	non-residential	277 697	410 870	810 390	1 198 560	1 575 379	4 272 895
Renovated (area, m2)	residential	15 223	25 470	63 919	102 662	141 699	348 974
	non-residential	376 820	788 068	1 107 533	2 064 716	3 188 592	7 525 728
	TOTAL	680 958	1 246 540	2 036 407	3 441 259	5 011 744	**12 416 909**

In summary, we estimate that, 5 years after the ARV project, a projected total number of about 8580 projects will be implemented with ARV innovations, for both residential & non-residential purposes, constituting a total area of about 12 417 000 m^2 of sustainable buildings which, ultimately, results in the total impacts described in EIC1-10.

ARV innovations will go beyond energy/cost reductions and direct CO2 savings. They will also enable energy flexibility to be commoditized and traded by the citizens as prosumers. Integration of flexible energy solutions in real-estate portfolios offers a new pathway to strengthen returns on energy retrofit financing. In ARV, we will leverage the benefits of energy positive neighbourhoods to create new incentives for citizens and financial service institutions to invest in energy efficiency via business model and financial instrument innovation, while considering regulatory and policy aspects.

The revenue stream and pricing model for the exploitable results will be based on the pricing of the individual solutions available in the e-market, combined with the necessary technical support, installation costs, and consultancy work. Therefore, predicting these values, at this stage, is difficult, as it is highly depending on: **i)** the extent of the renovations requested, which can range from minor to deep, **ii)** the level of technical expertise & time required to support the customer, **iii)** the specific challenges posed by e.g., geographical & / or architectural constraints, which could impact the final price per project, **iv)** geographical location and consequently cost per square meter. To perform a fair assessment of the pricing, we followed the EP report[47] on estimations of the renovation pricing, where the cost of minor renovations is €60/m^2, moderate renovations is €140/m^2, extensive renovations is €330/m^2 and nearly-zero renovations is €580/m^2. With the assumption that on average the users will perform moderate to extensive renovations (i.e., **€235/m^2** for residential buildings and **€124/m^2** for non-residential buildings), and that the price of new

Table 2.12 Business case for the ARV project.

		Average cost per project (€)	Total investment in ARV based projects in 5 years (M€)	Total revenues per total ARV partners & *e-market* companies in 5 years (M€)
New	residential	142 900	520	390
	non-residential	5 232 010	3 390	2 542
Renovated	residential	21 582	139	104
	non-residential	790 181	905	679
TOTAL			**4 953**	**3 714**

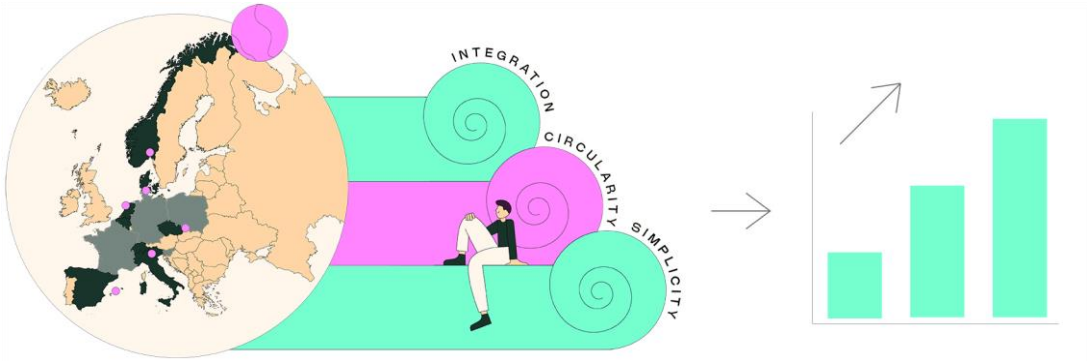
[47] https://www.europarl.europa.eu/RegData/etudes/STUD/2016/587326/IPOL_STU(2016)587326_EN.pdf

constructions would be on average **€1556/m²** (residential[48]) and **€820/m²** (non-residential[49]). Based on a conservative approach, for this forecast, the ARV consortium considers that, the ARV consortium will be able to capture 75% of the cost involved in renovation and new construction activities.

Based on these estimates, we can project a total aggregated revenue in 5 years of €3.7 billion for all the ARV partners and the companies within the ARV.

2.2.2.2 Commercialization Strategy & Routes to Market

Key exploitable results



ARV innovations (see table 1.7 in Section 1.4.2) **have the potential to be commercially exploited as products or services**, such as the 'Inside-Out energy façade modules', the 'Timber/bio-based plug-and-play modules', the 'LowEx system', the 'Digital Logbook for CPCC', the 'Circulation Booster', the 'Urban Energy Geostructure', the 'Green Security Token Offering (STO)', the 'Circular hub for optimized construction', the 'One-Stop-Shop for the large-scale renovation of urban areas', the 'iWell Cube', etc. The innovations will be commercialized together with technology and system providers in the ARV consortium. Service innovations routes to market will be paved in dialogue with energy service providers, real estate and building owner associations, and financing bodies. The municipalities and associations that are part of or associated with ARV will help to create an even larger pull in the market, further speeding up the transition towards CPCCs.

The six demonstration project clusters will, together with the ARV **Exploitation Board (AEB)**, be the key enabler and route-setters for market implementation and upscaling of ARV innovations. The AEB will ensure early identification and scalability of commercially viable innovations supported by the Innovation Manager (IM) and Innovation Management Board (T1.3). These groups will work together and liaise with possible partners and stakeholders outside the ARV consortium to identify the market for exploitable innovations. As ARV progresses, the AEB will work with partners and advise in developing Business Plans for exploitation. The associated partners of ARV will aid in further expansion of market for innovations. Through this pro-active approach, the consortium will identify and approach sources of private and public sector funding for follow-up developments after ARV ends.

WP1 and WP9 include tasks particularly addressed to achieve a successful and measurable exploitation, where the value for further use will be assessed, such as:

- The assessment of expected socio-economic impact of the knowledge and technology generated and the factors that would influence their exploitation (standardization, ethical or regulatory aspects, etc.)
- Detailed market study and uptake potentials and plan for internationalization and replication
- Financial opportunities and business models and technological implementation plan
- Methodology and strategy for an appropriated management of the knowledge generated in the project and IPR protection, according to the interest of the beneficiaries (T1.6)
- Analysis of the exploitation potential of the project results, reviewing all aspects from the point of view of potential investors, internal or external, and marketing people

[48] Manganelli et al, Sustainability 2019, 11, 249; doi:10.3390/su11010249

[49] https://zebra-monitoring.enerdata.net/overall-building-activities/average-cost-of-renovation-in-non-residential-per-m2.html#average-cost-of-construction-for-new-tertiary-buildings.html

- Analysis of transferability of the practices to the six jurisdictions as well as analysis of how to link revenue from flexible energy assets to the real-estate financing models to strengthen return potential
- Scale-up, level-up, mainstreaming of ARV through cooperative innovation, including replication profiles, feasibility studies, IP rights and market access.

An ***e-marketplace*** (D10.3) will aggregate, potentiate and exploit the ARV innovations. It will be launched on the ARV website as a ***one stop shop***, also serving as the main interface and contact point for all demonstration projects (current & future) targeting CPCCs, enabling virtual connectivity and collaboration, and acting as a communication and dissemination channel. It will serve as a database for all technology and service providers, as well as materials & local resources. The ARV e-marketplace will provide guidelines for end-users, links to different resources, information on product suppliers, software and datasets, as well as training material and technical guidance. The e-marketplace increases the potential for replicability, which will occur through the engagement from end-users and e-market members. This has advantages both for e-market members and to end-users of the proposed solutions.

Table 2.13 Benefits for *e-market* members and end-users.

Benefits for *e-market* members	Benefits for end-users of the proposed solutions
• Their products and services will be promoted under a seal of sustainability • Customers will find them without significant effort. • They will benefit from the synergistic approach the aggregated e-market enables. • The companies will benefit from increased visibility and market awareness. • The simple, integrative, and streamlined process is an incentive for end-users to adopt the solution. • The option for companies to sell their individual products enables targeting the DIY (Do It Yourself) market, which has a large market value and is represented by homeowners that undertake own stepwise renovations. These users are likely to be easily engaged to the ARV concept and integrative approach.	• End-users have access to a centralized shop, where they can find all the solutions for the full construction and/or renovation process. • The e-market platform connects the end-user to an educated project manager that will advise on the most efficient and appropriate solution, not for a specific component but for the whole project. • The process is highly streamlined and integrative, as opposed to fragmented stand-alone solutions. This will enable better services and faster installation times. • They will be directed to local stakeholders, that are able to target specific constraints of the relevant climate, geography, and architectural heritage. • End-users will benefit from the latest innovations in the respective fields, ensuring the best possible solution for a specific problem.

2.2.3 Research Data Management

ARV will generate many different types and forms of data. This will include reports, specifications, methodologies, processes, and energy data, to mention a few. Any data relating to the demo sites, *e.g.*, utility bills and metered data, will remain strictly the property of the demo sites and will only be shared with the permission of the demonstration site owner. Prior notice of any planned publication shall be provided to the Management Board at least 45 days before the publication. Any objection to the planned publication shall be made in accordance with the rules of the Consortium Agreement (CA). If no objection is made within the time limit stated above, the publication is permitted. For the avoidance of doubt, a Party shall not publish Foreground or Background of another Party, even if such Foreground or Background is amalgamated with the Party's Foreground, without the other Party's prior written approval. If any confidential information is provided for dissemination purposes or to the External Advisory Board (EAB) to gain valuable feedback for potential market exploitation, each member of the dissemination activity or EAB must sign a Non-Disclosure Agreement, assuring that they will not disclose the information to any third party. Relevant data protection acts will be complied with in full, and all personal data will be anonymized before it is used for academic research/commercial enterprise. In the following, we provide a brief analysis of the main elements of the ARV data management policy. The main elements comprise: ***(1)*** the type of data that will be collected, processed or generated, ***(2)*** the methodology and standards that will be used, ***(3)*** how this data will be exploited or shared and, finally ***(4)*** how it will be curated and preserved.

- Data set reference and name, identifier for the data set to be produced, and data set description
- Description of the data that will be generated or collected, its origin (in case it is collected), nature and scale and to whom it could be useful, and whether it underpins a scientific publication. Information on the existence (or not) of similar data and the possibilities for integration and reuse.
- Standards and metadata, and data sharing
- Reference to existing suitable standards of the discipline. If these do not exist, an outline on how and what metadata will be created.
- Description of how data will be shared, including access procedures, embargo periods (if any), outlines of technical mechanisms for dissemination and necessary software and other tools for enabling re-use, and definition of whether access will be widely open or restricted to specific groups. Identification of the repository

where data will be stored, if already existing and identified, indicating the type of repository (institutional, standard repository for the discipline, etc.).
- In case the dataset cannot be shared, the reasons for this should be mentioned (e.g. ethical, rules of personal data, intellectual property, commercial, privacy-related, and security-related).
- Archiving and preservation (including storage and backup)
- Description of procedures that will be put in place for long-term preservation of the data; indication of how long the data should be preserved, what is its approximated end volume, what the associated costs are and how these are planned to be covered.

ARV addresses the above-mentioned points, as part of the dissemination activities. In addition, the ARV Exploitation Board (AEB) and Innovation Manager IM will consider the additional guidance laid out and adapt where appropriate.

2.2.4 IPR / Knowledge Management and Protection

For the success of the project, it is essential that all project partners agree on explicit rules concerning IP ownership, access rights to any Background and Results for the execution of the project and the protection of intellectual property rights (IPRs) and confidential information before the project starts. Therefore, such issues will be addressed in detail within the CA between all project partners. The CA between all consortium partners will contain a description of each partner's role in the project and their expected contribution. Moreover, the CA will establish a legal framework for the project in order to provide clear regulations for issues within the consortium related to the work, IP-Ownership, Access Rights to Background and Results and any other matters of the consortium's interest. All partners have agreed to sign the obligatory CA in line with official Commission guidelines. The EM will be responsible for finalising the section on IPR in the CA. The CA will be finalized at the GA phase.

IPR management structure and process

The process for IPR management during the project has been designed to guarantee a structured process in place to identify, assess and protect the IPR generated throughout the project. At the centre of the IPR management process is the General Assembly (GA), which will oversee formulating the overall IPR strategy and ensuring compliance with Commission guidelines. Once the IPR strategy has been formulated and agreed upon by all partner representatives in the GA, the implementation of the IPR strategy will be handled by the EM.

Each partner is solely responsible for identifying the results that they generate in the project and report this to the AEB. Partners, in consultation with the AEB, are also responsible for carrying out a structured assessment process, including a thorough patent search, to determine whether foreground is best exploited via protection or through other means. Finally, if necessary, formalised license agreements with third parties may be implemented where this is deemed necessary to maximise exploitation of results, i.e., in geographical areas or market segments which the consortium is not able to service.

Principles for IPR ownership and access rights

As it will be described in detail in the CA, the partners preliminarily agree that the IP dealing with each of the main project results will be jointly owned by the partners involved in their development. If any Result is created jointly by at least two project partners and it is not possible to distinguish between the contribution of each of the project partners, such work will be jointly owned by the contributing project partners. Any joint Results, including inventions and all related patent applications and patents shall be jointly owned by the contributing parties. Details concerning jointly owned Results, joint inventions and joint patent applications would be addressed in the CA.

Patents application will be filed in any case where the requirements for inventive step and novelty seem to be fulfilled and there is industrial and commercial applications. Several partners in the consortium have previous experience in patent applications in their respective areas of expertise. The AEB and the Coordinator will draw upon this experience to ensure full compliance with EU and international rules and regulations on IPR. To ensure a smooth execution of the project, in the Consortium Agreement the project partners will grant each other and their affiliated companies, royalty-free Access Rights to their Background and Results for the execution of the project. This will allow the researchers the ability to execute the project to the best of their ability, without being hindered by administrative issues. The Consortium Agreement will define further details concerning the Access Rights for Exploitation to Background and Results.

Measures to provide open access to peer-reviewed scientific publications.

A central aim of this consortium is to provide benefit to the European community. Some of the project partners may be either using Open-Source code in their deliverables or contributing their deliverables to the Open-Source communities. Details concerning open-source code use will be addressed in the CA. The project budget includes Open Access Publication Fees to ensure research publications will have open access regardless of the journal, in

which they are published. Both open access publishing and self-archiving options will be considered (also called "gold" or "green" open access model, respectively).

2.2.5 Communication plan and activities

An effective communication strategy for the ARV project was designed based on a clear understanding of the complexity of the value chain as well as an assessment of non-technical barriers that are mainly related to the conservative nature of the construction sector and energy markets. The consortium will promote the project and its results, by providing targeted information to multiple audiences, in a strategic and effective manner and engaging in **one- and two-way exchange**. The communication activities will start at the outset of the project and continue throughout its entire lifetime. The overall goal is to create awareness among the public about the solutions designed by ARV and their relevance to our everyday lives. As well as raising the profile of ARV, and technical sciences in general, with the public, communication activities will also introduce students from schools and universities to science, research, and innovation.

The communication strategy will take into account **traditional communication activities** such as printed material, website, participation to exhibits and conferences in the field of construction, energy efficient buildings and new construction materials, as well as new methods such as **social networks, co-creation, virtual journeys and living labs (WP3)**. The most effective approach will be selected according to the specific target audience and to the message to be provided. To maximize the impact of ***communication activities***, a strategy was designed upfront, consisting of two main elements:

1) **a clear visual identity and solid marketing & communication plan** to ensure that the project becomes visible at multiple levels. The project will be established as an exemplary pioneer project in the EU.
2) **a targeted tailor-made local approach for each demo project CPCC, while supporting the co-creation process.** This is important to make local communities and local governments an active and integral part of the solution. Their active involvement will increase the chances of success and facilitate communication and dissemination efforts down the line. The ARV campaign will add a human face to this technical project by sharing the quantitative and qualitative evidence from the residents, by identifying Green Ambassadors and facilitating their training (WP3) so they can act as multipliers. Through the **demo sites**, ARV will analyse energy and environmental patterns and occupant behaviour. This creates a deeper understanding of local culture, climate, and markets, resulting in practical recommendations. The effective communication through multiple channels and media (online presence, newsletters, social media, audio-visual reports, conferences, etc.) and the creation of an active community of stakeholders, both online and offline, will ensure that all actions are well embedded in the spatial, economic, technical, regulatory, environmental, and social context of the project. The ***communication strategy*** has been delineated to ensure a high visibility of the project and maximize the impact of results. A distinct strategy will be designed for each specific ***audience***, using targeted ***messages*** and ***activities***, as described below:

Targeted Audience

The communication strategy has been defined to target different groups, namely:

- **Urban Authorities**: local councils and municipalities
- **Housing Community**: (associations of) homeowners, tenants (representatives), landlords, portfolio managers, housing co-operatives, social/public housing companies, etc.
- **Non-residential Community**: retail, care & health, education, hospitality, leisure, social services, and other commercial or public buildings.
- **Technology and Service Providers**: RES provider, storage technology, SME energy management, ESCO, Architecture, Engineering and Construction (AEC) Industry, green technology companies, etc.
- **Regulatory Authorities**: distribution network operator, transmission network operator, distribution systems operator, transport authority, planning bodies, etc.
- **Developers & Investors**: private & public sector banks, investment funds, institutional investors, ESCO etc.
- **Market Influencers**: policy makers at national and regional level, EU institutions (EP, DG ENER, CoR, EESC), World Green Building Council (WGBC), FIEC, CEER, ACER, EFIEES, Energy Cities, etc.
- Partners in relevant "Sister" projects under H2020 and other EU programmes.

These target groups will be the targeted by the communication activities to generate awareness about ARV project and concept exploiting the demo projects that will be used as a showcase through the organization of local workshops.

Communication activities

The communication and outreach plan/activities will comprise:

- **Communication Design (logo, forms, actions)**: A visual identity for ARV, including project logo, template, and forms for all relevant communication activities/documents, has already been produced by NTNU, and will be refined and included in the communication plan.
- **Visits to Living Labs:** ARV consortium will organize visits to the Living Labs (i.e. demo sites). We will organize visits targeting the general public, end-users, installers, public governance/government, societal partners, housing organization, etc. These visits will be held twice the first year of the project (to gain traction in communities) and once per year for the remainder of the project.
- **Seminars, Workshops, Open days and Visits:** The results will be presented for a broad audience at/by the universities and research institutes, namely through the organization of local seminars/workshops at each of the participating institutions targeting the general public. Young researchers and high school students will be particularly targeted. Hence, the consortium will organize visits to local high schools to inform the students about the project and encourage them to consider careers in science and technology, as well as invite high school communities for open days at universities. These arrangements will be sought held once a year in at least two schools in each country.
- **European Commission:** Publication of the results on the Commission's public websites. The consortium will provide periodic reports that include a publishable summary of such quality that the Commission can publish it right away in the public domain and will be understandable for a lay audience. The summary will include information on the expected results and their wider societal implications. The project research will be positioned within a broader socio-economic and policy context, so that it will be easier to explain the results and their relevance to policymakers and citizens.
- **Networking**: Active links will be established with European Institutions, International Organizations, Technical/administrative target groups, EU funded research projects, etc. These will be monitored, & ARV members will contribute to relevant events from other projects to share knowledge and results. This will be linked with the activities in WP10 on inter-project collaboration & clustering with "Sister Projects".
- **Media communication**: continuous public relation work, targeted communication and updates based on project partners´ news and project achievements, will be carried out. Brochures, short presentations, news articles, infographics, press kits, and policy briefs will be prepared and distributed. Brochures and other publications will be adapted in language and depth of detail depending on the different audiences: general public, possible replicators, authorities, local residents, and other close stakeholders. We will share stories from daily life that emerge through the project, helping the media better grasp the innovation and the importance of the ARV project for citizens.
- **Social networks**: Activate and manage, in collaboration with all project partners, dissemination actions through the most important social networks (LinkedIn, Twitter), and set up the ARV YouTube channel.
- **Informational Factsheet**: At the beginning of the project and at each reporting period a Factsheet will be produced to illustrate the project's progresses and deliverables. The Factsheet will be both printed and produced in electronic format (pdf). It is addressed to the target groups mentioned above and will have a schematic content.
- **Project result booklet:** A project result booklet, with a description of all the results achieved in ARV, will be developed (WP10).
- **Digital Newsletters**: Every 6 months the project will distribute a newsletter summarizing the main achievements during the period and will address the most relevant activities for the next periods.

ARV's website will collect information about these activities allowing common stream or collection of this information, newsletters, press releases etc., relevant to the project activities and partners. The ARV website will be updated throughout the project to inform visitors about upcoming events, news, and major project developments. All dissemination documents and public deliverables will be available in electronic format for download.

ARV's plan will also envisage ways of measuring communication efforts and impact at different stages of research. Indicators will be chosen to evaluate the impact (reaction or change) on the target audience.

Table 2.14 Summary of Initial Communication Plan

Goals	Target audiences	Key messages	Strategy
Increase of the share of positive energy buildings and communities	General public. Stakeholders from the target groups mentioned above, especially technology, energy and construction industry	Energy plus dwellings and neighbourhoods are becoming a reality	Show the evolution of ARV demo projects' performance indicators. Communicate the required conditions and solving barriers. Get involvement and green ambassadors. Regular updates on online dashboard linked to ARV Cloud Hub
Contribute to the reduction of GHG emissions	General public. All stakeholders from above mentioned target groups, especially public authorities at different levels	How PEB and PEDs and CPCC contribute to GHG reduction. Which measures and conditions are most cost-effective per $kgCO_2/m^2$ reduction.	Live update feed about GHG reduction in demo projects (compared to status quo & second best)
Improved indoor environment, leading to higher rate of users' satisfaction based on their demand and behaviour.	Residents (homeowners and tenants) Professional users of buildings	PEDs and CPCCs contribute both to GHG reduction and improved user satisfaction (in terms of IEQ, qualitative satisfaction, cost savings, and quality of living at community level)	Post occupancy surveys including measurements. Publications and presentations of projects reports, short video interviews
Similar or lower costs as compared to the 2020 nearly zero-energy buildings as an incentive to erect energy-plus-houses positive energy communities	Owners and managers of buildings (public, private and not-for-profit sectors). Public authorities (EU, national, regional, local). Financial stakeholders.	PEDs and CPCCs are no science fiction but a feasible option in terms of energy, CO_2 and cost savings while improving comfort of living.	Life cycle cost calculations featured in reports and other evidence for cost-effectiveness of PEDs and CPCCs approach through demo project results.
Accommodate learning, training and sustainable behaviour by engaging citizens in green living labs in local schools, community centres, and as informed users in public and private buildings	Citizens (end-users): Building owners, Tenants and citizens, Landlords, Associations (domestic cooperatives), Municipalities.	Climate Positive Circular Communities, where people can thrive and prosper for generations to come.	Establishing exhibition spaces for energy education, coaching to tenants in energy use through a Home Energy Management System (HEMS), appointment of "Green Ambassadors" among the tenants, support packages and training material for Living Labs
Achieving high architectural qualities by designing good spaces for people to live, work, and thrive	Construction / building sector (Potential E-market members), Citizens (End-users), Policy makers and regulators/ authorities	Environment-friendly, beautiful, safe, affordable living places & communities for all	Social media, short video series, podcasts and project booklet.

3. Implementation

3.1 Work plan — Work packages, deliverables

The ARV project will be divided in ten complimentary work packages as illustrated in the **PERT diagram** (right).

The timing of the different work packages and their components are given in the **Gantt chart** (next page).

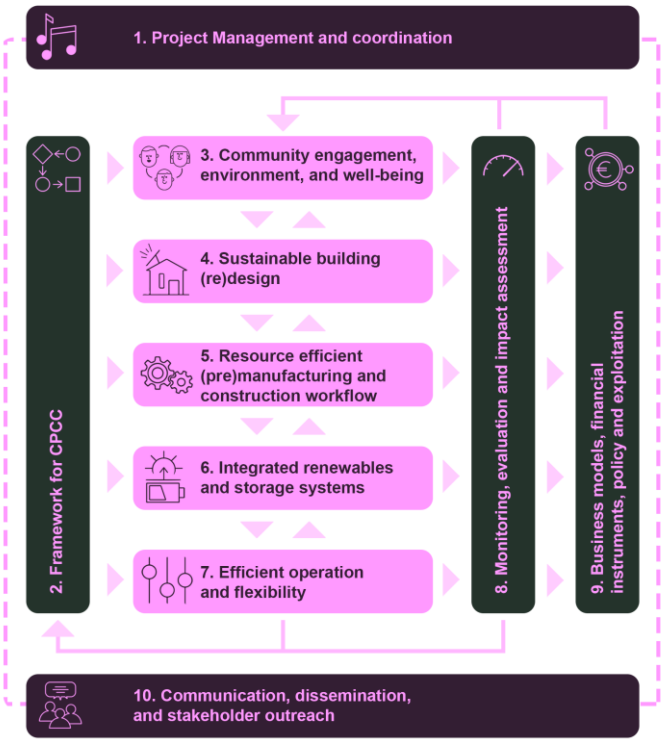


Figure 3.1. PERT Work package structure and interactions

GANTT

	Lead	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
WP1	**Project Management and coordination**																																																
T1.1	NTNU		D1.1, M1																																													
T1.2	NTNU											D1.2												D1.2												D1.2												D1.2
T1.3	NTNU					D1.3						D1.4						D1.3						D1.4						D1.3						D1.4					D1.3					D1.4
T1.4	NTNU		D1.5												D1.5												D1.5												D1.5							
T1.5	NTNU		D1.6												D1.6												D1.6												D1.6							
T1.6	NTNU		D1.7			D1.8									D1.7			D1.8									D1.7			D1.8								D1.7			D1.8					
WP 2	**Framework for CPCC**																																														
T2.1	IREC																																														
T2.2	IREC								D2.1, M2																																							D2.8
T2.3	IREC															M3		D2.2																												D2.4		
T2.4	IREC														D2.3																													D2.5				
T2.5	SINTEF																																			D2.6, M4												D2.7
WP3	**Community engagement, environment, and well-being**																																														
T3.1	SINTEF											D3.1												D3.1												D3.1												D3.1
T3.2	SINTEF									M5			D3.2																																		
T3.3	PALMA																							D3.3																								
T3.4	CVUT																								M6																								
T3.5	SINTEF																																															D3.5
WP4	**Sustainable Building (re) Design**																																														
T4.1	NTNU																																								D4.6							
T4.2	SINTEF											D4.1									M7			D4.1												D4.1											
T4.3	Housing Europe											D4.2									M7			D4.2												D4.2											
T4.4	IREC											D4.3									M7			D4.3												D4.3											
T4.5	CVUT											D4.4									M7			D4.4												D4.4											
T4.6	UNITN											D4.5									M7			D4.5												D4.5											
WP5	**Resource Efficient (pre)manufacturing and construction workflow**																																														
T5.1	Housing Europe																																														
T5.2	Housing Europe												M8											D5.1, M9																								
T5.3	UNITN																													M10					M11, M12												
T5.4	Housing Europe																																	D5.2, D5.8-D5.12, MS5.6												D5.3-D5.7

	Lead	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40	41	42	43	44	45	46	47	48
WP6	**Integrated renewables and storage systems**																																																	
T6.1	CVUT																																																
T6.2	SINTEF																				M 13																							D6.1						
T6.3	PZ																				M 13						D6.2																						
T6.4	UU																				M 13																								D6.3					
T6.5	CVUT																				M 13																								D6.4					
T6.6	EURAC																				M 13																											D6.5			
WP7	**Efficient operation and flexibility**																																																
T7.1	Center Denmark																																																
T7.2	Center Denmark																		D7.1																																
T7.3	CVUT																															D7.2																	
T7.4	ENFOR											D7.3						D7.4																																
T7.5	DTU																															D7.5																	
T7.6	NTNU																							D7.6								D7.7																	
T7.7	UU																																	M 14										D7.8					
T7.8	DTU																								D8.5																						D7.9			
WP8	**Monitoring, evaluation and impact assessment**																																																
T8.1	EURAC												D8.1																																				
T8.2	Center Denmark																		D8.2																															D8.3	
T8.3	NTNU																																																D8.4	
T8.4	EURAC																		M 15						D8.5																							D8.6	
T8.5	EURAC																																															D8.7, D8.8	
WP9	**Business models, financial instruments, policy and exploitation**																																																
T9.1	NTNU											D9.1												D9.1												D9.1												D9.1	
T9.2	GDFA						D9.2																																										
T9.3	GDFA																																			D9.3, M16						D9.4, M17						
T9.4	GDFA																																			D9.5								D9.6, M18			
T9.5	GDFA																																													D9.7		
WP10	**Communication, dissemination, and stakeholder outreach**																																																
T10.1	NTNU		D10.1																																														
T10.2	ACE							D10.2													D10.2																													
T10.3	HE			D10.3-10.4, M19-M20						D10.4									D10.4									D10.4										D10.4							D10.5						
T10.4	HE																																																
T10.5	HE																																														D10.7		D10.6	
T10.6	NTNU											D10.8												D10.8												D10.8											D10.8	

3.2 Management structure, milestones and procedures

The ARV management structure has been set up to effectively handle the complexity of the project and partner structures, and to clearly connect the responsible members of the various entities of the consortium. It is also designed to facilitate effective communication between the different partners and the managing bodies of the project and the European Commission. The management structure for the ARV project is illustrated in Figure 3.2 and the roles and tasks of the different management bodies are described below. The full procedure constituting the governance structure of the project, including representation in meetings, voting rights, etc., will be further outlined in the Consortium Agreement CA, based on the DESCA model for H2020 projects using the Module GOV LP.

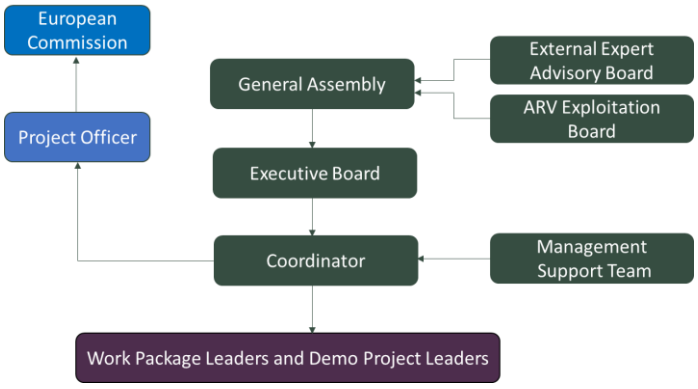


Figure 3.2. The main project management structure of ARV

The **Project Coordinator (PC)** and the **Project Management Team (PMT)**: As a beneficiary and coordinator in hundreds of European projects over the years, NTNU has accumulated extensive experience in the management and coordination of large, international research projects. As **PC**, NTNU will act as the intermediary between the beneficiaries and the European Commission. With the support of the **PMT** and the Financial Manager, it shall perform all tasks assigned to the coordinating institution as described in the Grant Agreement and CA. The tasks and duties of the PC and PMT are:

- Monitor the compliance of project partners with their obligations (assisted by the WP leaders);
- Act as a helpdesk for all beneficiaries for all project-related matters;
- Manage the continuous reporting, periodic reporting, quality assurance, and submission of deliverables to ensure that all documents/input are delivered on time and to the highest possible standard;
- Organize regular meetings of the Consortium and General Assembly, propose the agenda of those meetings, prepare the minutes and monitor the implementation of decisions taken; and
- Distribute the EU financial contribution to all beneficiaries.

The General Assembly (GA): is the ultimate decision-making body of the consortium. The PC will ensure that relevant decisions are discussed with the project officer and formalised in an Amendment to the Grant Agreement. The GA will decide on issues of strategic relevance, such as:

- Content, finances, and intellectual property rights (e.g. changes to the Description of Work DoW or Annex 2 of the Grant Agreement, changes to the CA)
- Evolution of the consortium (e.g. entry of a new- or withdrawal/termination of a -beneficiary)
- Appointments of members to the Executive Board

Composition: The GA consists of one senior voting member per beneficiary. Non-voting members from the beneficiaries may also be present during meetings. The voting members shall be deemed authorised to decide on the matters outlined above but will be advised to consult with their legal team on issues relating to IPR or changes to the consortium or budget. The PC will chair the meetings. The GA will receive important advice from the ARV Exploitation Board (AEB) and the External Expert Advisory Board (EAB). **Meetings:** Ordinary GA meetings, chaired by the PC, will take place at least once a year. The conditions for calling ordinary or extraordinary GA meetings will be described in the Consortium Agreement.

The Executive Board (EB): is responsible for the execution of the project. It will handle issues related to deliverables, completion of milestones, and critical risks. The EB shall propose solutions to such issues, to be voted on by the General Assembly. The EB may decide on minor issues that do not involve changes to the DoW or any of the voting items for the General Assembly outlined in the CA. To ensure transparency, the minutes of meetings shall be circulated among all beneficiaries. The EB will:

- Regularly collect information on the progress of the project to monitor the effective and efficient implementation of tasks, milestones, and deliverables

- Assist the coordinator in preparing meetings with the European Commission along with related data and deliverables.
- Propose decisions and prepare the agenda of the General Assembly meetings
- Be responsible for the proper execution of decisions of the General Assembly
- Agree on the content and timing of press releases and publications in accordance with Article 29 of the Grant Agreement

Composition: the EB consists of the Project Coordinator (PC), the Work Package leaders (WPL), and the Demo Project Leaders (DPL). **Meetings:** The EB will meet at least every 3 months, either physically in connection to consortium meetings, or online. Every 6 months a Project Performance Assessment (internal deliverable) will be conducted. The PC and the EB have the collective responsibility that the objectives of the project are achieved.

The Work Package Leaders (WPL) and the Demo Project Leaders (DPL): will work closely together to ensure the success of the project. In each of the thematic work packages, there will be a task entitled 'Innovation management of Work Package X', ensuring the coupling between the work in the WP and the demo projects. The WPL and DPL have a duty to report any major issues or delays to the Executive Board and General Assembly. The WPL and DPL will:

- Coordinate and plan the work in the work packages and the demo projects
- Monitor the progress of work in their work packages and demo projects and report to the EB
- Chair joint WP and Demo Project meetings and produce minutes from those meetings
- Alert the EB and GA of major issues, delays, or poor performance of a beneficiary or a demo
- Contribute to periodic reporting
- Identify IPR issues and opportunities and contribute to dissemination activities

Composition: The WP leaders are NTNU, IREC, SINTEF, NTNU, HU, CVUT, DTU, EURAC, GDFA, ACE. The demo leaders are HU, PALMA, OBF, PZ, KARV, and DTTN. **Meetings:** The WPLs and DPLs will organise common meetings in person or via web conference, as often as necessary.

The External Expert Advisory Board (EAB)

The EAB is a supporting body consisting of three internationally renowned external experts in main topics of the project. The selected experts are **Dr Ladeja Godina Košir**, **Founder & Executive Director of Circular Change**, Europe/Slovenia, **Dr Piotr Bartkiewicz**, **Professor at the University of Warsaw and partner of Go4Energy**, Poland, and **Dr Francis Allard, Emeritus Professor at La Rochelle University and chairman of Tipee**, France. The main task of the EAB is to provide guidance to quality of the project and to give feedback to the consortium on the overall progress of the project and its implementation. Through their respective networks, the EAB will also contribute to dissemination and wide scale uptake of ARV results. The EAB will be invited to consortium meetings on regular basis and may be invited to participate in the General Assembly (not having voting rights).

The ARV Exploitation Board (AEB)

An exploitation board will be established in T9.6 as a vehicle for scaling the business models and financing instruments. The Exploitation Board will be composed in part by strong innovation clusters as well as financial sector players that will spread the green building and renovation concepts to provide momentum to the 'renovation wave' that will be politically underpinned. The AEB is composed of industry experts selected from among the ARV partners and from influential external companies, to represent the whole value chain of CPCCs. The external members of the EAB are **Werner Jager, Director of Technology & Marketing in Hydro Building Systems**, Germany, and **Marianne Okland, CEO of Construction City Cluster**[50], Norway and **Dr Bruno Peuportier**, **Scientific Manager at the Centre for Energy Efficiency of systems CES**, France. The goal of the AEB is to contribute to enhancing the exploitation of ARV innovations, see Task 9.1 for a further description of their tasks. The AEB will meet regularly with the ARV Innovation Forum (Task 1.3) in order to ensure early identification and scaling of commercially viable innovations.

Innovation Management

Task 1.3 in WP1 will be dedicated to innovation management. The task will consist of all demo project leaders and work package leaders, led by an Innovation Manager (IM). The Innovation Manager will be hosted by NTNU using

[50]Construction City is an innovation cluster with a mission to drive collaboration and new solutions in the construction industry, www.constructioncity.no

the expertise of the NTNU Technology Transfer Office (TTO), which has extensive experience in working with innovation management and business models related to sustainable buildings and neighbourhoods through 15 years of experience and capturing more than 1800 ideas. Figure 3.3 shows an illustration of the structure of innovation management in the ARV project. In WP 1 (left) there is a task dedicated to innovation management (Task 1.3). The aim of this task is to ensure proper leadership of the demo projects aligned with the deliverables of the ARV project and the activities in the WPs (T1.3). The task participants encompass of the six demo project leaders (DPL), and is led by a representative of the PMT (NTNU). The DPLs will report on a monthly basis to NTNU on the progress of the demo projects, the status of the innovations, the compliance to and updates on the planning, potential problems and their potential solution. This will help keep track of the demo project status and relations. In addition, there will be a task in each WP (task 2.1, 3.1, 4.1, etc) dedicated to innovation management in each WP, linking the related work in the demo projects to the WPs.

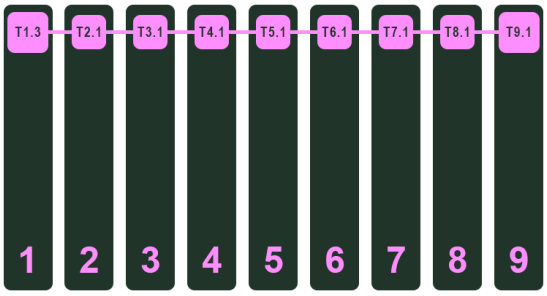
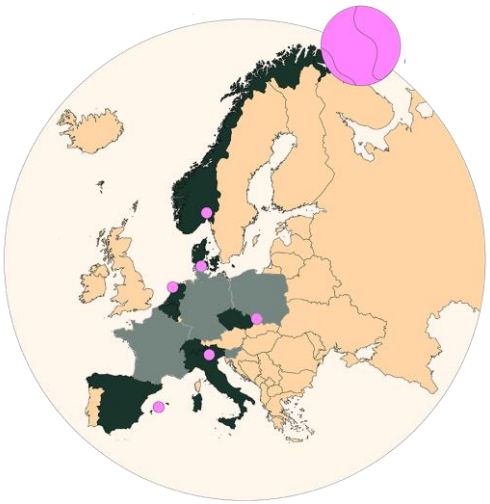


Figure 3.3. The link between activities related to demo projects and innovation management across the WPs.

3.3 Consortium as a whole

The **35 ARV partners** are carefully selected based on their experience, knowledge, and skills to contribute with outstanding innovations for Climate Positive Circular Communities (CPCCs). Together, they constitute the whole value chain of CPCCs, from planning, design, construction to operation and use of such communities. They also complement each other with respect to the knowledge, skills, products, and services they bring into the project, and they have wide reaching fields of impact and networks, which lay the ground for large scale market uptake of the ARV solutions. **11 of the partners are SMEs**. In addition to the 35 ARV partners in 8 countries, we have **38 associated companies and organisations** (confirmed by Letters of Support) **throughout Europe**, and the members of the Advisory & Exploitation boards are from France, Germany Poland and Slovenia, as indicated in the map. The partners, their role and contribution in ARV are described below.



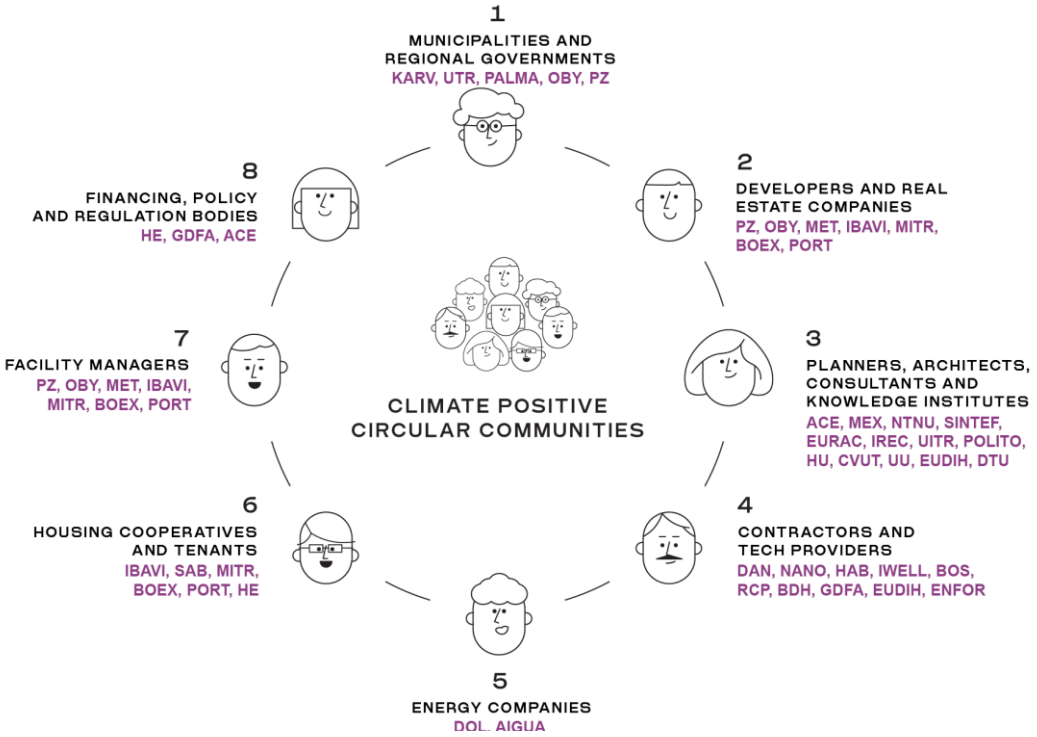


Figure 3.4 The ARV partners along the value chain of CPCC**.**

1) NTNU, the Norwegian University of Science and Technology (Knowledge institute) is the primary Norwegian university in engineering and technology, **will lead WP 1** on Project Management & Coordination **and WP 4** on Sustainable Building (re)Design. NTNU is contributing to all the WPs. NTNU has a professional administrative project support team to secure a high quality and a smooth project implementation. The NTNU team has extensive experience &knowledge in zero emission buildings and neighbourhoods (Leading ZEB Research Centre[51] and ZEN Research Centre[52] Sustainable Plus Energy Neighbourhoods, syn.ikia H2020[53]).	NTNU
2) The Architects' Council of Europe (ACE) represents the interests of over 600.000 architects from 31 countries in Europe. ACE consists of 44 Member Organisations. Having extensive experience from EU projects, ACE **will lead WP10** on Communication, Dissemination & Stakeholder Outreach & contribute to WP1–5, WP8 & WP9.	
3) Czech Technical university (CVUT) (Knowledge institute) in Prague is one of the oldest and largest technical universities in Europe. The ARV project will be carried out by the University Centre for Energy Efficient Buildings (CVUT UCEEB), which is a national centre of excellence in energy efficient and sustainable building. CVUT UCEEB will **lead WP 6** on Innovative Renewables and Storage Systems and the Czech demo case in Karviná.	ČVUT UCEEB
4) DTU, (Knowledge institute) the Technical University of Denmark **leads WP7** on Efficient Operation and Flexibility, with key members of DTU Compute, which have extensive experience in the digitalisation of energy systems. This DTU group was initiator of the concept of energy flexibility and had a central position within IEA Annex 67[54] in buildings and methodologies to use this flexibility to reduce CO_2 emissions and cost. The group has extensive experience in matching demand & consumption of energy in buildings & will contribute to WP2 & WP6.	DTU
5) Danfoss (DAN) has the headquarter in Sønderborg, DK, and is the largest Danish privately owned industrial company with 28.000 employees serving customers in more than 100 countries. In ARV, Danfoss will develop and demonstrate innovative solutions for heating control systems, both in hardware and software, with focus on reaching outstanding energy performance of the buildings. Danfoss will contribute mainly to WP7 with technical solutions reducing the return heating temperature from the buildings to the district heating network.	Danfoss ENGINEERING TOMORROW
6) ENFOR is a market-leading Danish SME of energy forecasting & optimization solutions for the energy sector. In ARV, ENFOR will provide solutions for forecasting of renewable energy production, electricity, and heat demand as well as optimization of district heating systems. ENFOR will primarily contribute to WP6 and WP7.	ENFOR
7) Project Zero (PZ) is a public-private-partnership to support the municipality of Sønderborg to become a ZERO carbon municipality by 2029 through offsetting 700.000 tons of energy-system related carbon-emissions. **PZ will be leader of the demo project in Sønderborg**, coordinating the activities & implementing energy-saving measures through retrofitting. PZ will participate in the implementation process and dissemination activities.	ProjectZero SØNDERBORG
8) EURAC Research is a private research centre with over 500 employees currently involved in 81 EU-funded projects. EURAC has a strong focus on renewable energies and the environment, but also on health, as well as political and social systems. In ARV, EURAC **will lead WP8** on Monitoring, Evaluation and Impact Assessment but will also contribute to WP3–5, among others.	eurac research
9) SINTEF, which is one of Europe's largest independent research organisations, **will lead WP3** on Community Engagement, Environment and Well-being. SINTEF's group has extensive experience and knowledge in working with stakeholder engagement and developing technologies for zero emission buildings and neighbourhoods working across themes like living labs, spatial planning, urban modelling, integrative energy efficient buildings and LCA. SINTEF is also contributing to WP1–8 and WP 10.	SINTEF
10) Palma City (PALMA) (Public authority) is the capital of the Balearic Islands (Spain) with a population of over 460,000. The main work in ARV is carried out by the City Model Department. It is supported by the Dept. for Housing, Dept. of Citizen Engagement, Environment Department and the Infrastructure Dept. PALMA is the **demo lead** in Spain. PALMA's contribution in ARV will focus mainly on WP2, WP4 and WP9.	Ajuntament de Palma
11) IBAVI, the Balearic Institute of Housing, has as a main goal to create and maintain accessible and affordable social housing. In ARV, IBAVI will contribute mainly to WP4, WP5 and WP8, which includes the integrated circular design and construction of the Spanish demo project.	IBAVI Institut Balear de l'Habitatge Govern de les Illes Balears
12) IREC, the Catalonia Institute for Energy Research, has extensive experience and expertise in sustainable development via new technological solutions and renewable energy technologies. IREC assists political decision-makers. In ARV, IREC **will lead WP2** on Framework and Tools for Effective Implementation and Assessment of CPCCs and mainly contribute with their expertise on integrated energy design on building and district level, business models for large-scale retrofits, citizen energy communities, and district & urban energy simulation. IREC will also lead the Spanish demo project.	IREC Shaping Energy for a Sustainable Future
13) Metrovacesa (MET) is one of the biggest real estate developers in Spain, working with residential and commercial developments, as well as land management. Especially regarding financing and business models, MET will contribute to ARV with their experience to promote the construction or renovation of energy efficient and sustainable buildings. MET will be mainly involved in WP3, WP7 and WP8.	metrovacesa
14) University of Applied Sciences Utrecht (UAS Utrecht) (Knowledge institute) brings in expertise on the transition to fossil free districts, healthy buildings, smart mobility and urban experience.UAS Utrechtmain focus is on integrating the different systems offered by ARV SME partners into energy & resource efficient retrofitting workflows.UAS Utrecht**will lead WP5** on Resource Efficient (Pre)Manufacturing and Construction Workflows	UNIVERSITY OF APPLIED SCIENCES UTRECHT

[51] https://www.zeb.no/index.php/en/
[52] https://fmezen.no/
[53] https://www.synikia.eu/
[54] http://www.annex67.org/about-annex-67/

15) Housing Europe (Housing Europe) is the European Federation of Public, Cooperative Social Housing, a network of 42 national and regional federations which together encompass about 41,400 public, social and cooperative housing providers in 22 countries, managing over 25 million homes which represent 12 % of the EU dwellings. In ARV,Housing Europewill be mainly involved in WP3 and WP10.	
16) Buro DeHaan (Buro de Haan) (SME) has experience in industrialisation and digitization for scalable renovation projects In the ARV, BURO DE HAAN will demonstrate pre-recognition of façade typologies and zero-engineering approaches (WP5) and contribute to in point cloud technology, engineering, image recognition and "file2factory" approach	
17) EU Digital Innovation Hub (CENTER DENMARK) is run by Center Denmark which is a non-profit & independent organization working to promote development of digitally integrated energy systems in order to enhance society's transition to 100 % RES and reduce environmental impact through digitalization and sector coupling. In ARV, CENTER DENMARK will demonstrate digital infrastructure for optimizing energy consumption & performance of buildings & neighbourhoods by using digital tools (AI) in WP7 and WP8.	
18) Sønderborg Andelsboligforening (SAB) is a non-profit independent and private social housing company owned by their residents (tenants). In ARV, SAB, as the host of the Demo project in Sønderborg, DK, will demonstrate new innovative energy saving measures in buildings, especially apartment buildings. SAB will involve the citizens/tenants in the project and disseminate the results to other social housing associations in Europe.	
19) Green Digital Finance Alliance (GDFA) is a non-profit organization that scales finance for the Paris agreement through fintech-enabled innovation. GDFA is a knowledge partner to the G-20 Working Group on Sustainable Finance and to the UN SG's Task Force for Digital Financing of the SDGs as part of its thought leadership work. In ARV, GDFA **will lead WP9** on Market Uptake to catalyze partner innovation by enabling them to deploy the new capabilities of fintech to address current barriers to scale green finance for carbon positive communities and to design standardized instruments for scaling across the EU.	
20) BOEX (Social housing corporation) has demonstrated in a previous project the first European Positive Energy Building retrofitting of a 10-story apartment building from the 60s and will offer their learning experience to the other Utrecht housing corporations. In the ARV project Bo-Ex will further apply the PEB retrofitting approach to 4-story mid-rise apartment buildings. Furthermore Bo-Ex will participate in the Smart Building and Smart Communities optimization activities using (BI)PV and battery storage	
21) RCP RC Panels (SME) is an innovative company offering prefab facades for zero-energy renovations. The main focus of RC panels is on integrating and demonstrating their façade panels into the energy and resource efficient retrofitting systems. RCP involved in the Dutch demo project will be most active in WP4 and WP5.	
22) Utrecht University (UU) (Knowledge institute) brings in expertise on the transition towards sustainable energy and resource systems, with special attention to integrating efficient use of energy and resources with renewable energy supply solutions, at various scales. Main focus in the ARV project is demonstrating the integration of renewables (BIPV primary) into the renovation systems and demonstrating a smart building and communities Virtual Power Plant for improved grid flexibility at various scales (building, district, city, country) WP6 & WP7	
23) Municipality of Utrecht (CITY OF UTRECHT) (Public authority) brings expertise on urban planning, citizen and community engagement and regulatory aspects. In the ARV project the Municipality of Utrecht will demonstrate social renovation, employment and energy coaching innovations and contribute to the energy and resource efficient retrofitting workflows where required.	
24) Bos Installatiewerken (BOS GROEP)(SME) has demonstrated in a previous project with Bo-Ex the Inside out retrofitting prototype and has vast experience in installation works. In the ARV project Bos will provide system engineering services for all building and installations components into modular components for quick mass customized production and retrofitting (WP4 and WP5)	
25) iWELL (SME) is a developer of smart energy storage systems. In the ARV project iWell will demonstrate the integration of stationary storage batteries as part of the smart building and communities' system to offer flexibility at grid flexibility at various scales (building, district, city, country) (WP6, WP7)	
26) MEX architects (SME) is an architect with experience in retrofitting of social housing apartment flats. In a previous project with Bo-Ex Mex has participated in the Inside out retrofitting prototype. In the ARV project Mex will provide innovative design services for integrating building components, active facades, BIPV into attractive and low resource designs (WP4 & WP5)	
27) Mitros (MITROS) (Social housing corporation) has demonstrated in a previous project Zero Emission Building Retrofitting and will offer their learning experiences to the other Utrecht housing corporations. In the ARV Mitros will prepare a retrofitting plan for PEB building retrofitting using low-temperature district heating, the specific focus of this activity is on setting up a modular ventilation, heating and cooling system. Furthermore, Mitros will participate in the Smart Building and Smart Communities optimization activities using (BI)PV & battery storage.	
28) City of Karviná (KARV) is located in the east of the Czech Republic on the border to Poland and has over 50,000 inhabitants. In ARV, the City of Karvina will mainly contribute with implementing CPCC living labs and involve citizens in WP3 and the implementation of storage solutions in WP6.	
29) DOL Dolomiti Energia is an Italian energy and gas supplier, with strong efforts in reducing environmental impacts thanks to the supply of 100% clean energy with traced and guaranteed origin, CO_2 free gas &innovative energy efficiency services designed specifically for families &for businesses. DOL's main role will be in WP3.	
30) Habitech (DTTN) – The Energy and Environment District promoted by the Autonomous province of Trento is the leading national center for green building, renewable energy, and innovation. DTTN promotes and coordinates	

integrated and innovative processes to improve buildings and real estate assets. In ARV, DTTN will lead the activities in the case study in Trento and will closely work with EURAC and UNITN, especially in WP4 and WP5.	
31) UNITN, the University of Trento, has outstanding experience with international projects as it has been involved in 117 FP7 and 119 H2020 research projects. In ARV, UNITN's Dept. of Civil Environmental & Mechanical Engineering will provide the scientific coordination for the prefabricated timber modular based approach, lab tests, technical surveys, and passive & active energy system design in WP4, WP6 and WP8.	UNIVERSITÀ DI TRENTO
32) Politecnico di Torino (POLITO), is one of Europe's leading universities in technical-scientific research and has exceptional experience with international research projects from FP7 and H2020. In ARV, the Department of Structural, Geotechnical and Building Engineering Department (DISEG) and the Department of Architecture and Design (DAD) will be involved. In WP4 and WP5, they will contribute to the design, installation and management of the energy tunnel (Piedicastello tunnel), innovative architecture & BIPV.	POLITECNICO DI TORINO
33) Oslobygg (OBF) is one of Norway's largest builders and real estate players with approx. 2.5 million m^2 of property and is owned by the municipality of Oslo. Their aim is to be at the forefront of sustainable and innovative solutions and technical. In ARV, OBY will be the **developer and leader of the Norwegian Demo** project and contribute mainly to WP3, WP4 and WP8.	
34) NANO Power is an integrator of transportation battery packs and energy storage systems which will contribute mainly to WP6 and WP7 to the potential usage of second life batteries, the optimization of battery performance vs. battery size targeting cost optimization and the possibility to reduce fixed energy costs.	NANOPOWER
35) AIGUASOL is an energy consultancy, engineering and research company based in Barcelona, working mainly with comfortable indoor and outdoor spaces, as well as efficient energy systems. In ARV, they are primarily involved in WP2 and WP4, focusing on using and testing tools for the implementation of CPCCs and integrating circular design in the Spanish demo project.	AIGUASOL

3.4 Resources to be committed

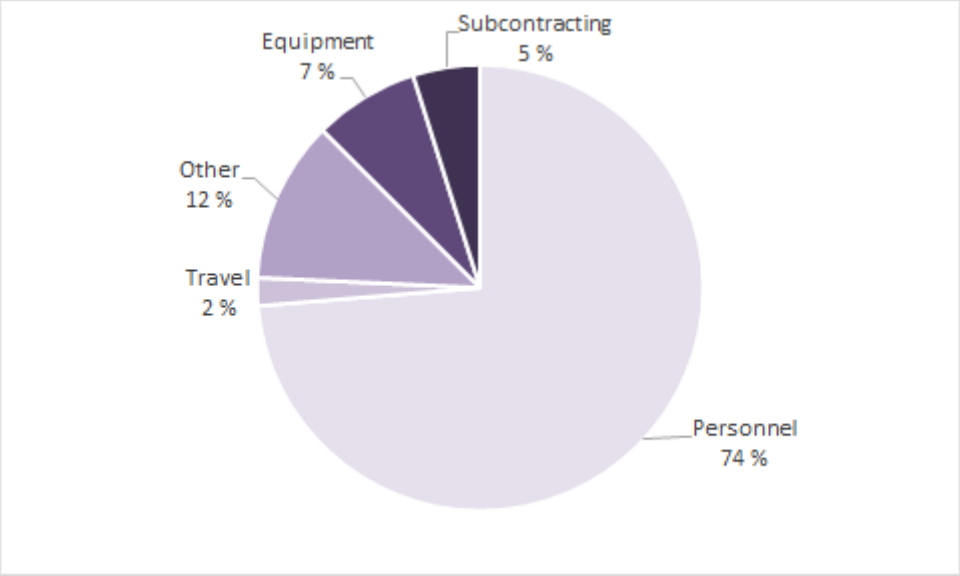


Figure 3.6. Share of direct eligible costs

The budget for total eligible costs for the ARV project is €21 316 652,68 with a **requested grant from the EU at €19 998 409,07**. Figure 3.6 shows the distribution of direct eligible costs.

The lion's share of the budget is for personnel carrying the work in the project, with 74% of the share. The second largest component is for other goods and services, with 12% of the share, which will cover materials and installations supporting the building activity in the project. Travel costs, which account for 2% of the share, are calculated according to an overall travel plan, using standard rates. Travel activity mainly includes beneficiaries' participation in project meetings and visits to demo sites for beneficiaries whose demos are located in different cities. There is a need to subcontract part of the work in task 2.5 for IREC, task 3.3 for BOEX, MITROS, PALMA, task 4.3 for RC Panels, task 4.4 for IBAVI, task 5.4 for BOEX, , task 7.5 PALMA, task 7.6 for BOEX, task 9.5 for CITY OF UTRECHT, as well as some work relating to training courses for PROJECTZERO and IT security for ENFOR. Subcontracting accounts for 5% of total direct eligible costs.

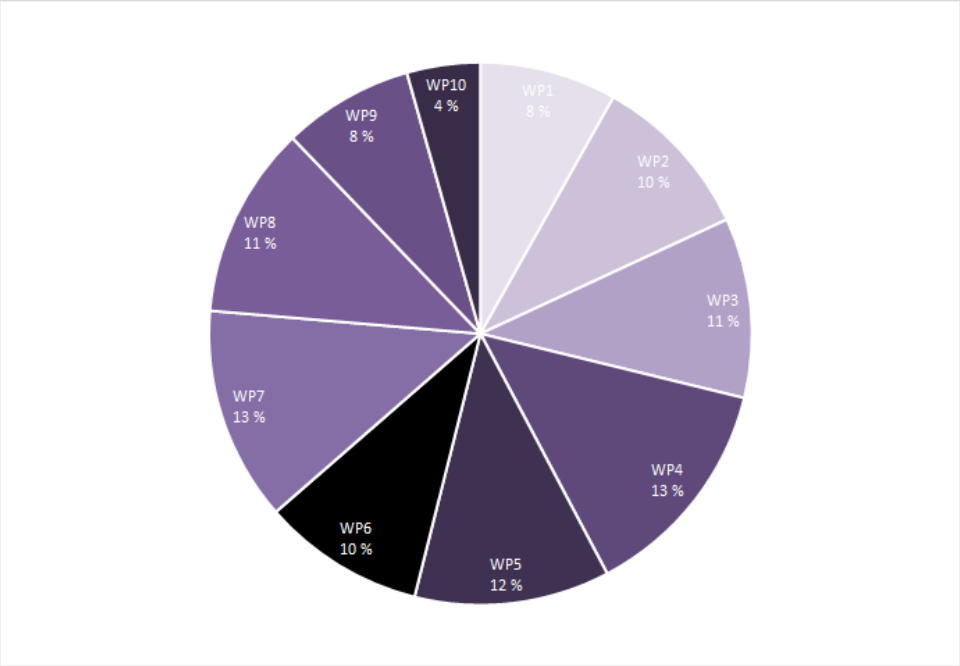


Figure 3.7. Share of PMs by WP

The allocated effort by WP is shown in Figure 3.7. The figure shows that the distribution of effort is even, with the exception of WP10, the work package for communication, with 4% of the effort. WP7 is the work package with the most effort, with 13%, while all the rest has between 8% and 12% of the effort each. NTNU has a larger budget than the other partners due to its integrative role, spanning almost all the WP topics: In table 3.4a the split of PM between WP and partners is shown, whereas in table 3.4b, the costs for the partners where costs for' travel', 'equipment', and 'goods and services' exceeds 15% of the personnel costs for that partner are shown. All depreciation costs for equipment, infrastructure or other assets in the project are in compliance with Article 6 and will be recorded in the appropriate beneficiary's accounts, purchased in accordance with Article 10 of the grant agreement and written off in accordance with international accounting standards and the beneficiary's usual accounting practices.

Table 3.4b: 'Other direct cost' items (travel, equipment, other goods and services, large research infrastructure)

02 – ACE	Cost (€)	Justification
Travel	10 000	Consortium meetings (1 person per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €5 000 total), other travels, e.g. conferences/workshops, policy events, stakeholder events, travels to demo sites (1 person per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €5 000 total)
Other goods and services	42 000	€15 000 for website, ICT infrastructure, cloud services, database and hosting costs, linked to subtask 10.3.1; €12 000 for 2 conferences for industry & civil society, linked to subtask 10.4.3; €5 000 for awareness raising events, linked to subtask 10.4.3; €10 000 for final conference, linked to T10.5
Total	52 000	

03 – CVUT	Cost (€)	Justification
Travel	15 000	Consortium meetings (1 person per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €5 000 total); other travels, e.g. conferences/workshops, policy events, stakeholder events, travels to demo sites (2 persons per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year per person, €10 000 total)
Other goods and services	428 500	€8 500 for software for online facilitation and data processing, linked to tasks 3.3 and 3.4; €9 000 for workshops, linked to tasks 3.2, 3.3, 3.4 €37 000 for building integrated swappable façade system with integrated RES, linked to subtask 5.4.4 €16 000 for local Peltier HVAC unit system, linked to subtask 5.4.4 €29 000 for second life battery energy storage system, linked to task 6.3 €13 000 for weather forecasting system, linked to task 7.4 €15 000 for indoor air quality monitoring platform, linked to task 8.2 €7 000 for outdoor air quality monitoring platform, linked to task 8.2 €4 000 for monitoring stations, linked to task 8.2 €41 000 for RES and storage energy system solution for building electricity needs - BIPV part, linked to T 6.3 €15 000 for green roof and rainwater management, linked to subtask 5.4.4

		€31 000 for RES and storage energy system solution for building electricity needs - BAPV part, linked to T6.3 €6 000 for EV charging system, linked to T 6.3 €70 000 for RES and storages energy system solution for building electricity needs – heating, linked to task 6.2 €74 000 for building energy management system (BEMS), linked to tasks 7.5, 7.6, 7.7, 8.1, 8.2 €14 000 for building shading system, T6.3 €35 000 for building energy management system - operation, monitoring and control, T 8.2 €4 000 for CFS audit
Total	443 500	

05 – DANFOSS	**Cost (€)**	**Justification**
Travel	9 250	Consortium meetings (1 person per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €5 000 total); other travels, e.g. conferences/workshops, policy events, stakeholder events, travels to demo sites (1 person per year for 4 years: flight (€750) + 1,25 nights on average * €250 per night gives €1 000 per year, €4 250 total)
Equipment	62 500	1 unit of prototype for circulation booster for domestic hot water at € 21 000, including installation costs. The technical equipment is a prototype and will have a depreciation period corresponding to the 2 years monitoring period in the project (linked to T6.3); 4x45 units of prototype for SOLO radiator thermostats/automatic at € 41 500 total, including installation costs: the technical equipment are prototypes and will have a depreciation period corresponding to the 2 years monitoring period in the project (linked to T6.3).
Other goods and services	35 000	To monitor the Danfoss SOLO thermostats multiple internet connection are needed and for this internet connection subscription is needed (linked to T6.3). This is budgeted to be €25 000. To interpret and conclude the data logs there could be need of specialized R&D consultants outside Danfoss A&S. This is budgeted to be €10 000 (linked to T6.3).
Total	106 750	

10 – PALMA	**Cost (€)**	**Justification**
Travel	15 000	Consortium meetings (1 person per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €5 000 total); other travels, e.g. conferences/workshops, policy events, stakeholder events, travels to demo sites (2 persons per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year per person, €10 000 total)
Other goods and services	123 600	Costs associated to the One-stop shop service (total €9 600), linked to task 3.3; catalogue of renovation solutions (total €10 000), linked to task 4.4; expositions, show-rooms, and materials for off-site educational and training actions, etc in the Energy Transition Living Lab - TE21 (total €25 000), linked to task 3.3; engagement campaign for CEC - Citizen Energy Communities (total €15 000), linked to task 3.3; harmonization and generation of GIS Data for Demo District from different data sources in unique common urban 3D-based tool (total €40 000), linked to tasks 2.3 and 3.3; IEQ multi sensors & electricity portable metering system (20 units at €1 000 each, total €20 000), linked to task 8.1; €4 000 for CFS audit
Total	138 600	

11 – IBAVI	**Cost (€)**	**Justification**
Travel	6 250	Consortium meetings (1 person per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €5 000 total); other travels, e.g. conferences/workshops, policy events, stakeholder events, travels to demo sites (1 person for 1 year: flight (€750) + 2 nights * €250 per night gives €1 250 total)
Equipment	9 900	Hybrid ventilation system control system and additional elements depreciated over the active use in the project, linked to task 4.4
Other goods and services	57 980	€45 000 for IEQ Sensors and comms for Monitoring and Evaluation, linked to task 8.3; €9 400 for external assistance for IEQ monitoring system, linked to task 8.3; €4 000 for CFS audit
Total	74 130	

13 – MET	**Cost (€)**	**Justification**
Travel	6 250	Consortium meetings (1 person per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €5 000 total); other travels, e.g. conferences/workshops, policy events, stakeholder events, travels to demo sites (1 person for 1 year: flight (€750) + 2 nights * €250 per night gives €1 250 total)
Other goods and services	64 000	€54 000 for monitoring and advanced control system for centralized services (HVAC + PV) in two multifamily buildings, linked to task 8.2; €10 000 for IEQ multi sensors, linked to T8.2
Total	70 250	

14 – UAS Utrecht	**Cost (€)**	**Justification**
Travel	21 250	Consortium meetings (2,25 person on average per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €11 250 total); other travels, e.g. conferences/workshops, policy events, stakeholder

		events, travels to demo sites (2 persons per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year per person, €10 000 total)
Equipment	70 000	Equipment costs for innovative plug-play integration of energy installations, depreciated over the active use during the project duration: to optimze the performance of facade elements (consisting of low-carbon materials and integrated energy installations), building materials and sensoring equipment, linked to T 4.3.
Other goods and services	4 000	€4 000 for CFS audit
Total	95 250	

15 – HOUSING EUROPE	**Cost (€)**	**Justification**
Travel	13 750	Consortium meetings (1 person per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €5 000 total); other travels, e.g. conferences/workshops, policy events, stakeholder events (1 person for 1 year: flight (€750) + 2 nights * €250 per night gives €1 250 total); travels to demo sites (1 person visiting 6 demos: flight (€750) + 2 nights * €250 per night gives €1 250 per demo visit, €7 500 total)
Other goods and services	49 800	€13 900 for dissemination and communication through printed materials, linked to subtask 10.3.3; €17 500 for online tools for web meetings, video interviews, video for the 6 CPCC demos, animation video, podcasts (COVID-proof measures), linked to subtask 10.3.3; €6 000 for 1 dedicated workshop per demo, linked to subtask 10.4.1; €6 000 for one targeted events to municipalities, linked to subtask 10.4.2; €5 000 for awareness raising events
Total	63 550	

16 – Buro de Haan	**Cost (€)**	**Justification**
Travel	6 250	Consortium meetings (1 person per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €5 000 total); other travels, e.g. conferences/workshops, policy events, stakeholder events, travels to demo sites (1 person for 1 year: flight (€750) + 2 nights * €250 per night gives €1 250 total)
Equipment	35 000	€35 000 for digitalization tools and datasets for the pre-recognition of facade typologies, linked to T5.2
Total	41 250	

18 - SAB	**Cost (€)**	**Justification**
Travel	3 250	Consortium meetings (1 person per year for 3 years: flight (€750) + 1 nights * €250 for 1,33 nights on average gives €1 082,5 per year, €3 250 total)
Equipment	54 000	Installation of demonstration equipment in 45 apartments, depreciated in project period. The 45 units at €1 200 each of technical equipment are prototypes and will have a depreciation period corresponding to the 2 years monitoring period in the project. Necessary to have 2 separate housing blocks with each 22 + 23 apartments to have a certain amount of monitored apartments with different kind of inhabitants, linked to task 6.3.
Total	57 250	

20 - BOEX	**Cost (€)**	**Justification**
Travel	6 250	Consortium meetings (1 person per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €5 000 total); other travels, e.g. conferences/workshops, policy events, stakeholder events, travels to demo sites (1 person for 1 year: flight (€750) + 2 nights * €250 per night gives €1 250 total)
Equipment	535 000	€250 000 of equipment costs for the design and demonstration of innovative elements of facade panels (bio-based / recycled material for facade panels and integrated systems for heating, ventilation, insulation, electricity), linked to tasks 4.3 and 5.4. Cost estimation breakdown: 1) Low-carbon biobased/recycled material for the production of prefabricated sandwich facade panels. Estimated costs: 50 dwellings x €2 500 EUR = €125 000 EUR total costs fully depreciated over project period. 2) Integrated energy installation equipment (tailor made energy installation equipment (pipes, cables, connectors). Estimated costs: 50 dwellings x €2 500 EUR = €125 000 EUR total costs fully depreciated over project period. €60 000 for the innovative BIPV panels to be installed at the demo-site buildings, linked to task 6.3; €100 000 for Home Energy Management System monitoring system, linked to task 7.4 and WP8; €50 000 for procurement of battery storage at apartment buildings, linked to task 7.6. 3) Equipment costs for innovative elements to integrate Hemubo and Inside Out renovation concepts, aimed at modular, plug-and-play energy and ventilation installation equipment. Estimated costs: 25 dwellings x € 3 000 EUR = € 75 000 EUR total costs fully depreciated over project period.
Other goods and services	4 000	€4 000 for CFS audit
Total	545 250	

27 – Mitros	**Cost (€)**	**Justification**
Travel	6 250	Consortium meetings (1 person per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €5 000 total); other travels, e.g. conferences/workshops, policy events, stakeholder events, travels to demo sites (1 person for 1 year: flight (€750) + 2 nights * €250 per night gives €1 250 total)

Equipment	176 000	1) €28 000 for integration of LT DH and related HVAC systems, linked to task 6.2; €48 000 for Home Energy Management System monitoring system, linked to task 7.4 and WP8; €25 000 for procurement of battery storage at apartment buildings, linked to T7.6. 2) Equipment costs for innovative elements to integrate Hemubo and Inside Out renovation concepts, aimed at modular, plug-and-play energy and ventilation installation equipment. Estimated costs: 25 dwellings x € 3 000 EUR = € 75 000 EUR total costs fully depreciated over project period.
Other goods and services	4 000	€4 000 for CFS audit
Total	186 250	

29–DOL	**Cost (€)**	**Justification**
Travel	5 000	Consortium meetings (1 person per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €5 000 total
Other goods and services	253 000	€210 000 for prototype of energy tunnel in the existing Piedicastello tunnel in Trento, linked to subtask 6.2.5: provision and installation of Radial BHE (€60 000), pipe circuit (€15 000), spritz and insulation (€20 000), safety and additional costs (€50 000), connection pipes to buildings (€40 000), support in design of the prototype (€25 000); €43 000 for NSGE floor slab thermal activation in new construction, linked to subtask 6.2.5: support in design of the prototype (€8 000), provision and Installation of pipes circuit (€12 000), workforce cost (€3 000), safety and additional costs (€10 000), provision and Installation of heat pumps (€10 000).
Total	258 000	

30– DTTN	**Cost (€)**	**Justification**
Travel	5 000	Consortium meetings (1 person per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €5 000 total
Total	5 000	

Linked third party to DTTN – X-LAM Dolomiti)	**Cost (€)**	**Justification**
Other goods and services	454 000	Prototype of timber based prefabricated, multifunctional and modular facades, testing of cladding, lab testing, linked to subtask 5.4.5 (€42 500). Prototype of new Positive Energy Building Construction, linked to subtask 5.4.5, 6.3.5: foundations set-up under direct supervision (€90 000), provision and installation of wooden structure (€255 000). provision of other systems, energy distribution systems, ICT, BEM, integration and safety (€ 62 500). €4 000 for CFS Audit.
Total	454 000	

Linked third party to DTTN – Fanti Legnami)	**Cost (€)**	**Justification**
Other goods and services	285 000	Prototype of timber based prefabricated, multifunctional and modular facades, testing of cladding, lab testing, linked to subtask 5.4.5 (€42 500). Prototype of new Positive Energy Building Construction, linked to subtask 5.4.5, 6.3.5: provision and installation of innovative façade 500m2 BIPV, green solutions, windows (€180 000), provision of other systems, energy distribution systems, ICT, BEM, integration and safety (€62 500).
Total	285 000	

34 – NANO	**Cost (€)**	**Justification**
Travel	5 000	Consortium meetings (1 person per year for 4 years: flight (€750) + 2 nights * €250 per night gives €1 250 per year, €5 000 total)
Other goods and services	30 000	€30 000 for second life battery storage system - batteries and hardware, linked to T6.3.
Total	35 000	

Section 4: Members of the consortium

4.1. Participants (applicants)

NTNU Norwegian University of Science and Technology	**1. Norges teknisk-naturvitenskapelige universitet NTNU | NO Norwegian University of Science and Technology**	
	Web site: www.ntnu.no **PIC number: 999977851**	**Number of employees: 7400** **Number of students: 42 000**

Brief description of legal entity/partner organization

NTNU is the largest university in Norway, with 14 faculties and 70 departments and divisions. NTNU has 42 000 students and more than 4 600 person-years in academic or scientific positions (41% women). The university uses its main scientific profile in technology and the natural sciences and its cross-disciplinary competency to meet global challenges, summarized by its vision: *Knowledge for a better world*. Three out of four Strategic Research Areas at NTNU – Sustainability, Energy and Health – contribute directly to sustainable urbanization, delivering creative innovations with far-reaching social and economic impact in close collaboration with cities, industry, authorities, and civil society. NTNU has a strong focus on international mobility and research training. 11% of its students and 41% of PhD graduates are foreign nationals, as well as about 1/3 of the academic staff. NTNU currently participates in 126 signed H2020 projects, 30% are coordinated by NTNU. In FP7, NTNU participated in 139 projects.

NTNU hosts a number of **national centres of excellence and national centres for research-based innovation**. Most relevant for this proposal are:

- **ZEN, Zero Emission Neighbourhoods in Smart Cites**, develops solutions for future buildings and neighbourhoods/areas that will contribute to realize a zero-emission society.
- **CenSES, Centre for Sustainable Energy Studies**, develops fact-based knowledge for strategic decisions relevant to government and industry. The focus is knowledge for a national energy policy, for national and international climate policy, and for strategies of innovation and commercialization.
- **CINELDI, Centre for Intelligent Electricity Distribution**, will ensure that we are building the smart energy system of the future. CINELDI will contribute to designing the future's flexible and robust electrical distribution grid at an acceptable cost. CINELDI will facilitate renewable energy, electrification of transport and more efficient use of energy.
- **HighEFF, Centre for an Energy-Efficient and Competitive Industry for the Future**, develops energy-efficient processes and components aiming at reducing energy consumption by 20-30% and greenhouse gas emissions by 10%. HighEFF will help ensure that Norway has the world's greenest industries.
- **HydroCen, Norwegian Research Centre for Hydropower Technology**, aims to ensure and develop research and education in hydropower-related technology. The centre provides the hydropower sector world-class knowledge and innovative solutions.

Contribution to Work Packages and Tasks in the project

NTNU is leading the ARV project and the **WP1 Project Management and Coordination**. NTNU will also **lead** the **WP4**. In WP4 NTNU is leading T4.1 Innovation forum on Integrated and Circular Design and contributes to Task 4.2, about the design and evaluation of the Norwegian Demo project. Moreover, NTNU will coordinate and facilitate the cooperation between all the tasks within WP4. NTNU is also contributing to all the WPs.

WP2. Framework and tools for effective implementation and assessment of CPCC: NTNU is contributing to innovation forum, the assessment framework of Climate Positive Circular Communities and the evaluation tools.

WP3. Community engagement, environment, and well-being : NTNU is contributing to the plan, the overall methodology for establishing CPCC Living Labs and the implementation.

WP5: NTNU is contributing to innovation forum of Resource Efficient (Pre)Manufacturing and Construction Workflows T5.1

WP6: NTNU is contributing to innovative renewables & storage systems tasks T6.1, T6.2 and T6.5

WP7: Efficient operation and flexibility. NTNU will contribute to the the flexibility functions and index, and the performance optimization. NTNU will lead Task7.5 on Deployment of methods for describing energy flexibility.

WP8: NTNU will contribute to all the tasks on Monitoring, evaluation and impact assessment

WP9: NTNU will perform an economic analysis of the long-term sustainability of some of the business models mentioned by GDFA and will lead sub-task in 9.3. NTNU will also lead the task on policy and regulations for the large-scale deployment of climate positive circular communities.

WP10: NTNU will have a substantial role in all the tasks. Dissemination, Communication and Stakeholder Engagement. Will lead T10.1 ARV visual identity and will contribute to all the tasks.

Profile of key personnel in the project

[redacted] [redacted](F) is a Professor in Integrated Energy Design at the Norwegian University of Science and Technology. She is also leading continuing education courses on Zero Emission Buildings. [redacted] was a leader of the research on pilot and demonstration buildi [redacted] the Research Centre on Zero Emission Buildings (www.zeb.no). She is currently involved in the research centre on Zero Emission Neighbourhoods in Smart Cities (www.fmezen.no), 2017-2024, where she has been the leader of the work on pilot projects and living labs. She is leader WP2 in syn.ikia H2020 on the development and demonstration of plus energy multi-storey apartment buildings. [redacted] has more than 20 years of experience from research and development within the fields of energy efficient buildings and renewable energy. She also has experience from consulting and construction practices. [redacted] has been engaged as a researcher at SINTEF Building and Infrastructure, she has been an environmental manager at LINK architecture, and an energy advisor at Skanska Norway.
E-mail: [redacted]

[redacted] [redacted] (M) is a Professor in Building Physics and Director of the Research Centre on Zero Emission Neighbourhoods in Smart Cities (ZEN Research Centre) at the Norwegian University of Science and Technology (NTNU). The ZEN Research Centre has 32 partners from the building industry and energy sectors, as well as governmental organizations and municipalities. Our goal is to develop solutions for future buildings and neighbourhoods with no greenhouse gas emissions and thereby contribute to a low carbon society. [redacted] holds a MSc degree in environmental physics and a PhD degree in building physics. He has written and contributed to 100+ articles and has a h-index of 27. His research interests include zero emission buildings and neighbourhoods, energy use in new and existing buildings, heat, air and moisture transfer in building envelope systems, as well as development and application of new building materials. [redacted] is also project manager for the development of a large-scale research infrastructure on zero emission buildings (1800 m^2 office living laboratory), and Director of the Research Centre Zero Emission Buildings. Previously he worked as a senior research scientist at SINTEF Building and Infrastructure and visiting researcher at Lawrence Berkeley National Laboratory (LBNL).

[redacted] [redacted] (F) is Associate Professor in Integrated Energy Design at the Department of Architecture and Technology at the Norwegian University of Science and Technology, NTNU. She has more than fifteen years of experience in energy efficiency and sustainable design strategies from building to neighbourhood and city scale. Her expertise relates to the energy performance of buildings, the integrated energy design, the zero-emission neighbourhood concepts, the positive energy districts, the urban and building physics and climate-resilience of the built environment. [redacted] has authored 64 publications of which 22 articles in peer-reviewed scientific journals with high impact factors which have received 1094 citations (h-index is 12). She aspires to contribute towards the transfer of technological progress achieved in sustainable architecture and engineering to applications that pave the way to a low carbon, energy-efficient and resilient built environment. With an active role in more than twenty EU funded research projects (RIA, IA, CSA, and MSCA ITN), [redacted] is the Project Leader of [redacted] (IA) and Leader of Subtask D in the IEA EBC-Annex 83-Positive Energy Districts.
E-mail: [redacted]

[redacted] [redacted] (M) is a Professor in Architecture and teaches within the international master programme of Sustainable Architecture at NTNU Faulty of Architecture and Design. His main teaching and research interest are within sustainable architecture and neighbourhoods (zero emission buildings and neighbourhoods). He has a special interest in passive energy design where the architecture itself responds to the climate and utilise passive strategies to achieve zero emission and plus energy buildings and neighbourhoods. [redacted] has a background from research within the field of low energy architecture (8 years at SINTEF) where he led and participated in several national and international research project, amongst them the EU projects RetroKit (FP7) and Cohereno (IEE). He has also worked as a consultant in the private industry (8 years) and led a large architectural office (3 years) were he was responsible for several low energy and plus energy buildings within the fields of education, health and housing.
E-mail: [redacted]

[redacted] (M) is a Senior Researcher at IØT-NTNU, working in four H2020 projects: SET-Nav (WP lead), INVADE (task contributor), +CityxChange (tasks contributor and lead), and Open ENTRANCE (WP lead). He also works as an advisor and research scientist in the Smart Distribution Grids group at SINTEF-Energy (Norway). Prior to this, he was working at ETH Zurich (Switzerland). There, he supported the research work and management of two multi-disciplinary flagship projects focused on electricity market design and combining energy-economic models. He holds a PhD in Operations Research from Lancaster University (UK) and a M.Sc. in Systems Engineering and Operations Research from The George Washington University (USA). His main research topics include smart grids and distributed generation, energy storage, applied stochastic programming, and energy-economic systems model integration to analyze the energy transition.
E-mail: [redacted]

[redacted] (F) is a Professor at the EPT at NTNU. She has strong district heating, energy planning, building energy monitoring, building simulation, optimization, and fault detection. She is a member of the Outstanding Academic Fellowship Programme at NTNU hat focuses to qualify some of our foremost young research talents for nternationally leading research careers. She has been a project leader for wo research projects, one Horizon 2020 MSCA-IF, several collaboration nd industry related projects, and a project on innovative teaching. Some of her projects were focusing on performance and control analysis of heat pump and energy supply systems for buildings. All these have given her lots of practical experiences and ideas about innovations related to heat pump implementation and energy supply systems for buildings. Further, in the NTNU/EPT laboratory, the entire CO_2 heat pump plant and the heated room has been initiated and developed by her together with the NTNU/EPT laboratory engineers. Until now, [redacted] has been the main supervisor for more than 45 MSc students, two completed PhD students, five on-going PhD students, and four Postdoctoral Fellow (two completed and two on-going). She is the main or co-author of 39 journal papers and has Scopus h-index 16. She is reviewer for more than 10 relevant journals and has been evaluator of the research proposals in Italy, Kazakhstan, Australia, Singapore, and Sweden.
E-mail: [redacted]

[redacted] (M) is an Associate Professor and leader of the strategic area "Solutions for Smart cities" at The Department of Civil and Environmental Engineering (IBM) at the Norwegian University of Science and Technology (NTNU). He has 15 years of experience in research, consultation, and teaching, within the field of integrated building design within climate-neutral smart cities. He is expert in simulation and optimisation for early decision support. He has developed several methodologies and indicators for quantifying the building performance where building envelopes, HVAC systems, renewables, and flexibility assets are interacting. His toolbox includes building performance simulation (BPS), building automation systems (BAS), multi-objective optimisation (MOO), life cycle cost analysis (LCCA), and building information modelling (BIM). During his carrier, he has participated in developing two in-house simulation-based optimisations tools: MOBO and OptnZEB-I. As an academic author/co-author, [redacted] has published 28 peer-reviewed journal papers, 4 book chapters, 22 conference articles till now. He has 2030 citations, h-index: 18, and i10-index: 25. As a project leader/partner, [redacted] is a partner in ZEN Center and ENERSENSE group (a strategic research area with a focus on the nexus of energy efficiency, energy storage and sensor technologies, including automation). [redacted] is an active member of the International Energy Agency – Energy in Building and Communities program (IEA EBC) and a partner in the H2020 projects TRAN-URBAN-EU-CHINA and QUANTUM. Otherwise, he is a steering committee and advisory board

member for the research projects: "OCCuPANt" funded by the University of Liège, Council for Research and Development. [redacted] is also a collaborator in the project "The optimal transitions from interactively-isolated systems to the mutually-integrated unity between zero-energy building(s) and zero-energy vehicle(s)", funded by the Hong Kong Polytechnic University, University Grants Committee (UGC).
E-mail: [redacted]

[redacted] (F) is a Post-doctoral Fellow at the ZEN Research Centre at the Norwegian University of Science and Technology (NTNU) and researcher at the Department of interdisciplinary studies of culture, NTNU. [redacted] is a social anthropologist whose main field of research is the interaction between people and the physical and technical environment. Her research is interdisciplinary engaging with energy research, STS studies and architecture. Current research focuses on the sustainable transition and implications for the good life through the design and use of experiments in living labs located in nine ZEN pilot neighbourhoods in Norway. [redacted] has also worked with a long-term residential experiment in **ZEB living lab .** Where the impact of zero emission technology on domestic routines and home-making strategies was studied. [redacted] has published widely in international journals. She has also participated in international conferences within the fields of social science and energy research. [redacted] has extensive experience in projects funded by the Norwegian Research Council and EU (CommonEnergy, Retrofit, EcoCity).
E-mail: [redacted]

Relevant publications, and/or products, services, or other achievements

Publications (recent 10):

1. Resch, E.; Andresen, I. (2018). A Database Tool for Systematic Analysis of Embodied Emissions in Buildings and Neighbourhoods. Buildings, vol. 8 (106).
2. Wiik, M.R.K.; Fufa, S.M.; Kristjansdottir, T.F.; Andresen, I. (2018). Lessons learnt from embodied GHG emission calculations in zero emission buildings (ZEBs) from the Norwegian ZEB research centre. Energy and Buildings, Vol. 165.
3. Homaei S., Hamdy M. (2020). A robustness-based decision-making approach for multi-targets high-performance buildings. Applied Energy, Volume 267, 2020, 114868, ISSN 0306-2619
4. Mariño S., Eguia P., Grandaa E., Hamdy M. (2020). Performance Comparison of Multi-Objective Optimization-based approaches for Calibrating White-box Building Energy Models. Energy and Buildings, Volume 216, 2020, 109942, ISSN 0378-7788, see
5. Schönfeldt Karlsen S., Hamdy M., Attia S. (2020). Methodology to assess business models of dynamic pricing tariffs in all-electric houses. Energy and Buildings, Volume 207, 2020, 109586, ISSN 0378-7788, see.
6. M. Rabani, H. B. Madessa, O. Mohseni, N. Nord (2020). Minimizing delivered energy and life cycle cost using Graphical script: An office building retrofitting case, Applied Energy, Volume 268
7. Woods, Ruth; Berker, Thomas. (2019) Living labs in a zero emission neighbourhood context. IOP Conference Series: Earth and Environmental Science (EES). vol. 352 (1).
8. Zepter, J. M., Lüth, A., Crespo del Granado, P., Egging, R., (2019). Prosumer integration in wholesale electricity markets: Synergies of peer-to-peer trade and residential storage. Energy and Buildings, Vol 184.
9. J. Brozovsky, N. Gaitani, A. Gustavsen (2020). A systematic review of urban climate research in cold and polar climate regions, Renewable and Sustainable Energy Reviews, https://doi.org/10.1016/j.rser.2020.110551

10. How to define (net) zero greenhouse gas emissions buildings: The results of an international survey as part of IEA EBC annex 72. Building and Environment. Volume 192, April 2021, 107619D.Satola M.Balouktsi c T.Lützkendorf A. HoulihanWiberg A.Gustavsen .

Products and services:

Zero Emission Building Definition – A Life Cycle Approach to planning, design and construction of Zero Emission Buildings.

The NTNU Research Team has contributed to realization of **8 real-life zero emission demonstration buildings** in Norway (http://www.zeb.no/index.php/en/pilot-projects), through the Research Centre on Zero Emission Buildings. They include detached houses, office buildings, and educational buildings. The ambition level for several of the ZEB demos are higher than the plus energy level, since the balance also include embodied emissions from materials.

Contribution to **definitions of Plus Energy Buildings and Plus Energy Neighbourhoods** to FutureBuilt (www.futurebuilt.no) and Oslo Municipality (https://www.oslo.kommune.no/).

Project and activities

1. The **ZEN Research Centre** has 32 partners from the building industry and energy sectors, as well as governmental organizations and municipalities. Our goal is to develop solutions for future buildings and neighbourhoods with no greenhouse gas emissions and thereby contribute to a low carbon society.
2. The **ZEB Research Centre** with 21 partners from the building sector. Activities included development of new advanced building materials (e.g. insulation materials, electrochromic materials, low emissivity coatings, and phase change materials), smart building envelope systems, and new ventilation systems/membranes for better indoor air quality.
3. National projects (Research Council of Norway) in development, modelling and simulation, and testing of advanced building envelope systems – SkinTech (2016-2019), ReInVent Windows (2017-2021).
4. Large scale infrastructure project funded by the Research Council of Norway on ZEB Laboratory (a 1800 m2 office buildings to investigate plus energy and zero emission building technologies and user/worker-technology interaction).

Relevant ongoing and previous projects

ZEN Research Centre on Zero Emission Neighbourhoods in Smart Cities (Centre for Environment-friendly Energy Research funded by Research Council of Norway + industry), 2017-2024_The Research Centre ZEN, hosted by NTNU, aims to enable the transition to a low-carbon society by developing solutions for future buildings and neighbourhoods/areas that will contribute to realize a zero-emission society. The ZEN Research Centre has the laboratory facilities ZEB Test Cell Lab, ZEB Living Lab and 9 large-scale demonstration projects in Norway.

syn.ikia H2020 project/ Sustainable Plus Energy Neighbourhoods, funded by EU, coordinated by NTNU. The syn.ikia innovation project within the EU Horizon 2020 framework involves 13 partners from six countries and aims to enable the development of sustainable plus energy neighbourhoods in different climates, contexts and markets in Europe. Over the course of the project, four real-life plus-energy demo neighbourhood projects tailored to four different climatic zones will be developed, analysed, optimized and monitored, demonstrating the functionality of the plus-energy neighbourhood concept for the rest of Europe.

+CityxChange (H2020, Smart Cities and Communities), 2018-2023. NTNU coordinates the 32 partners in the project. Lighthouse Cities are Trondheim, Norway, and Limerick, Ireland.

ECHOES – Energy Choices (H2020) focuses on consumer/prosumer energy behaviour and supports the Energy Union and the SET Plan. Coordinated by NTNU.

INVADE (H2020) focuses on smart system of renewable energy storage based on integrated EVs and batteries to empower mobile, distributed and centralised energy storage in the distribution grid. NTNU is WP leader.

EERA JP Smart Cities, chaired by NTNU. In EERA JP Smart Cities, universities and research institutes from across Europe cooperate with industry, cities and citizens to support innovation and demonstration projects with knowledge-based experimentation, applied and fundamental research, to deliver quality and impact, and to ensure scalability and replicability of locally developed and tested solutions/processes. Building on the experiences from H2020 smart city lighthouse projects, and corresponding national/regional initiatives, EERA JP Smart Cities plays a defining role in the European research and innovation landscape on smart cities, as key drivers towards a climate-neutral Europe and world.

SET-Nav - Navigating the Roadmap for Clean, Secure and Efficient Energy Innovation, started in April 2016 and is co-funded by the EU Horizon 2020 programme. The project intends to support strategic decision making in Europe's energy sector, enhancing innovation towards a clean, secure and efficient energy system.

ZEB Research Centre on Zero Emission Buildings (Centre for Environment-friendly Energy Research funded by Research Council of Norway + industry), 2009-2017

QUANTUM (Quality Management for Building Performance), was a four year-long project from Jan. 2016 to Dec. 2019. The goal of the project was to develop and demonstrate pragmatic services and appropriate tools with high replication potential supporting quality management (QM) for building performance in the design, construction, commissioning and operation phase as a means to close the gap between predicted and actual energy performance in European buildings.

Significant infrastructure and/or technical equipment

NTNU has laboratory facilities that can be used in this project:

ZEB Living Laboratory

The ZEB Living Lab is a multipurpose experimental facility built by Zero Emission Buildings, Faculty of Architecture and Fine Arts, NTNU. The Living Laboratory is a test facility that is occupied by real persons using the building as their home. The focus is on the occupants and their use of innovative building technologies like intelligent control of installations and equipment, interactive user interfaces and interplay with the energy system as a whole. A highly flexible plus energy dwelling. This laboratory is a 100 m2 large regular residential building, but highly flexible, instrumented and controllable. Typical experiments include user-technology interaction (e.g. Graphical User Interfaces), testing of energy flexible operation (e.g. model predictive control and self-consumption

of renewable energy), and testing of various (interaction between) renewable energy sources (PV, solar thermal and heat pump are installed).

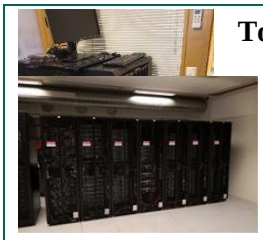
ZEB Test Cell Laboratory for research and development of plus energy and zero emission/energy building technologies. The Test Cell Laboratory is used for testing low-energy, integrated building systems under realistic operational conditions. The Test Cell can be divided into two smaller chambers that can be used to compare different technologies. The Test Cell Laboratory is a technical development facility where different elements of building materials, building envelopes, energy installations and control systems are developed and optimized together.

ZEB Office Living Laboratory

The **ZEB lab** is a laboratory for zero emission buildings, an arena where new and innovative materials and solutions are developed, investigated, tested and demonstrated in mutual interaction with people. The building includes systems like building integrated photovoltaics (BIPV), phase change materials (PCM), heat pumps, a highly flexible control system, possibilities for model predictive control, a combined mechanical and natural ventilation system. Systems can be changed/adjusted in the various experimental setups.

The **Advanced Materials and Component Laboratories** are used for both development and research on building materials, building envelope components (such as smart facades), technologies for energy supply (for example building integrated photovoltaics) and building services like for instance ventilation systems. The most important laboratories are: Large Scale Vertical Building Envelope Climate Simulator, Accelerated Climate Ageing Laboratory, Climate Exposure Laboratory, Building Component and Structure Thermal Performance Laboratory, Rotatable Hot-Box Apparatus, Advanced Spectrometer Laboratory, and Advanced Materials Technologies Laboratory.

e-Infrastructure (Hardware)



To facilitate computational tasks (i.e., simulation and data-analysis tasks)

NTNU has its own super-computers, located in air-conditioned rooms, in most of its departments. The figure shows one of the super-computers at the Department of Civil and Environmental Engineering at NTNU. In addition, huge computational power of approximately 85 million CPUs is available via national high-performance computing (HPC) systems. For instance, the HPC system ''SAGA'' which is operated under auspice of UNINETT Sigma2 AS. The SAGA provides several computational cloud-serves (i.e., parallel computing and data storage) and it is located in the datacentre called Valhall at NTNU.

e-Infrastructure (Software). To facilitate computational tasks (i.e., simulation and data-analysis tasks), NTNU has a set of licentiate software packages including:

- IDA ICE Expert 4.8: IDA Indoor Climate and Energy (IDA ICE) is a new type of simulation tool that takes building performance to another level. It accurately models the building, its systems, and controllers – ensuring the lowest possible energy consumption and the best possible occupant comfort.
- BesignBuilder Pro v6: DesignBuilder Packages for Engineers are an integrated set of high-productivity tools to assist with sustainable building design and gain credits with environmental schemes such as LEED and BREEA.M. Leading services engineers and energy modellers use DesignBuilder to make design choices that optimise energy efficiency, comfort and cost.
- HOMER Pro: The HOMER Pro® microgrid software by HOMER Energy is the global standard for optimizing microgrid design in all sectors, from village power and island utilities to grid-connected campuses and military bases. Originally developed at the National Renewable Energy Laboratory, and enhanced and distributed by HOMER Energy, HOMER (Hybrid Optimization Model for Multiple Energy Resources) nests three powerful tools in one software product, so that engineering and economics work side by side.
- MATLAB: MATLAB® combines a desktop environment tuned for iterative analysis and design processes with a programming language that expresses matrix and array mathematics directly.
- ModeFrointier: The comprehensive solution for process automation and optimization in the engineering design process. modeFRONTIER modular environment is key to reduce complexity, improve efficiency and cut development time.

Operational capacity of legal entity/partner organization

n/a

	2. Architects' Council of Europe **ACE | BE** **Conseil des Architectes d'Europe**
	Web site: www.ace-cae.eu **PIC number: 924742517**
	Number of employees: 8

Brief description of legal entity/partner organization

The Architects' Council of Europe (ACE) is the representative organisation for the architectural profession at European level. Its headquarters and Secretariat are located in Brussels. Its membership currently consists of 44 Member Organisations, which are the regulatory and professional representative bodies in all European Union (EU) Member States, and accession Countries, Switzerland and Norway. Through them, the ACE represents the interests of over 600.000 architects from 31 countries in Europe. The principal function of the ACE is to monitor developments at EU level, seeking to influence those areas of EU Policy and legislation that have an impact on architectural practice and on the overall quality and sustainability of the built environment. The ACE is dedicated to the better understanding of technical, environmental and cultural values and to the promotion of the highest standards of education and practice in architecture. Its mandate is to ensure that the views and expertise of the profession are delivered to the institutions of the European Union and to seek, as far as possible, consensus among its Members in all of its policy positions. Its policy is defined and approved by the General Assembly of all the Member Organisations, meeting twice yearly. The **main role of the ACE in ARV is to lead WP10**: Communication, Dissemination and Stakeholder Outreach

Contribution to Work Packages and Tasks in the project

WP 1 Management: Coordination & General Management Activities
WP 2 Framework for effective planning, design, construction and operation of CPCC: Assessment framework for CPCC
WP 3 Community, environment, and well-being: Contextualisation and implementation of CPCC Living Labs
WP 4 Sustainable building (re) design: Integrated design of CPCC
WP 5 Resource efficient (pre) manufacturing and construction workflows: Optimisation of the workflows
WP 8 Monitoring and evaluation: Assessment of KPIs for design and construction
WP 9 Market uptake: ARV e-marketplace and business models
WP 10 Communication, dissemination and training: WP leader. Dissemination & Communication Strategy, Dissemination and communication channels, Stakeholder outreach

Profile of key personnel in the project

[redacted]
Diploma in Architecture, Master of Engineering in Real Estate Economics and Facilities Management, PhD in Construction Management on: 'Social network analyses of knowledge transfer in sustainable office building projects in the UK and Germany'. Work experience in different sectors of the built environment, from small independent companies to global blue-chip groups in Europe and the US. Expertise on a broad range of sustainability issues in the built environment and knowledge management. Working on various EU funded projects (FP7, H2020, Erasmus+) for seven years, leading work packages on communication, dissemination, exploitation, stakeholder involvement, international workshops and policy paper development.

[redacted]
Graduate Architect and Urban Planner with a Master in Civil Engineering from USP (Brazil) and a Master of Science in Sustainable Environmental Design from AA School (UK). Self-motivated Architectural Designer with four years of experience in the UK. In addition, seven years of experience

in Brazil working in the retail industry on the design and construction of commercial units across the country. Working on H2020 projects since March 2019.

[redacted]

Master of Architecture from the Polytechnic School of the University of Palermo (IT). Four years of work and research experience within the architecture industry and as a visiting researcher at the University of Coimbra. Strong expertise in innovative technologies (laser scanning, photogrammetry, scan-to-BIM) applied to both architecture and cultural heritage. Working on H2020 projects since August 2019.

[redacted]

Modern languages graduate with 30 years' experience of working for professional bodies in the third sector (architecture) at national, European and international level. Responsible for researching and analyzing documentation to inform decision-making and policy development with a view to representing architects' interests and influencing EU legislative proposals; managing the ACE team.

[redacted]

Master in Sociology. Assisting the Secretary General in general Management Activities, accounting tasks, administrative management of personnel, preparation of the administrative papers for project proposals and administrative follow-up of approved projects, financial reporting of projects, organisation of events, preparation and implementation of questionnaires, statistical analysis of the results

Relevant publications, and/or products, services, or other achievements

ACE Publications:

- ACE Guide Introduction to BIM, 2019
- The Value of Design And The Role Of Architects, 2019
- 20 Architectural Projects Against Climate Change, 2018
- Work with European Architects!, 2018
- Sector Study: The Architectural Profession in Europe, 2018

Relevant previous projects

1. RenoZEB www.renozeb.eu (H2020) Accelerating nearly zero energy renovation for buildings and neighbourhood
2. TripleA-reno www.triplea-reno.eu (H2020) Attractive, Acceptable and Affordable deep renovation by a consumer orientated and performance evidence-based approach
3. Cultural-E www.cultural-e.eu (H2020) Climate and culture-based design and market valuable technology solutions for Plus Energy Buildings
4. Drive0 www.drive0.eu (H2020) Driving decarbonization of the EU building stock by enhancing a consumer centred and locally based circular renovation process
5. DigiPLACE www.digiplaceproject.eu (H2020) *Towards a European Digital Platform for Construction*

Significant infrastructure and/or technical equipment

n/a

Operational capacity of legal entity/partner organization

n/a

	3. CESKE VYSOKE UCENI TECHNICKE V PRAZE CVUT | CZ CZECH TECHNICAL UNIVERSITY IN PRAGUE
	Web site: www.uceeb.cvut.cz PIC number: 999848744 / **Number of employees: 4084 (2019) Number of students: 17 229 (2019)**

Brief description of legal entity/partner organization

CVUT (founded in 1707) is one of the oldest and largest technical universities in Europe. It offers a range more than hundred study programmes with over 400 fields of study. The project will be carried out by University Centre for Energy Efficient Buildings (CVUT UCEEB) which is a national centre of excellence in energy efficient building and sustainable innovations for the whole building life cycle. The main strength of the Centre is knowledge transfer to practice through close cooperation with industry and municipalities. CVUT UCEEB has five research departments that include energy and resource efficiency, advanced control systems, indoor environmental quality and sustainability in the built environment.

Since its establishment in 2012, CVUT UCEEB has focused on applied research and cooperation with industry. It has already finished/begun over 600 projects – funded both from public and private sources. Currently, there are 3 ongoing H2020 projects implemented by CVUT UCEEB: SPARCS - Sustainable energy Positive &
zero cARbon CommunitieS https://sparcs.info/, Powerskin+ https://www.powerskinplus.eu/ and PLURAL https://www.plural-renovation.eu/ and researchers are involved in Positive Energy Districts European Network – COST Action –
CA17126 https://www.cost.eu/actions/CA19126/#tabs|Name:overview, CVUT UCEEB is the leader of Working Group 1: PED Mapping, Characterisation and Learning. There are also two ongoing projects in IEA EBC Annex 83 – Positive Energy Districts https://annex83.iea-ebc.org/ and IEA EBC Annex 72 – Assessing Life Cycle Related Environmental Impacts Caused by Buildings https://annex72.iea-ebc.org.

CVUT UCEEB will be represented by experts from the following three research departments:

- Architecture and the Environment
- Energy Systems in Buildings
- Control and monitoring of intelligent buildings

Contribution to Work Packages and Tasks in the project

WP1: Participation on smooth running of the project.
WP2: Positive Energy District framework expertise, evaluation of local RES generation in urban environment, solar potential study performance.
WP3: citizen, communities and stakeholder engagement, awareness raising and learning, participatory methods, methodology development, co-creation workshops, user-centred design of building systems, pre- and post-surveys, qualitative and quantitative data collection, mapping of stakeholders involved, interests, and needs.
WP4: zero-emission/positive energy building concepts, integrated and efficient building design, digital design solutions, RES integration in building design, digital design and 3D simulations (digital twins), climate change resilient solutions.
WP5: expertise in climate change adaptive measures - summer cooling by heat pumps, green roof, elimination of heat islands, rainwater management (rain gardens, greenery), swappable façade-integrated RES (flexible solution enabling easy application of PV/PV-T/solar thermal/façade heat exchangers for possible coupling with heat pumps).
WP6: design, simulation and strategies for building and district energy systems (thermal and electricity), application of renewable energy sources, energy storages (batteries, water) and their operation, energy systems simulation, expertise in - heat pump, BAPV, BIPV, PVT, energy storage, waste heat.
WP7: Monitoring of the operational efficiency.

WP8: Data architecture design, communication protocols, datawarehouse, monitoring, data collection, analysis, IAQ sensors and evaluation, IoT platform.
WP10: dissemination and communication of project demo-site and project results, communication channels (website, social media, newsletters), marketing.

Profile of key personnel in the project

[redacted] (M) graduated from the Faculty of Civil Engineering of the Brno University of Technology, majoring in Building Constructions where he worked as a researcher as well. For several years he worked in Scandinavia and Southeast Asia in the field of sustainable construction. At CEZ Group, he focused on the topic of Smart City and Electromobility. Since 2019 he has been the head of the research department Monitoring and Control of Intelligent Buildings at CVUT UCEEB.

[redacted] (M), Head of department Architecture and the Environment, is expert in sustainability assessment systems and performance of the built environment. He graduated and got PhD at CVUT Faculty of Civil Engineering and worked at various R&D and consulting positions in the construction and RES industry. Since 2006 research scientist at the Faculty of Civil Engineering and since 2012 at CVUT UCEEB. Participated in projects – LEnSE (FP6), PERFECTION (FP7), SuPerBuildings (FP7), MORE-CONNECT (H2020) and contributed to development of the national building sustainability certification scheme SBToolCZ. [redacted] is active member of the International Initiative for Sustainable Built Environment (iiSBE), founding member of the Czech Green Building Council and organizer of www.cesb.cz conference series. https://orcid.org/0000-0002-3142-2631

[redacted] (M) gained his Ph.D. at the CVUT Faculty of electrical engineering and his focus is on electronic and sensor design for special applications. Between 2007-2012 as postdoc researcher and team leader in Tyndall NI, Ireland. Since 2012 at CVUT UCEEB, where he established and lead department Monitoring and Intelligent Control in period 2015-2019, in 2019 as visiting researcher at InnoRenew CoE, Slovenia, focusing on renewable construction materials. Co-founder of two companies and inventor of several EU and US patents. He is a principal investigator of several research projects in the field of IoT sensor design, renewable energy sources and other topics. https://orcid.org/0000-0002-0647-2987

[redacted] (M) holds PhD from the Electronic Engineering Department at the Polytechnical University of Catalonia (UPC). His background is in supervision and automatic fault detection in grid-connected photovoltaic (PV) systems, as well as modelling and degradation analysis of different PV module technologies. At CVUT UCEEB deals with PV applications, microgrids, smart energy management of multiple renewable energy sources (RES) and battery energy storage systems (BESS). https://orcid.org/0000-0003-4122-5823

[redacted] M) graduated from faculty of Mathematics and Physics at Charles University in as freelance consultant and software developer. Since 2018 member of the department of Monitoring and Control of Intelligent Buildings where he focuses on developing the prediction of PV irradiation and PV forecast service. https://orcid.org/0000-0003-2955-1634

[redacted] (F) gained an undergraduate degree in Media Studies and Sociology, at Masaryk's University in Brno, and consequently a Master's degree in Sociology at University of West Bohemia. Then worked as research analyst specialized in quantitative research in terms of informal care taking. Since 2019 researcher at CVUT UCEEB involved in rainwater management in urbanized landscape and implementing the Smart City principles into Czech towns and cities. Currently working on a methodology to help Czech municipalities with deployment of blue-green infrastructure and projects in effective city management and planning processes and applying the participative design process for public spaces and buildings.

[redacted] (M) graduated from the Department of Heat Energy at the Omsk Transport University (Russia). Since 2014 works as researcher at CVUT UCEEB where he is engaged in R&D in renewable energy sources integrated into the building envelope. He deals with modelling and experimental testing of solar elements and advanced glazing. He is currently completing his doctoral studies at the Institute of Environmental Engineering, Faculty of Science, Czech Technical University in Prague. https://orcid.org/0000-0002-9535-6143

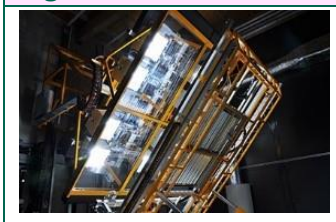
Relevant publications, and/or products, services, or other achievements

- Envilop – Environmentally Friendly Building Envelope – connected to several utility models, the main one with reg. No CZ 266197, https://isdv.upv.cz/webapp/!resdb.pta.frm
- PV Forecast – tool for PV irradiation forecast – for CZ, local using skyscanners, or locally installed exposure sensors, http://wp2.pvforecast.cz/en/home/#services
- SBToolCZ National Sustainability Assessment Tool - Czech method for complex quality assessment of building performance in which the characteristics of the building and its surroundings are evaluated with respect to the sustainable development,https://www.sbtool.cz/en/homepage-english/
- Volf, M., et al. Application of Building Design Strategies to Create an Environmentally Friendly Building Envelope for Nearly Zero-Energy Buildings in the Central European Climate. Energy and Buildings. 2018, 165 35-46. ISSN 0378-7788. DOI 10.1016/j.enbuild.2018.01.019.
- Kichou, S.; Skandalos, N.; Wolf, P. Energy Performance Enhancement of a Research Centre Based on Solar Potential Analysis and Energy Management. Energy. 2019, 183 1195-1210. ISSN 0360-5442.

Relevant previous projects

- **MORE CONNECT** - Development and advanced prefabrication of innovative, multifunctional building envelope elements for MOdular REtrofitting and CONNECTions, H2020 GA 633477, 2014-2019, https://www.more-connect.eu/
- **POWERSKIN+** Smart modular building facade systems for retrofit will affordably enhance energy efficiency, H2020 GA 869898, 2019-2023, https://www.powerskinplus.eu/
- **SPARCS** - Sustainable energy Positive & zero cARbon CommunitieS, H2020 GA 864242, 2019-2024, www.sparcs.info
- **Autonomous curtain wall panel,** Technology Agency of the Czech Republic, GA TH03020341, 2018-2020, https://starfos.tacr.cz/en/project/TH03020341?query_code=4feqaacjmlpa
- **IEA EBC Annex 72** – Assessing Life Cycle Related Environmental Impacts Caused by Buildings https://annex72.iea-ebc.org

Significant infrastructure and/or technical equipment



Solar laboratory

- Solar simulator with artificial sunlight with indoor test stand
- Outdoor test stand for long-term monitoring of solar components
- Test stand for determining the optical characteristics of transparent materials
- Portable ultrasonic flow & heat meter for pipes DN 10 to DN 2000 for in-situ measurements
- Mertel EurotestPV device for complete testing and diagnostics of photovoltaic panels and installations
- Mass flow meters for measuring different kinds of fluids
- Outdoor test cell (3 x 3 m) for solar components integrated into building envelope
- Accredited testing of liquid solar thermal collectors (thermal performance, time constant, stagnation temperature)
- Preaccreditation testing of solar collectors (exposure test, resistance to high temperature, thermal shock)
- Development and testing of air solar thermal collectors and hybrid concepts (air-liquid, photovoltaic-thermal)
- Optical evaluation of homogeneous and inhomogeneous glazing and prismatic structures
- Research and development in building envelope integration of solar components
- PV characteristics testing for PVT collectors

Electronic Systems and Diagnostics

- Electronic devices – power sources, oscilloscopes, spectral analyzer, measuring systems, soldering workplace
- Diagnostic systems – thermal camera, endoscopic camera, precise accelerometers, laser measurers, magnetometers and metal detectors
- 3D printing center FORTUS 400mc – modeling space of 406 × 355 × 406 mm, resolution up to 0.127 mm, materials ABS-M30, PC-ABS, PC, PC-ISO, ULTEM
- Spectral analyzers – measured spectrum from 200 to 1750 nm, precision of measuring ±20 pm, dynamic range up to 60 dB
- Interrogator – measured spectrum from 1270 to 1650 nm, precision of measuring ±1 pm, maximum number of wave channels 1000, detection threshold -40 dBm
- Laser source – C+L band, width of the spectral line <100 kHz, tuning step: 1 pm, output 15 dBm
- Welding kit – Fitel S178A including the optical fi breaker, quick weld in seven seconds, allows for directly welded on connectors

Photovoltaic systems

- Simulator of PV field with maximum output of 20 kW (1000 V / 20 A) capable of static as well as dynamic simulation of the electric output of PV modules according to set operational conditions (intensity of radiation, temperature, shielding)
- Exact analyzer of output ZIMMER LMG 670 for measuring and recording of electrical quantities
- Assembly of three programmable loads ZSAC for AC as well as DC load with the output up to 5,2 kW
- Experimental PV field with the output of 2,5 kWp and an assembly for the verification of behavior of hybrid systems in real conditions

Control systems and optimization

- The lab has a testing device with a heating circuit with all the necessary sensory equipment and a wide range of control options for actuators. All the data is continuously recorded; in addition, the experiment can be controlled via completely remote access.
- For this purpose, the team created a platform which is specifically focused on rapid prototyping and commissioning of various experimental sets.

Operational capacity of legal entity/partner organization

n/a

Tekniske Universitet	**4. Danmarks Tekniske Universitet** **DTU | DK** **Technical University of Denmark**
	Web site: www.dtu.dk — **Number of employees: 5881** **PIC number: 999990655** — **Number of students: 12048**

Brief description of legal entity/partner organization

Founded in 1829 with the mission of creating value for the benefit of society, DTU is an international elite technical university where education, scientific advice, and innovation rest on a solid foundation of world-class research. The University is at the academic and multidisciplinary forefront of the technical and the natural sciences—with new initiatives in a number of demanding engineering disciplines. DTU has a strong track record of industry partnership and is ranked number 1 in the Nordic region and number 9 in Europe among the most innovative universities according to Reuters. To date, DTU has coordinated or participated in 399 H2020 projects and has an extensive central support network for European projects including: project, financial, legal, IPR/innovation, and risk management.

DTU Compute is the largest environment for math & comp science in DK, covering topics from research to ICT. DTU Compute hosts CITIES, which is the largest national research on smart energy systems. DTU Compute related EU projects: SmartNet, FLEXCoop, eBalance+, syn.ikea, OpenE, SmartCityAccelerator, HEAT 4.0, uGRIP, COOL Data, CESI, etc. DTU Compute has defined AI, IoT and the green transition as key research areas.

DTU Civil Engineering (DTU Byg) carries out teaching and research in smart cities area and contributes to establishing digitalized building sector in Denmark. DTU Byg develops methods based on big data to provide energy efficiency and energy flexibility solutions for buildings and districts. Byg is active in smart cities projects, e.g. CITIES, HEAT 4.0, SCA, EnergyLab Nordhavn.

Contribution to Work Packages and Tasks in the project

DTU will primarily contribute to WP2, 6, 7 and 8, additionally also WP1 and 10.

WP 2 Framework for effective planning, design, construction and operation of CPCC:

DTU will use and test innovative methods and tools for Large-Scale Retrofitting actions in the demo of Sønderborg.

WP 6 Renewable energy and storage:

DTU will contribute to the demonstration of low temperature district heating and forecasting PV energy production.

WP 7 Efficient operation and flexibility:

DTU is the WP leader and will develop and test digital solutions and infrastructures for efficient operations in the ARV project. Specifically, the focus is on unlocking the available flexibility in all the six demo sites for optimizing the self-consumption and minimizing the carbon footprint by data-driven and intelligent

operations. DTU will collaborate with the ARV Cloud HUB (CENTER DENMARK) on efficient operations of all demo sites and harvest innovation digital synergies.

WP 8 Monitoring and evaluation:

DTU will contribute to the development of monitoring, evaluation and impact assessment.

Profile of key personnel in the project

[redacted] (M) is a Professor and the Head of section Dynamical Systems – DYNSYS. Furthermore, he is the head of Center for IT-intelligent Energy Systems (CITIES). He received the Ph.D. in Statistics from the Technical University of Denmark in 1986. He was appointed Asst. Prof. in Statistics in 1986, Assoc. Professor in 1989, and Professor in Mathematical Statistics with a special focus on Stochastic Dynamical Systems in 1999, and the Head of the National Center for IT-Intelligent Energy Systems (CITIES) 2014. The total budget for the research projects he has received is more than 30 million Euro. He has published 550 publications including 230 journal papers, 12 research monographs (Citations: >24000, h-index: >70, i10-index: >400 (Google Scholar)). [redacted] for more details. His main research interest is related to analysis and modelling of stochastic dynamics systems. This includes signal processing, time series analysis, identification, estimation, grey-box modelling, prediction, optimisation and control. The applications are mostly related to Energy Systems, Smart Cities, Informatics, Environmental Systems, Bioinformatics, Biostatistics, Process Modelling, and Finance.

[redacted] is an Associate Professor with the Department of Civil Engineering, DTU. She received the Ph.D. degree in Architecture Engineering from the University of Tokyo, in 2014. She was a Postdoctoral Researcher with the Department of Built Environment, Eindhoven University of Technology from 2014 to 2016, then with the Department of Civil Engineering, DTU from 2017 to Nov. 2018. She was appointed to an Assistant Professorship in 2018. She has been a major contributor and WP/task leader of several large research and demonstration projects in the area of smart energy systems and smart cities, including CITIES (IFD), EnergyLab Nordhavn (EUDP), COMBIOTES (H2020), etc. She works on energy demand management in real buildings using building integrated ICT, and quantification of energy flexibility potential in buildings using data-driven approaches based on data mining and machine learning. Under her supervision, three PhD candidates have successfully defended their theses and four are on-going. She was a major contributor of International Energy Agency EBC Annex 67- Energy Flexible Buildings, 2014 - 2019. She is the Co-Operating Agent of IEA EBC Annex 82- Energy flexible buildings towards resilient low carbon energy systems, 2021-2024. Her research interest includes smart cities, energy demand flexibility, energy system modelling, big data analysis, building physics and services. She is also the author of more than 60 papers including 40 peer-reviewed journal papers.

Relevant publications, and/or products, services, or other achievements

1. Real, J. P., Rasmussen, C., Li, R., Leerbeck, K., Jensen, O. M., Wittchen, K. B. & Madsen, H (2021): Characterisation of thermal energy dynamics of residential buildings with scarce data, Energy and Buildings, vol. 230.
2. R.G. Junker, C.S. Kallesøe, J.P. Real, B. Howard, R.A. Lopes, H. Madsen (2020): Stochastic nonlinear modelling and application of price-based flexibility, Applied Energy, vol. 275.
3. C. Finck, R. Li, W. Zeiler (2020). Optimal control of demand flexibility under real-time pricing for heating systems in buildings: A real-life demonstration. Applied Energy, vol. 263.

4. C.M. Herget, R. Li, P. Pinson (2020): Demand side management of heat in smart homes: Living-lab experiments, Energy, vol. 195.

5. R.G. Junker, A.G. Azar, R. Lopes, K. Lindberg, G. Reynders, R. Relan, H. Madsen (2018). Characterizing the energy flexibility of buildings and districts. Applied Energy, vol. 225.

Relevant previous projects

- CITIES (Danish Innovation Fund, 2014-2020)

Develop integrated city energy systems, building short-term operational models that feed longer term planning models, considering the spatiotemporal variations, interactions, dynamics, and stochastics in the energy system. Relevant activities within the project include the development of controller of low level system components that can inform higher-level aggregate models employed in market and control framework design; the development of energy flexibility index which can be used as a measure of the smartness of buildings. http://smart-cities-centre.org/

- Flexible Energy Denmark (Danish Innovation Fund, 2019-2023)

The aim of the project is to develop tools and solutions based on big data and artificial intelligence to activate flexibility at all levels of the energy system. The methods are being tested in living labs. As a part of the project, a cloud data platform will be used to collect and store the data, while products from different industry partners are tested and improved in terms of better controls and algorithms by the work of DTU.

https://www.energiforskning.dk/da/project/flexible-energy-denmark-fed

- SmartNet (Horizon 2020, 2016-2019)

Till now, distribution networks have been managed with a fit-and-forget philosophy. In the future, strict real-time coordination will be needed between the different actors that are involved in the provision of ancillary services. Optimising the interface between TSOs and DSOs will prove a crucial factor to ensure the achievement of an overall efficiency target. Different TSO-DSO interaction modalities are compared on the basis of national key cases (Italy, Denmark, and Spain); where physical pilots will be developed to monitor transmission's distribution parameters and investigate modalities for the acquisition of ancillary services from specific resources located in distribution systems.

http://smartnet-project.eu/

- Syn.ikia (Horizon 2020, 2020-2024)

The goal of syn.ikia aims to develop and test methodologies to develop sustainable and energy plus neighbourhoods, i.e. highly energy efficient neighbourhoods with a surplus renewable energy in four different climate zones in Europe. The syn.ikia concept relies on the interplay between novel technologies at the neighbourhood scale, energy efficiency and flexibility, energy sharing among users, good architectural and spatial qualities, sustainable behaviour and citizen engagement.

https://synikia.eu/

- ebalanceplus (Horizon 2020, 2020-2024)

The aim of the project is to increase the flexibility of energy networks, to test new business models and support import stakeholders with tailor-made end-user interfaces. The project will help reforming the operation of electricity grids and markets for the future low carbon society. Using digital technologies,

smart grids offer greater energy efficiency and make it possible to integrate more renewable energy sources into the grid. Ebalanceplus deals with technical, economic, and social aspects of intelligent electricity grids and increases their flexibility and resilience.

Significant infrastructure and/or technical equipment

- CTSM-R - Grey-box modelling

At DTU Compute we are leading the development of CTSM-R, which is the tool used on IEA Annex 58 and 71 for detailed description of the thermal characteristics of buildings. Prototype tools for separating the total energy consumption into components which are related to the building fabric and another component which are due to occupancy behaviour have been developed also been developed and applied in IEA Annex 66. Both software systems will be used, and potentially further upgraded.

- Center Denmark (CENTER DENMARK)

An European Digital Innovation Hub for Smart Energy Systems, and ERA-NET Smart Energy System Platform Provider. It is an independent and non-profit national and European research center with the aim of unify and embed research results within the field of digitalization of energy systems, and innovate data-intelligent methods jointly with the industries and low-carbon cities and municipalities. CENTER DENMARK aims at a widespread use of data without compromising privacy and GDPR, and the focus is on providing the knowledge for a transition to the future weather driven energy system while ensuring democraticy governance.

- Climify

Climify is developed by DTU COMPUTE. Climify is a digital platform for plug and play connection of IoT sensors and actuators, for easy monitoring and controlling of buildings and buildings' HVAC systems. The platform climify.org offers 3 main applications. The first application is an IoT device installation app, to be used on portable devices (e.g. mobile phones or tablets of system administrators): this app allows easily installing and locating of a sensor or an actuator, within a building. The second application is an online service for data visualisation and HVAC control: while the monitoring data can be plotted, the service offers several data evaluation methods; moreover, the settings of the connected actuators (e.g. the set temperature of a smart thermostatic valve) can be modified and controlled. The third application can be installed on portable devices (mobile phones and tablets of buildings' occupants) and allows occupants to provide feedback on their perception of the indoor climate through several questionnaires' formats.
Through the three applications developed within climify.org, we aim at providing the best indoor climate and the lowest energy use through a low cost, digital solution. DTU is in the process of creating a spin-off for the commercialization of Climify.

- uni-lab.dk

Climate change calls for a strong, joint action from research, industries and from the citizens. With uni-lab.dk we aim at bringing together all living labs and test labs in Denmark in order to enhance their cooperation among each other and with Danish industry.
Uni-lab.dk can help universities in Denmark find a suitable lab where they can develop their next sustainable solutions related to their particular research field. But it can also help the Danish companies find the right partners for the development, test and demonstration of their next-generation products. Uni-lab.dk is built

upon Center Denmark, a national hub for the digitization of the Danish energy systems. Currently, 9 Living Labs and 4 testing Labs are associated to uni-lab.dk
Operational capacity of legal entity/partner organization
n/a

	5. Danfoss A/S **DAN | DK**
	Web site: www.danfoss.com **PIC number:** 999914316 **Number of employees:28.000**

Brief description of legal entity/partner organization

Danfoss engineers' technologies enable the world of tomorrow do more with less. We meet the growing need for infrastructure, food supply, energy efficiency and climate-friendly solutions.

We are active in the field of renewable energy as well as district heating infrastructure for cities and urban communities. Besides this our products and services are used in areas
such as refrigeration, air conditioning, heating, motor control and mobile machinery.

District energy systems are extremely flexible. Efficient heating and cooling of buildings reduce 2 emissions and energy costs and make it possible for urban leaders to embrace a new vision for supplying energy to their cities, one that combines local renewables, cogeneration plants and district energy in a smart and innovative way.

Our innovative engineering dates back to 1933 and today Danfoss is a world-leader, employing 28,000 employees (2019) and serving customers in more than 100 countries. Turnover for the year 2019 was 6,3 Billion EUR. Danfoss is headquartered in Nordborg. Today we are structured around four dedicated business segments: Drives, Heating, Cooling and Power Solutions. We are privately held by the founding family.

The work is made mainly by the Heating Application Centre, a dedicated team of specialists acting as internal and external consultants in the field of product development, conceptual development of energy systems and techno economic studies. Furthermore, the relevant business units are involved, e.g. Residential Heating business unit, as well as business units related to prototype realization.

Contribution to Work Packages and Tasks in the project

WP 7 Efficient operation and flexibility:
Product/concept/system development of HVAC systems
In deep knowledge of building physics
In deep knowledge of comfort control equipment
In deep knowledge of control principles, also AI based
Highly skilled in Techno Economic Analysis

WP 8 Monitoring and evaluation:
Monitoring, analysis and AI based control is the key strategic area going ahead. Investments made, thus high level of skills are in place.

WP 9 Market uptake:
Large Enterprise with strong market position and ability to launch new concepts.

WP 10 Communication, dissemination and training:
Large Enterprise with strong market communication channels.

Profile of key personnel in the project

[redacted] (M) - Director Danfoss Heating Segment pplication centre - is leading activities within the field of conceptual development of energy technologies, covering development of components and ystems and their interaction in smart energy systems. The Application Centre has the role as internal and external consultants in the field of market and project upport, district energy technology and product development.

[redacted] (M), Application Specialist in Danfoss Heating Segment Application Center – is working on development and testing of new products and concepts in field of heating systems usually in cooperation with external business partners and universities. Recently the focus is on remote data acquisition and commissioning of heating installations.

[redacted] (M), R&D Director for RH-DT Controls. Specialist in indoor climate solutions, incl. development of electronic termostats and related advanced control principles. Business model analysis and feasibility studies.

Relevant publications, and/or products, services, or other achievements

Publications:

Thorsen, J.E., Brand, M., Gudmundsson, O. "Smart Operation of ULTHD Booster Substation for Multifamily Building", 5th International Conference on Smart Energy Systems, Copenhagen, 2019.

Thorsen, J.E., Ommen, T., "Field experience with ULTDH substation for multifamily building, Energy Procedia 149 (2018) 197-205.

Lund, H., Werner, S, Wiltshire, R., Svendsen, S., Thorsen, J.E, Hvelplund, F., Mathiesen, B.V. "4th Generation District Heating (4GDH). Integrating Smart Thermal Grids into Future Sustainable Energy Systems." Energy Journal, EGY5906, 2014.

Thorsen, J.E., Gudmundsen, O., Brand M. "Performance Specifications for Heat Exchangers for DH Substations of the Future", the 14th International Symposium on District Heating and Cooling, 2014, Stockholm, Sweden.

Thorsen, J.E., Iversen, J. Impact of lowering dT for Heat exchangers used in DH systems, the 13th International Symposium on District Heating and Cooling, 2012, Copenhagen, DENMARK.

Relevant previous projects

EUDP (DK) – EnergylabNordhavn, New Urban Energy Infrastructures and Smart Components, www.energylabnordhavn.dk
Our role is: Development and demonstration of ultra-low temperature district heating substation, load shift of flats and heat recovery from supermarket.

Innovation Fund DK – HEAT 4.0, Digitally Supported Smart District Heating
Our role is: Demonstrating smart heating control in multi flat buildings

EU H2020 – REWARDHeat, Smart networks, integrating renewable and waste energy sources, www.rewardheat.eu
Our role is: Development and demonstration of ambient loop district heating substation for multi flat building.

Innovation Fund DK – 4DH, 4 generation District heating, www.4dh.dk
Our role: Member of SC, providing energy system data and contributions to conferences.

Innovation Fund DK – RE-INVEST, An innovative research-based endeavor towards a 100% renewable energy system in Europe, www.reinvestproject.eu
Our role is: Member of SC and contribution on data for thermal energy infrastructure.

Significant infrastructure and/or technical equipment

Relevant prototypes for demo will be developed during project.

Operational capacity of legal entity/partner organization

Product/concept/system development of HVAC systems
In deep knowledge of building physics
In deep knowledge of comfort control equipment
In deep knowledge of control principles, also AI based
Highly skilled in Techno Economic Analysis
Monitoring, analysis and AI based control is the key strategic area.
Large Enterprise with strong market position and ability to launch new concepts.

ENFOR	**6. ENFOR A/S** **ENFOR | DK**	
	Web site: https://enfor.dk **PIC number:** 968694478	**Number of employees:** 11 **Number of students:** 4

Brief description of legal entity/partner organization

ENFOR provides market-leading energy forecasting and optimization solutions for the energy sector. Utilities, energy traders, transmission and distribution system operators use ENFOR solutions for forecasting of renewable energy production, electricity and heat demand as well as optimization of district heating systems. ENFOR was established in 2006 as a spin-off from the Technical University of Denmark. The company has a solid operational track record and has successfully served customers all over the world for many years.

Contribution to Work Packages and Tasks in the project

WP 6 Renewable energy and storage: Forecasting and optimization systems for renewable energy and storage

WP 7 Efficient operation and flexibility: Forecasting and optimization systems for renewable energy and storage

Profile of key personnel in the project

[redacted]M) is head of model development and co-founder of ENFOR. He holds a Ph.D. in Statistics from Informatics and Mathematical Modelling, Technical University of Denmark in modelling of parametric and non-parametric systems. Before founding ENFOR he was employed as Assoc. Prof. at the Technical University of Denmark and has been working with modelling and optimization in relation to energy systems for 15 years. He has published a large number of research papers regarding prediction of wind energy, heat load, power load and related subjects.

Professional experiences:

- Development of methods for wind power forecasting, heat load forecasting, electricity load forecasting, electricity price forecasting.
- Development of methods for advanced forecast products (probabilistic forecasts, scenario generation).
- Development of methods for optimal decision support / control strategy based on forecasts.
- Development of methods for estimating thermal characteristics of buildings

Relevant publications, and/or products, services, or other achievements

- Wind and solar power forecasting systems
- District heating forecasting and temperature-optimization software

Relevant previous projects

Participation in H2020 project **Syn.ikia**

Significant infrastructure and/or technical equipment

n/a

Operational capacity of legal entity/partner organization

n/a

ProjectZero SONDERBORG	**7. Project Zero A/S** **PZ | DK**
Web site: www.projectzero.dk **PIC number: 950688077**	**Number of employees: 5**

Brief description of legal entity/partner organization

ProjectZero is a public-private-partnership established in 2007 to support the municipality of Sonderborg´s transition to become a ZEROcarbon municipality in 2029 by transitioning 700,000 tons of energy-system related carbon-emissions to zero.

ProjectZero´s legal structure has the Project Zero-Foundation as its highest authority, where the board of directors represents the founders and key funders: the city council of Sonderborg, the Danfoss-foundation, the university of Southern Denmark, the municipal utility company and Sydbank. The Project Zero-foundation controls 100% the Project Zero A/S company, acting as a PPP-body for energy planning, coordination, actions, monitoring, communication etc across the Sonderborg community. The Board of directors in Project Zero A/S represent key local stakeholders like: house associations, banks, schools/education, utilities, city administration and the city council.

The current Roadmap2025 (created by 100 local experts/stakeholders and approved by the city council in 2018) determine the framework for how to achieve a 75% carbon reduction across sectors in Sonderborg. The execution of the Roadmap2025 is structed in 8 segmented working-groups, where the 100 experts now focus on execution.

Contribution to Work Packages and Tasks in the project

WP 1 Management: *Project management and coordination*

WP 3 Community, environment, and well-being: *Creating innovative climate action participatory platforms, creating rolemodels*

WP 4 Sustainable building design: *Design of zero energy buildings and sustainable city areas*

WP 6 Renewable energy and storage: *Design and implementation of renewable energy and storage systems in buildings*

WP 7 Efficient operation and flexibility: *Management of sustainable buildings and energy retrofitting activities. Management of district heating systems in buildings.*

WP 8 Monitoring and evaluation: *Planning and management of monitoring systems, evaluation of energy retrofitting demonstration projects.*

WP 9 Market uptake: *Exploitation, replication, public affairs*

WP 10 Communication, dissemination and training: *Citizens, companies and stakeholder engagement, dissemination, training, publications, society engagement and communication.*

Profile of key personnel in the project

[redacted](M), Managing Director
Education and background in social science (business). Working with ProjectZero since 2007. Both nationally and internationally experienced from projects, policy and communication. Has been a project/WP/task-manager in several EU-projects during last 10 years. Vice-chairman of the CITIES

research and demonstration project since 2014. Member of the EU POD Panel (since 2019) and a NORLYS (utility) representative (since 2018).

[redacted]

[redacted](M), Building/Renewable Energy Expert
M.Sc in energy efficient buildings from DTU and whole life since in building/energy-consulting. Several years managing own consultancy company, but also a partner in the DEM Danish Energy Management. Recently a parttime employee of ProjectZero. Has comprehensive knowledge of the house associations across Sonderborg and worked in the past as an external research-application-reviewer for the EU-Commission. Torben is currently the project manager for the Sonderborg H2020 HAPPI-project, focused on scaling energy retrofit across the six house associations.

[redacted]

[redacted](F), Network Project Manager
Master in energy planning from Aalborg University. Worked with ProjectZero since 2016 and now specialized on energy monitoring, digitalisation projects, replication of EU H2020 SmartEnCity-project by the SmartEnCity Network, communication etc.

[redacted]

[redacted](M), ProjectZero Business Development
Master of science from Southern Denmark University. More than 20 years' experience from industry, focused on market and new business development for energy efficiency solutions. Now focused on (green) business engagement, innovation and demonstration-projects.

[redacted]

Relevant publications, and/or products, services, or other achievements

Participatory platforms for segment participation:
ZERObolig; ZERObolig forening; ZEROcompany; ZERObutik; ZEROskole; House of Science

Publications:
- Roadmap2025
- Grøn Vækst Sønderborg

Relevant previous projects

EU H2020 **SmartEnCity**
EU Interreg **BSR ActNow**
EU H2020 **Happi**
EU H2020 **Refurb**
Energibyerne.dk

Significant infrastructure and/or technical equipment

n/a

Operational capacity of legal entity/partner organization

n/a

eurac research	**8. EURAC Research** **EURAC | IT**	
	Web site: www.eurac.edu **PIC number:** 999887253	**Number of employees:** 517

Brief description of legal entity/partner organization

EURAC is an applied research centre located in Bolzano, South Tyrol. Founded in 1992 as a private association, EURAC currently has eleven institutes organised into four main areas of research: Autonomies, Mountains, Health and Technologies. Through an interdisciplinary approach, they work on the protection of minorities and multilingualism, investigate climate change, draw up sustainable development plans through the use of renewable energy, and contribute to the health of the community by conducting biomedical studies.
It has a turnover of about 21 million Euros. In the past 9 years EURAC participated in about 70 projects and at present is involved both as coordinator or partner in 45 projects funded within various EU programmes, including H2020, FP7, IEE, Interreg. Further than European funding and commissioned projects, EURAC receives contributions from the centre's members, and has a financial agreement with the Province of Bolzano.
The Institute for Renewable Energy conducts applied research on advanced energy systems, based on or including sustainable energy sources. Its activities include national and international research projects, as well as direct cooperation with industry partners. The institute also supports the promotion of renewable energy technologies and assists political decision-makers the scientific consultancy. Scientific results are based on laboratory tests of single components and integrated energy systems, as well as the monitoring of applied demonstration sites, experimental outdoor installations and residential buildings. The institute offers support also in the elaboration of complex energy models as decision support system for single energy systems or buildings as well as for urban and regional areas.

Adequacy to the project/ role in the project:
Within the Institute for Renewable Energy, the Research Group on "Urban and regional energy systems" – URS offers high level competences and experiences concerning: development of urban and regional energy plans and Sustainable Energy Action Plans in alpine municipalities (SEAP); development of tools and models for energy strategic planning; indoor and outdoor environmental and micro-climate monitoring; spatial decision support; big data analysis and database management; financial evaluations of sustainable energy solutions at urban and regional level, smart city projects and demo case management. The group members are involved in international and national scientific networks and initiatives: International Energy Agency (IEA), International Society Of City And Regional Planners (ISOCARP), Alpine Convention, EUSALP AG9.

URS has been actively involved in various EU (STARDUST, SINFONIA, SMARTBEEJS RECHARGE.GREEN, LOCSEE, GRETA) and national (SEAP of the city of BOLZANO and BRESSANONE) projects related to the management of energy transition at the urban or regional scale. Currently URS is the demo site coordinator of STARDUST H2020 smart city project in Trento and SINFONIA FP7 smart city project in Bolzano, developing an innovative and integrated ICT-energy-mobility solutions aiming at deep energy retrofit of buildings, and digitalization of systems as well as the urban environment to increase the quality of life in cities. In parallel, USR is involved in SMARTBEEJS Marie Curie H2020 project, targeting the definition of skills and multidisciplinary knowledge necessary to PhD candidate to develop Positive Energy Districts, with the ability to understand and engage with the needs of citizens and communities.

Additionally, for administrative matters, the Research Development Office (RDO), Scientific Communication Service and Accountancy and Legal Office offer support to researchers in preparation and management of the research projects.

Contribution to Work Packages and Tasks in the project

EURAC Research is among the scientific partners of the Project.
It coordinates WP8 (Monitoring and evaluation).
It is also supporting the demo City of Trento in the design and implementation of the CPCC «Piedicastello Destra Adige» and is involved in all WPs:

- WP1 Project management
- WP2 Framework for CPPC
- WP3 Community, environment and well being
- WP4 Sustainable building (re)design
- WP5 Resource efficient (re)construction
- WP6 Innovative renewables and storage systems
- WP7 Efficient operation and flexibility
- WP8 Monitoring and evaluation
- WP9 Market uptake
- WP10 Communication

Profile of key personnel in the project

[redacted] M) (Degree in Urban and Regional Planning, PhD in Environmental/Energy Engineering), the team coordinator, is responsible for the research team on Urban and Regional Energy Systems. He is technical responsible for the smart city FP7 project SINFONIA and for the H2020 STARDUST SCC project coordinating the implementation of the 2 LH districts in the cities of Bolzano end Trento. He coordinated the Interreg South East Europe LocSEE "Low-Carbon South East Europe" working with 8 South East Europe Countries. He is expert at the International Energy Agency SHC TASK 51: Solar Energy and Urban Planning and IEA EBC Annex 83 on Positive Energy Districts and in the COST action Positive Energy districts,COST Action CA19126. He is elected Vice-President of ISOCARP, the International Society of City and Regional Planners with responsibilities on the Academic Development. Since 2015, he promoted the international conferences on "Smart and Sustainable Planning for Cities and Regions" —SSPCR— held by EURAC (http://www.sspcr.eurac.edu/). In 2018 he attended as speaker to the World Urban Forum 9 and the REAL CORP 2018. He is already active in the SCC Stakeholder platform and in the SCIS working group.

[redacted] (M) is an urban and environmental planner by training and holds a Ph.D. in real [redacted]. Building on more than 10 years of practical experience in planning design, his research currently focuses on smart city projects and multiple-benefits of energy transition. Since 2015, he is responsible for coordinating the international conference on 'Smart and Sustainable Planning for Cities and Regions' (SSPCR), and has acted as session moderator/chair or keynote speaker in national and international events. He is coordinating the local working team of smart city project H2020 STARDUST in Trento and Eurac activities in the VARCITIES project (H2020). Adriano is member of the COST action Positive Energy districts,COST Action CA19126, sub task co-leader in the IEA EBC Annex 83 on Positive Energy Districts, concerning economic, environmental and social assessement. He has also participated in numerous EU research projects (FP7 Sinfonia, SEE Locsee, AS Recharge.green), the design of Sustainable Energy Action Plans (SEAPs), and he is the author of more than 20 papers in scientific journals and conferences. Since 2015, he coordinates the international conferences on "Smart and Sustainable Planning for Cities and Regions" —SSPCR— held by EURAC [redacted] and is editor of the proceeidngs volume published by SPRINGER.

[redacted]F) (Degree in Architecture, PhD in Sustainable Energy Systems [redacted]gram) is a post-doctoral researcher of the Urban and Regional Energy Systems group. She combines professional experience, as an architect, in Portugal, Denmark and the Netherlands, with a data-driven researcher mindset. Since 2011, she has participated in a diversity of projects, mostly focusing on the development of environmental impact assessment approaches to support decision-making. In particular, she has experience on the application of life-cycle assessment to urban systems (e.g., buildings, transportation), urban metabolism, circular economy and waste prevention and management. At Eurac, she has worked on circular economy projects (SEC – Strategy for circular economy in the Province of Bolzano), positive energy districts (IEA Task 83), smart cities (STARDUST), advanced mobility (LifeALPS), among others.

[redacted] (F) (Degree in Urban and Regional Planning, PhD in Environmental/Energy [redacted]oc researcher in the team on Urban and Regional Energy Systems at EURAC. Her fields of work are mainly related to spatially explicit analysis and data-processing using GIS (Geographical Information Systems) to estimate or calculate the energy demand of buildings and the energy potential production from renewable energy sources (RES). During her PhD she also gained experience in the fields of Strategic Environmental Assessment (SEA) of plans and development of scenarios for the sustainable energy transition of cities and regions.

[redacted] (M) has a BSc in Mathematics (Università degli Studi di Torino), MSc in Mathematics (Università degli Studi di Torino) and PhD in Pure and Applied Mathematics (Università degli Studi di Milano & Universitat Politècnica de Catalunya), thesis in the topic of mathematical analysis and Partial Differential Equations. His m**ain field of activity concerns d**ata analysis, impact assessment modelling and modelling of dynamical systems. Pietro is actually involved in following projects: Sinfonia FP7 (monitoring actions); Renewable Cooling Tender for EU commission, BuiltHub H2020.

Relevant publications, and/or products, services, or other achievements

- Bisello, A. Assessing Multiple Benefits of Housing Regeneration and Smart City Development: The European Project SINFONIA. *Sustainability* 2020, *12*, 8038
- S. Croce, D. Vettorato "The definition of urban surface uses: a systemic approach for climate resilient and sustainable cities" IOP Conference Series: Earth and Environmental Science 588, December 2020
- D'Alonzo V, Novelli A, Vaccaro R, Vettorato D, Albatici R, Diamantini C, Zambelli P "A Bottom-up Spatially Explicit Methodology to Estimate the Space Heating Demand of the Building Stock at Regional Scale" Energy and Buildings, January 2020
- Bisello, A. and Vettorato, D. (2018) 'Multiple Benefits of Smart Urban Energy Transition', in Droege, P. (ed.) Urban Energy Transition. Second Edition. Elsevier, pp. 467–490.
- Mosannenzadeh, F., Bisello, A., Vaccaro, R., D'Alonzo, V., Hunter, G. W., & Vettorato, D. (2017). Smart energy city development: A story told by urban planners. Cities, 64, 54-65.

Relevant previous projects

STARDUST - Holistic and Integrated Urban Model for Smart Cities https://cordis.europa.eu/project/rcn/212410_en.html , H2020, 2017 – 2022.

COST Action PED – Positive Energy districts , COST Action CA19126, https://www.cost.eu/actions/CA19126/ 2020-2024

VARCITIES - the EU-funded VARCITIES project aims to create a vision for future cities with the citizen and the so-called human community at the centre. It will therefore implement innovative ideas and add value by creating sustainable models for improving the health and well-being of citizens facing diverse climatic conditions and challenges around Europe. https://www.varcities.eu/ H2020 – 2020-2025

SINFONIA - Smart initiative of cities fully committed to invest in advanced large-scaled energy solutions https://cordis.europa.eu/project/rcn/197825_it.html , FP7, 2014 -2020.

SMARTBEEJS Marie Curie H2020 - Human-Centric Energy Districts: Smart Value Generation by Building Efficiency and Energy Justice for Sustainable
Living, https://cordis.europa.eu/project/rcn/223178/factsheet/en, 2019 – 2023.

Significant infrastructure and/or technical equipment

With dedicated laboratories, the Institute for Renewable Energy offers test services studying heat pumps, both thermally and electrically driven, and solar photovoltaic modules, and measuring the thermal properties of passive and active solar building components. Extensive dynamic simulations are performed to enhance the product development process and virtually integrate the component in an overall system.
INDOOR FACILITIES:

- SOLARE PV LAB - Sun simulator for photovoltaic modules
- ACCELERATED LIFE TESTING LAB - Climatic chamber for accelerated life tests
- MULTIFUNCTIONAL FACADE LAB - Laboratory for performance characterization of multifunctional facades
- HEAT PUMPS LAB - Laboratory for heat pump systems test

OUTDOOR FACILITIES

- PV INTEGRATION LAB - Facility for the integration of photovoltaic systems in buildings and grids
- ENERGY EXCHANGE LAB - Facility for tests on advanced district heating and cooling networks
- FACADE SYSTEM INTERACTIONS LAB - Facility for evaluating facade system and indoor environment interactions

Operational capacity of legal entity/partner organization

n/a

SINTEF	**9. SINTEF AS** **SINTEF | NO**
	Website: https://www.sintef.no/ **PIC number: 919303808**
	Number of employees: 2000

Brief description of legal entity/partner organization

SINTEF is one of Europe's largest independent research organisations. Every year, we carry out several thousand projects for customers large and small. For more than 60 years, SINTEF has developed solutions and innovation for society and customers all over the world. This is how we have become a world-leading research institute. Our vision is *Technology for a better society*.
We deliver innovation by developing knowledge and technologies that are brought into practical use. SINTEF is multidisciplinary with international top-level expertise in the fields of technology, the natural sciences, medicine and the social sciences. We conduct contract R&D as a partner for the private and public sectors, and we are one of the largest contract research institutions in Europe.
The work of SINTEF in ARV will be undertaken by the institute of **SINTEF Community**, Department of Architecture, Building Materials and Constructions which works across themes of integrative energy efficient buildings, life-cycle analysis, urban modelling, living labs and spatial planning, and Department of Mobility and Economics.

Contribution to Work Packages and Tasks in the project

Norwegian demo contact: Steinar Grynning
WP 1 Management: -/-
WP 2 Framework for effective planning, design, construction and operation of CPCC:
Task leader of 2.5, Visualization technologies/laboratory (Jo Skjermo, Judith Thomsen)
WP 3 Community, environment, and well-being: Work package leader (Judith Thomsen), task leader 3.2 overall Living lab methodology (Caroline Cheng), contributor (Daniela Baer)
WP 4 Sustainable building design: task leader of 4.5 BIPV solutions (Steinar Grynning) and contributor Nicola Lolli, and nature based- solutions (Berit Time)
WP 5 Resource efficient manufacturing and construction workflows: contributor LCA (Nicola Lolli)
WP 6 Renewable energy and storage: contributor (Steinar Grynning)
WP 7 Efficient operation and flexibility: contributor (Steinar Grynning)
WP 8 Monitoring and evaluation: contributor, link to WP3 data collection, follow up the monitoring in the Oslo Demo (Judith Thomsen, Caroline Cheng)
WP 9 Market uptake: contributor (Caroline Cheng)
WP 10 Communication, dissemination, and training: link to the Living Lab activities of WP3. Task lead of 10.2.2 (Daniela Baer)

Profile of key personnel in the project

[redacted] (F), PhD in Architecture, MSc in Architecture, is a research manager at the Dept of Architecture, Building Materials and Constructions in SINTEF Community. [redacted] is currently a Work Package leader at the Research Centre on Zero Emission Neighbourhoods in Smart Cities (www.fmezen.no) where she is leading the WP on pilots and living labs. [redacted] PhD is within the area of housing research, exploring satisfaction with the built environment through qualitative and quantitative methods. Previously, [redacted] has worked in the Centre on Zero Emission Buildings [redacted] and in the national research project EBLE – Evaluation of housing with low energy needs.

[redacted] (M), PhD in Architecture Design, History and Technology, is a research manager at the Dept of Architecture, Building Materials and Constructions in SINTEF Community. [redacted] has an extensive background from both theoretical studies as well as
from design, implementation and the carrying out of laboratory and field measurements. He has close collaborations with the building industry through numerous national industrial and research projects like Research Centre on Zero Emission Neighbourhoods in Smart Cities (www.fmezen.no), Centre on

Zero Emission Buildings (www.zeb.no), National Centre for Research Based Innovation (SFI) *Klima 2050 – Risk reduction through climate adaptation of buildings and infrastructure and* the national research project EBLE – Evaluation of housing with low energy needs. [redacted] is also involved in international research through various IEA-Annexes, COST actions. He has had two research stays at Lawrence Berkeley National Laboratories in Berkeley, California.

[redacted] (F): Chief scientist in SINTEF Community, a civil engineer and holds a doctoral degree in building physics from NTNU, Norway. Her expertise is in the areas of climate adaptation of buildings, moisture, heat and air transport in building envelopes in general and wooden buildings in particular. She has worked as a municipality planner and has a long career in research in different research positions such as the former Norwegian Building Research Institute. [redacted] has participated in several international projects and networks in Europe, she has also been a member of many national and international committees. She is the managing director of the National Centre for Research Based Innovation (SFI) *Klima 2050 – Risk reduction through climate adaptation of buildings and infrastructure.*

[redacted] (M): (PhD in Architecture, MSc in Sustainable Architecture, March) is a senior research scientist at the Dept of Architecture, Building Materials and Constructions at SINTEF Community. [redacted] carried out research in the field of Lifecycle Assessment applied to buildings, building energy simulations, energy and resource efficiency in buildings, user comfort in buildings, and cost analysis of Zero Emission Buildings. [redacted] has been a Task Leader in the EU FP7 PROFICIENT, currently Work Package Leader in the H2020 NERO project, and has published a number of articles in international journals and in conferences focusing on the aspect of environmental impact of materials and energy use in residential buildings. [redacted] has worked in academia for 10 years and as a professional for 3 years.

[redacted] (F), PhD in Industrial Economics and Technology Management, MSc Industrial Ecology (Environmental Management), is a research scientist at the Dept of Architecture, Building Materials and Constructions at SINTEF Community. [redacted] conducts research in the use of different types of tools in supporting innovation efforts and inter-organizational collaborative work. She is currently a task leader for innovation management, exploitation and market uptake in the H2020 syn.ikia project (2020-2023). She also holds an adjunct Associate Professor position at NTNU Business School at the Norwegian University of Science and Technology. Before her research and teaching career, Cheng had held managerial positions in strategic marketing and business development in the financial sector in Singapore and Hong Kong.

[redacted] (F), PhD in Geography, is a research scientist at the Dept of Architecture, Building Materials and Constructions at SINTEF Community. Dr. Baer is involved in the Research Center on Zero Emission Neighbourhoods in Smart Cities (www.fmezen.no) and Sharing Neighbourhoods (https://www.sintef.no/en/projects/sharing-neighbourhoods/). [redacted] is an active member of Norwegian Management Committee COST Action PED-EU-NET European Network for Positive Energy Districts. Prior to becoming a researcher, she has worked for 8 years in various urban planning projects (Associate in the project "Future Urban Industries", Stiftung Neue Verantwortung, Berlin, Germany (2011-2012); Consultant and Neighbourhood Manager for a Business Improvement District (BID) at CIMA GmbH, Hamburg and Luebeck, Germany (2009-2010); Project manager at Büro für Stadterneuerung [Office for Urban Renewal] Berlin, Germany (2006-2009).

[redacted] (M), PhD in Visualisation and Computer Graphics, is a research scientist at the Dept of Mobility and Economics at SINTF Community with over 20 years of experience in research using advanced visualization methods. He has been project manager, work package leader and key member of a long range of projects, including several on Virtual Reality. In addition, he is presently leader for the GEMINI centre for eXtended Reality, a cooperation between SINTEF and Norwegian University of Science and Technology (NTNU). He has a strong background and competence in the development, modelling, programming and implementation of simulated scenarios to be used in VR and AR and has developed both small and full-scale driving simulations for the Norwegian Public Roads Administration and SINTEF. He currently leads the SINTEF research group state-of-the-art VR-laboratory.

Relevant publications, and/or products, services, or other achievements

1. Thomsen, Judith; Berker, Thomas; Hauge, Åshild Lappegard; Denizou, Karine; Wågø, Solvår Irene; Jerkø, Sidsel. The Interaction between Building and Users in Passive and Zero-Energy Housing and Offices: The Role of Interfaces, Knowledge and User Commitment. *Smart and Sustainable Built Environment* 2013; Vol 2.(1) s. 43-59
2. Hauge, Åshild Lappegard; Thomsen, Judith; Löfström, Erica. How to get residents/owners in housing cooperatives to agree on sustainable renovation. *Energy Efficiency* 2013; Vol 6 (2); pp 315-328
3. Taveres-Cachat, Ellika; Grynning, Steinar; Thomsen, Judith; Selkowitz, Stephen. Responsive building envelope concepts in zero emission neighborhoods and smart cities – A roadmap to implementation. *Building and Environment* 2019; Vol 149. Pp 446-457
4. Lolli, Nicola; Lien, Anne Gunnarshaug; Rønneseth, Øystein. Cost optimization of a zero-emission office building. *Buildings* 2020, Volum.10.
5. Gullbrekken, Lars; Time, Berit. Towards Upgrading Strategies for nZEB-Dwellings in Norway. *Journal of sustainable architecture and civil engineering.* 2019; Vol 25.(2) pp. 35-42

Relevant previous projects

H2020 NMBP- EEB-2019 syn.ikia
Duration: 2020-2023
Website: https://www.synikia.eu/
Role of SINTEF: WP leader

FME ZEN The Research Centre on Zero Emission Neighbourhoods in Smart Cities (Centre for Environment-friendly Energy Research funded by Research Council of Norway + industry)
Duration: 2017-2024
Website: www.fmezen.no
Role of SINTEF: Research partner, WP leader

FME ZEB The Research Centre on Zero Emission Buildings (Centre for Environment-friendly Energy Research funded by Research Council of Norway + industry)
Duration: 2009-2017
Website: www.zeb.no
Role of SINTEF: Research partner, WP leader

H2020-EE-2016-CSA: NERO – Nearly Zero Energy Wooden Buildings in Nordic Countries
Duration : 2017-2020
Website : https://cordis.europa.eu/project/rcn/210342/factsheet/en
Role of SINTEF: WP leader

SFI Klima 2050 – Centre for Research-based Innovation: Risk reduction through climate adaptation of buildings and infrastructure (funded by Research Council of Norway and national partners)
Duration : 2015-2022
Website : http ://www.klima2050.no/
Role of SINTEF: Centre leader

Significant infrastructure and/or technical equipment

NTNU/SINTEF laboratory infrastructure relevant to ARV:

- Laboratories for testing of building materials and components
- VR -Virtual reality lab for visualization of 3D scenarios

Zero Emission Laboratories:

- ZEB Test Cells Lab (twin cells) for research and development of ZEB technologies
- ZEB Living Lab – A dwelling for user-technology interaction studies.
- ZEB Lab – a flexible ZEB office for research on heating, ventilation, BIPV, PCM storage, and workplace design

Operational capacity of legal entity/partner organization

SINTEF is a research institute with several departments/institutes whose research activities are in line with the projects` activities. If needed the involvements of researchers from other departments/institutes will be considered, based on the need of the tasks in which SINTEF is involved. This to avoid disruptions and delays of the project development.

Ajuntament de Palma	**10. Palma City Council** **PALMA | ES**	
	Web site: www.palma.cat **PIC number:** 967168474	**Number of employees:** 881

Brief description of legal entity/partner organization

The participant in ARV is the town council of the city of Palma de Mallorca, the capital of the Balearic Islands (> 460.000 inhabitants).

The work will be undertaken by the City Model Department (Model de Ciutat). Other departments and public organizations, also part of the Ajuntament de Palma, will collaborate in this project. These would include: PMH (Patronat municipal de l'Habitatge), Engagement Department (Participació Ciutadana) which deals with integrating citizen participation in some decision-making processes, Environment Department (Mediambient) in charge of reviewing the current regulation like PACES and developing new ones and the Infrastructure Department (Infraestructures) in charge of the efficiency energy on Town hall owned buildings.

Contribution to Work Packages and Tasks in the project

WP 2 Framework for effective planning, design, construction and operation of CPCC:
Use of planning methods and tools for Large Scale retrofitting actions at District level, for CEC at District level, and for Urban Planning at District Level: Energy &Circularity impact

WP 3 Community, environment, and well-being:
Social engagement for Large Scale Renovation. Centre for the Energy Transition –TE21 & Living labs. CEC- Citizen energy Communities
Demo developer in Districte Innovador Llevant in Palma de Mallorca

WP 4 Sustainable building design:
Integrated design process & catalogue of solutions for refurbishment of buildings with 50% of energy reduction

WP 5 Resource efficient manufacturing and construction workflows:
Integrated workflow for Large Scale Renovation of urban dense areas through Public private Partnerships (PPP).

WP 7 Efficient operation and flexibility:
Optimal management in CEC

WP 8 Monitoring and evaluation:
Energy monitoring & data collection in current buildings, retrofitted and new buildings and in CEC.

WP 9 Market uptake:
Business and financial models for Large Scale Renovation and CEC

Profile of key personnel in the project

[redacted] M)
General Director, Technical director, Deputy director of Urban Modeling, Fair Housing and Sustainability of Palma City Council since 2015. He is an architect and Doctor in Urbanism from the "Universitat Politècnica de Catalunya", combining research in urbanism with the corresponding transfer of knowledge in planning, programs and projects at the municipal and supramunicipal level. The following works are remarkable:

- In the town councils of Calvià (Mallorca), Gavà (Barcelona) and in the Barcelona Metropolitan Area.
- At the Universitat Politècnica de Catalunya as Deputy Coordinator of the Urbanism Research Group, Professor of the Department of Urbanism and Spatial Planning and at the European Postgraduate Master in Urbanism.
- Co-director of the *Revista Iberoamericana de Urbanismo*.

General Director, Technical director, Deputy director of Urban Modeling, Fair Housing and Sustainability of Palma City Council

[redacted] M)
[redacted] is an industrial engineer specialized in buildings. He was Energy Director for the Balearic Islands Government in 2010 and currently acting as the Housing Director for Palma and Director of the Coordination Department of the Sustainable and Integrated Urban Development Strategy, [redacted] brings experience in sustainability and urban regeneration.

Director of Housing and Manager of the Municipal Board of Housing and Integral Rehabilitation of Neighborhoods

Relevant publications, and/or products, services, or other achievements

Relevant previous projects

- FP7 – CIVITAS-DYNAMO project. Website: https://civitas.eu/content/dynmo
- FP7 – CONURBANT project. Website: https://www.conurbant.eu/en/
- Interreg MED – INCIRCLE project. Website: https://incircle.interreg-med.eu/
- European Parlament – Biodivercities project.
  Website: https://oppla.eu/groups/biodivercities/timing-and-end-date-biodivercities-project

Significant infrastructure and/or technical equipment

n/a

Operational capacity of legal entity/partner organization

n/a

IBAVI Institut Balear de l'Habitatge Govern de les Illes Balears	**11. Institut Balear de l'Habitatge IBAVI | ES**	
	Web site:	**Number of employees:**

Brief description of legal entity/partner organization

The Balearic Housing Institute (IBAVI) is a public body attached to the Ministry of Mobility and Housing of the Government of the Balearic Islands, whose objective is the promotion of protected housing. The IBAVI's primary purpose is the creation and maintenance of a real estate park of public social housing that is accessible and affordable for the citizens of this community. The Balearic Housing Institute also processes and manages grants and subsidies designed to facilitate and improve access to housing for residents of this community. The IBAVI was created on December 30, 1986, and its Constitution Decree was published in the BOCAIB No. 9 of January 20, 1987

Contribution to Work Packages and Tasks in the project

WP4: Sustainable building (re)design
WP5: Integrated Manufacturing processes and worflows – **Task 5.3**
WP8: Monitoring and Evaluation
WP9: Market Uptake
WP10: Communication

Profile of key personnel in the project

[redacted] is currently the Balearic Social Housing Institute (IBAVI) Manager and Director. She is graduated in Economics by the Pompeu Fabra University, Barcelona and Ludwig Maximilians Universität, München. She has a Master's degree in Corporate Social Responsibility (CSR) and Sustainability from UNED & Jaume I University (UJI). She was the Mallorca Island Council Director of Finance, Budgets and Projects from August 2015 to March 2019 being in charge of SCR development from July 2017 onwards. She was also the Founder and CEO of Tucktuck Community, S.L. from 2012 to 2020, and international cooperant aid for the Fair Trade Project at Vicente Ferrer Foundation from March 2011 to June 2012, in Anantapur, India.

Email: [redacted]

Telephone: [redacted]

[redacted] is an architect from the Barcelona School of Architecture (ETSAB). During his studies, he has received scholarships to study to UC Los Angeles, TU Delft and ETSAM. Currently he is the Head of the Technical Department of the Balearic Social Housing Institute, and he has been the director of the Life Reusing Posidonia project, funded by the European programme LIFE+ for Nature Conservation & Climate Change Adaptation Projects. As member of the IBAVI team he has received some awards that facilitate his credibility when he explains that things can be done differently, like FAD Award 2018, Spanish Biennale Award 2018, Spanish Architecture 2019, and shortlisted for the Mies European Award 2019. He has given lectures around Europe and his work has been extensively published and exhibited.

Email: [redacted]

Telephone: [redacted]

Relevant publications, and/or products, services, or other achievements

Publications:

- Life Reusing Posidonia book. 2017. http://eng.reusingposidonia.com/the-book/
- Life Reusing Posidonia documentary. 2017. http://eng.reusingposidonia.com/the-documentary/
- Balearic eco-friendly building materials catalog. 2018. http://eng.reusingposidonia.com/catalog-of-materials/
- Posidonia oceanica as thermal insulation. Journal of Construction. Vol 17, No 2 (August 2018).
- http://revistadelaconstruccion.uc.cl/index.php/RDLC/article/view/2067/2135

Other publications resume: file:///C:/Users/aparato/Downloads/AFTERLIFE-LRP-ENG.pdf

Relevant previous projects

- LIFE +: LIFE12/ENV/ES000079 (Life Reusing Posidonia). 2013-2018.
- Euroregió Pirineus Mediterrània: 'Buildings that tend to industrialization and the nZEB' project. 2014-2015.

Significant infrastructure and/or technical equipment

1- Neptune grass thermal insulation, a nature-based solution that will be performance at the demo building, which can be applied only on those places where the Posidonia Oceanica is a local resource.
2- Embodied energy calculation method.
3- Low emissions architectural solutions in order to build <500Kg CO2/m2.

Operational capacity of legal entity/partner organization

n/a

Shaping Energy for a Sustainable Future	**12. Institut de Recerca en 110nergía de Catalunya IREC | ES**	
	Web site: www.irec.cat **PIC number: 996435993**	**Number of employees: 120**

Brief description of legal entity/partner organization

The Catalonia Institute for Energy Research (IREC) is a publicly funded institution of approximately 120 people created in 2008 based in Barcelona and Tarragona that conducts research and promotes innovation over a wide range of energy related science and technology fields. IREC contributes to sustainability via development of new technological solutions, promotion of scientific and technological know-how related to clean energy and its efficient use as well transfer of solutions and expertise to market actors. Activities include national and international projects as well as direct cooperation with leading industrial partners. The institute also supports the promotion of renewable energy technologies and assists political decision-makers.

IREC has a large expertise and skills in research and industrial projects, with an annual turnover of about 10M€. IREC belongs to the CERCA and TECNIO networks of research and technologic centres of the Generalitat of Catalunya as well as to several Joint Programs of the European Energy Research Alliance (EERA, www.eera-set.eu). IREC is a full member and founder of the KIC Innoenergy and the Catalonia Energy Efficiency Cluster (CEEC) to promote energy innovation in Europe. Finally, IREC leads RIS3CAT community in energy belonging to the Smart Specialization Platform- S3 (http://s3platform.jrc.ec.europa.eu/), published more than 600 peer-reviewed papers, holds more than 35 patents and has supported the creation of 3 spin-off companies. IREC counts with state-of-the-art experimental laboratory facilities for evaluating and improving the performance of emerging energy technologies and building thermal/electrical components under realistic dynamic conditions.

IREC is organized in 2 Departments: i) Energy Efficiency for Systems, Buildings and Communities area (ECOS); ii) Advanced Materials for Energy. Topics of interests include Renewable energy sources (e.g., PV, wind, heat recovery, fuel cells, hydrogen), Circular economy (e.g., carbon conversion, catalyst), Smart energy Management and Systems (for systems, buildings, and communities), Energy Systems Analytics (e.g., Internet of Energy) and Energy Storage (e.g., electrochemical batteries, redox flow batteries).

Within the ECOS area, lays the Thermal Energy and Building Performance Group. The group has wide expertise in dynamic energy simulation and the implementation of energy efficiency strategies, heat reuse and the integration of renewables in buildings, Post-Occupancy evaluation and building flexibility.

Contribution to Work Packages and Tasks in the project

IREC will **lead WP2** on ‘’Framework and tools for effective implementation and assessment of CPCC’’ as well as act as supporting technological center for the democase in Palma de Mallorca.

In addition, IREC will contribute to the following WPs:

- **WP 2** Framework for effective planning, design, construction and operation of CPCC
  - Definition of CPCC assessment framework
  - Test and use of methods and tools for techno-socio-economic planning of Large-scale Renovation buildings & Citizen Energy Communities
  - Virtual Reality 3D Models for planning and citizen awareness
- **WP 3** Community, environment, and well-being:
  - Technical support in Living Labs Implementations
- **WP 4** Sustainable building design:
  - Energy modelling and integrated design for retrofitting of buildings in demo in Palma de Mallorca

- BIPV analysis and modelling. Testing BIPV solutions
- **WP 7** Efficient operation and flexibility:
  - Model predictive controls for the enhancement of centralized systems in multifamily buildings
- **WP 8** Monitoring and evaluation:
  - Data analysis and impact assessment of implemented innovations in Palma de Mallorca
- **WP 9** Market uptake:
  - Business models analysis for Large Scale retrofitting and CEC
- **WP 10** Communication, dissemination and training:
  - Publication of results & international conferences and seminars

Profile of key personnel in the project

[redacted] (M) [redacted] rently Group Leader of the Thermal Energy and Building Performance research group at IREC. Previously to joining IREC, he co-founded and led the cooperative firm AIGUASOL, which has become an international reference in the field of thermal energy efficiency, renewable energies, building physics and software development. He holds a doctorate degree in Thermal Engineering from the Polytechnic University of Catalonia (Spain) and he has research and professional experience in the fields of heat and mass transfer, fluid mechanics, building energy efficiency, thermal comfort and dynamic simulation. In his current position, he leads collaborations in several national, international and industrial research projects directed towards improving energy performance in buildings and energy systems.

[redacted] (F) [redacted] is part of the Energy Efficiency Systems, Buildings and Communities group (ECOS) at IREC since 2011. She works as a researcher in energy efficiency in buildings. She has participated in national and international projects related to refurbishment of buildings, NZEB / nZEB concepts, energy flexibility of buildings, stochastic models of occupancy and environmental comfort of the users (MEDNICE, MARIE, RePuBlicZEB, ECOE, SABINA, Rehab-SALUT). She has obtained recently a PhD in Sustainability at the Polytechnic University of Catalonia, which mainly focused on evaluate the refurbishment of residential buildings in Mediterranean climate. She combines her work as a researcher at IREC, with the position of Associate Professor in the Department of Fluid Mechanics at the Polytechnic University of Catalonia since 2016.

[redacted] M) [redacted] is a researcher at the Catalonian Institute for Energy Research (IREC). He obtained his PhD in 2020 from the Polytechnic University of Catalonia (UPC) and under the funding of the Marie Skłodowska-Curie Actions granting scheme of the European Union (project INCITE), working at IREC. His research focuses on designing efficient control strategies for heat pump systems, notably to enhance the energy flexibility of buildings. This work includes simulation studies but also a large experimental part, where the strategies are tested on real heat pump systems in semi-virtual laboratory environment. He also participates actively in the activities of the IEA EBC Annex 67 about energy flexible buildings. [redacted] graduated in 2014 carrying out a double degree between the École Centrale of Nantes (France) and the Technical University of Denmark (DTU). After graduation, he held a position of Research Assistant from 2015 to 2016 at the International Centre for Indoor Environment and Energy (ICIEE) at DTU, studying the performance of plus-energy houses and the use of solar panels for nocturnal radiative cooling, both topics also including experimental tasks.

Relevant publications, and/or products, services, or other achievements

1. **Salom, J.,** Pascual, J., (2018). Residential Retrofits at district scale. Business Models under Public Private Partnerships. ©InnoEnergy, 2018. ISBN 978-84-09-07914-8. http://www.innoenergy.com/residentialretrofitsreport
2. **T. Péan, J. Salom, J. Ortiz**, Environmental and Economic Impact of Demand Response Strategies for Energy Flexible Buildings. Proceedings of BSO 2018: 4th Building Simulation and Optimization Conference, Cambridge, UK: 11-12 September 2018.
3. A. Tejero**, J. Ortiz**, **J. Salom**, Evaluation of Occupancy Impact In A Residential Multifamily nZEB Through A High Resolution Stochastic Model. Proceedings of BSO 2018: 4th Building Simulation and Optimization Conference, Cambridge, UK: 11-12 September 2018.
4. **T. Péan, J. Ortiz and J. Salom**. Impact of Demand-Side Management on Thermal Comfort and Energy Costs in a Residential nZEB. Buildings, vol. 7, no. 2, p. 37. (2017)
5. **Péan T., Salom J**., Costa-Castelló R., 2018, "Review of control strategies for improving the energy flexibility provided by heat pump systems in buildings", Journal of Process Control, doi: 10.1016/j.jprocont.2018.03.006.

Relevant previous projects

- **H2020 syn.ikia** (https://synikia.eu/; 2020-2024). The syn.ikia project will design a blueprint for sustainable plus energy buildings and neighbourhoods. This will include a balanced application of integrated energy design, energy- and cost-efficiency measures, local renewables, local storage, energy flexibility, and energy sharing and trading. The project will encourage community engagement and allow for flexible management of energy demand. It will also provide big data-based infrastructure management and smart networks.
- **H2020 EmpowerMED** (https://www.empowermed.eu/; 2019-2023). The project, taking into account the dynamic role women play in an economy, will connect them with health practitioners in a series of awareness pilot programmes to reduce energy poverty, assess its impact on health, and share knowledge for policy building at local- and EU-wide level.
- **H2020 GrowSmarter** (http://www.grow-smarter.eu/home/; 2015-2019) will demonstrate at 3 lighthouse cities (Stockholm, Cologne and Barcelona) 12 smart, integrated solutions as a way of preparing for a wider market rollout. Through this project, building retrofitting and infrastructures of energy supply connection will be implemented in Barcelona. Energy consumption and thermal comfort in citizen's houses is monitored to evaluate the impact of the energy intervention in buildings. The project will have a large impact across EU, by means dissemination activities and also involvement of follower cities.
- **H2020 SABINA** (http://sabina-project.eu/; 2016-2020) aims to develop new technology and financial models to connect, control and actively manage generation and storage assets to exploit synergies between electrical flexibility and the thermal inertia of buildings. SABINA targeted flexible energy storage by using the existing thermal inertia in buildings and the coupling between heat and electricity networks to reduce the electricity bill and, at the same time, giving the opportunity on buildings to participate in energy markets to obtain additional revenues for demand side energy markets.
- **FP7 RENEWIT** (http://www.renewit-project.eu/: 2013-2016) developed advanced simulation tools for the integration of renewable sources in IT data centers, as well as applications of heat reuse. The role of IREC in this project consisted on laboratory experiments for testing energy management and heat reuse techniques on a data center, defining energy concept and control strategies for supplying renewable energy and heat reuse strategies in data centres and performing energy simulations.

Significant infrastructure and/or technical equipment

IREC counts with state-of-the-art experimental laboratory facilities for evaluating and improving the performance of emerging energy technologies and building thermal/electrical components under realistic dynamic conditions. The laboratory infrastructure that is most relevant to this project is the Semi-Virtual Laboratory for Energy Integration (SEILAB) provided with cutting-edge technology comprising a data centre and systems for energy consumption, storage and district heating/cooling integration. SEILAB is provided with systems for generation and storage of heat and power and state-of-the art facilities for testing thermal and electrical equipment. A novel and advantageous feature of the laboratory is its semivirtual approach, which allows for the real equipment to be operated as a function of the Energy demand/production of a dynamic virtual building model. IREC laboratory applies a building semi-virtual testing environment for evaluating the performance of a comprehensive range of equipment technologies such as energy generation systems, thermal storage and space heating and cooling equipment, with the aim of defining strategies for assessing and integrating major energy systems in buildings. A liquid cooled micro-data centre is also available in SEILAB to test heat reuse strategies and control algorithm. This micro-data centre is connected either with a climate chamber or to a district heating/cooling. Moreover, SEILAB has the following facilities: 3 thermal test benches for emulating thermal energy loads/sources; 2 electrical test benches for electrical energy production/consumption; walk-in climate chamber; meteo station: temperature, wind speed, RH, global and diffuse radiation. PV station; HVAC equipment: air to water heat pump Buderus and water to water heat pump Dynaciat water storage tanks 1500, 1000 and 300L.

Operational capacity of legal entity/partner organization

n/a

metrovacesa	**13. Metrovacesa, S.A.** **MET | ES**	
	Web site: www.metrovacesa.com **PIC number: 915199269**	**Number of employees: 190**

Brief description of legal entity/partner organization

With more than 100 years of history, Metrovacesa is one of the biggest Real Estate developers in Spain, with 125 active developments (7.429 units) at the end of 3q20. Our mission is create homes to improve our clients´ lives. Our vision to become the national champion in residential development, being the developer of choice for customers, employees, communities and shareholders. To that end we must continuously achieve superior financial and operating results while adhering to the highest standards of business conduct. We have three business lines, Residential Development, Commercial Development and Land Management.

Contribution to Work Packages and Tasks in the project

WP 3 Community, environment, and well-being: POE surveys as part of post-sale satisfaction process in Real State High Energy Efficient Buildings in the framework of Energy transition Living Labs.
WP 7 Efficient operation and flexibility: Efficient operation and control of centralized systems in multifamiliy buildings to improve energy matching with renewables energy sources.

Profile of key personnel in the project

[redacted] (M) [redacted] has 20 years' experience in the Real Estate sector and has worked at Metrovacesa for the last 12. He has accumulated extensive experience in land management. Prior to his appointment as Land Manager at Metrovacesa in October 2015, he was Regional Manager for a year for 700.000 m2 for residential and commercial use. [redacted] has been Land Manager in the regions of Levante and Catalonia from June 2005 to January 2015, specifically overseeing the urban development area. He was in charge of development at García de los Reyes, a private Spanish architecture firm, from July 2001 to May 2005. During this period, he was member of the Municipal General Town Planning Office at Almuñécar Town Hall (Granada). Miguel is a graduate in Architecture from the Granada Higher Technical School of Architecture and holds an Executive MBA from the Madrid Business Institute

[redacted] 19 years´ experience in the Real Estate sector and has worked at Metrovacesa for the last 2,5 as residential development`s manager for the regions of Cataluña and Baleares. He is responsible for the residential projects that Metrovacesa is actually developing in Sector Levante District in Palma. [redacted] has previous experience in other relevant companies in the sector in Spain as Solvia, Building Center, Applus+, Gerens Hill International or Colonial. [redacted] is a graduate in Technical Architecture from the Universitat Politécnica de Catalunya and holds an Executive Real Estate Development grade at IESES Business School.

[redacted] as 15 years´ experience in the Construction sector and has worked at Metrovacesa for the last 3 as Building Facilities Technical Manager. [redacted] has previous experience in FCC, one of the biggest construction groups of the country. [redacted] is a graduate in Mechanical Engineering from the León University.

Relevant publications, and/or products, services, or other achievements

Relevant previous projects

Significant infrastructure and/or technical equipment

JARDINS DE LEVANT (https://metrovacesa.com/promociones/illes-balears/palma-de-mallorca/jardins-de-llevant) 114 units residential development at Sector Levante District in Palma. Currently under construction. Expected to be completed at the end of 2021.

JARDINS DE LEVANT (https://metrovacesa.com/promociones/illes-balears/palma-de-mallorca/jardins-de-llevant) 114 units residential development at Sector Levante District in Palma. Currently under construction. Expected to be completed at the end of 2021.

SOL DE LLEVANT & TERRASES DE LLEVANT. 115&88 units residential development at Sector Levante District in Palma.
Currently obteining construction permision. Forward purchase agreement for a Build to Rent turnkey project signed wit AEW. Expected to be completed during 2023.

Operational capacity of legal entity/partner organization

n/a

	14. University of Applied Sciences Utrecht **HU | NL**
Web site: www.hu.nl or **PIC number:** 986208507	**Number of employees: 3.329** **Number of students:** 36,000

Brief description of legal entity/partner organization

University of Applied Sciences Utrecht - Through its practice-based research, University of Applied Sciences Utrecht contributes to solutions for a wide range of societal issues. Issues submitted by our partners working in the field – at the regional, national and international level.UAS Utrechthas around 36,000 degree seeking students enrolled and offers over 70 different degree courses (bachelor and master level, full-time and part-time, summer school and professional courses). Education and research are closely related at HU.

Centre of Expertise Smart Sustainable Cities was founded in 2014, led by UAS Utrecht, a joint initiative of companies, educational institutes and local government, with the mission to move forward towards a sustainable city. Governance of the centre lies with the program council, which consists of representatives of the VET providers (HU-UAS and ROC-MN), sector and industry representatives (BAM, Engie, Stroomversnelling, Happpy Balance, USI) and local government (City of Utrecht). This Centre is active in four programs: fossil free areas, healthy buildings, smart mobility and urban experience. An important theme for the centre is the transition to fossil free areas, offering research and education. The centre has over 100 partners that participate in one or more of the activities of the centre. Multidisciplinary (construction, engineering, IT, retrofitting, co-design, operations & maintenance, building physics, monitoring & real estate finance etc.) researchers and student teams participate in the programs of the centre.

The research group Applied Urban Energy Transition has the following expertise: construction, engineering, renovation, operations & maintenance, building physics, monitoring & real estate finance, customer journey, supply chain innovation, product development. The research unit is part of CoE Smart Sustainable Cities.

Contribution to Work Packages and Tasks in the project

WP 1 Management: *Demo coordination*
WP 2 Framework for effective planning, design, construction and operation of CPCC: *Pre-manufacturing framework*
WP 3 Community, environment, and well-being: *Social impact in districts.*
WP 4 Sustainable building design: *Circular and Energy Efficient Retrofit design of building components with the crossover between installation and building technology. Design for retrofitting in occupied state through multidisciplinary design teams.*
WP 5 Resource efficient manufacturing and construction workflows: *Retrofit construction process in occupied state. Circular HUBs for distribution and manufacturing*
WP 6 Renewable energy and storage: *Designing and monitoring renewable energy systems*
WP 7 Efficient operation and flexibility: *Social innovation for innovation adoption*
WP 8 Monitoring and evaluation: *KPI's assesments for construction and design to deliver performance guarantees.*
WP 9 Market uptake: *Business models for As a Service.*
WP 10 Communication, dissemination and training: *Embedded design research education methods.*

Profile of key personnel in the project

[redacted] (F) is Professor of Applied Urban Energy Transition at the University of Applied Sciences Utrecht. She is leading the theme energy neutral and circular regions in the Centre of Expertise Smart Sustainable Cities. The professorship is affiliated with the courses of the Institute for Design and Engineering (IDE). From January 2012 until 2019 she was Professor Spatial Transformations at the Hanze University in Groningen. Until 2016 she combined the position in Groningen with a professorship Innovative Technology in Construction at Saxion University. [redacted] studied Architecture at the Delft University of Technology, where she also ob [redacted] a doctorate with her thesis *Components Design: the role of architects in product innovation*. She furthermore worked for a period of four years at Slavenburg's Bouwbedrijven, where she was in charge of incorporating client-focused innovations into the operating processes. She then joined TNO (the Netherlands Organisation for Applied Scientific Research) as a senior building process innovation researcher in the Energy and Comfort Systems department, where she focused on the development, together with companies in the building sector, of sustainable building components and processes that meet the needs of clients and end users. She has more than 50 publications on her name and worked at several EU projects e.g. ManuBuild, eHub, Retrokit and Cost Effective. As the chair of Urban Energy (all Dutch professorships of the Universities of Applied Sciences focused on the energy transition in the built environment) she is member of the writing committee of the BTIC (Dutch Center for Building Technology Innovation) program on energy transition in the built environment. She is a board member of Earth, Wind & Fire (EWF) promoting passive climatisation principles, Eurosolar NL, promoting renewable energy, and Booosting, an innovation network in construction and a member of the Groninger EnergieKoepel (GrEK). She is furthermore a member of academic networks Het Groene Brein, W104 Open Building Implementation and W119 Customized Industrial Construction (the former TG57, Industrialised Building) of the International Council for Research and Innovation in Building and Construction (CIB).

[redacted] (M) Senior lecturer [redacted] graduated as a physicist at the University of Utrecht in 1994 and subsequently conducted doctorate research in the field of atomic and molecular physics at Stichting FOM. From 1999 until 2006, he worked as a researcher and project manager in the field of hydrogen technology at the ECN (Netherlands Energy Research Centre, now known as TNO) in Petten for applications in the built environment, industry and mobility. Those applications were developed together with several European consortiums. The further development and optimisation of fuel cells and stacks were the main challenges. From 2007 to 2009, he worked at TNO in Apeldoorn, where his focus shifted to thermal storage systems and heat pump technology for residential and non-residential building. Issues in the field of sustainable energy were addressed on behalf of market gardeners, data centres, housing corporations and the installation sector, in addition to fundamental research in the field of energy storage, among other fields, such as energy piles and thermochemical materials. In 2010, [redacted] carried out research as part of an international heat pump monitoring programme (Sepemo Build) at government agency RVO, and participated in the development of the Renewable Energy Monitoring Protocol and the order in council regarding heat and cold storage in the urban environment. Since late 2010, he has worked at the University of Applied Sciences Utrecht in the field of energy systems research and education. Since 2013, he has worked as a senior lecturer in the Applied Urban Energy Transition professorship, in charge of acquisition, project management and research in the field of local energy systems and sustainability techniques for areas and buildings.

[redacted] (M) works as a researcher and project manager in the Applied Urban Energy Transition professorship, at the Centre of Expertise Smart Sustainable Cities and at the Built Environment Institute. He is an initiator of several workshops aimed at linking trade and industry, research and education, with a view to achieving the greatest possible positive impact on society. He is project manager of Inside Out at the University of Applied Sciences Utrecht and researcher of the monitoring of comfort performances and the building process, where a ten-storey block of flats is being converted into high energy generating flats for housing corporation Bo-Ex. The students are participating in that project as designers and testers. New projects that [redacted] is working on relate to Dutch and international knowledge of the existing housing stock, knowledge of the (potential) demand in relation to Business to Consumer and Business to Business; application of Industry 4.0 by having several Product Market Combinations run along the same product line; Open Building as a modular strategy for building components designed on the basis of user wishes and technology of the existing housing stock, implemented in an Industry 4.0 product environment. [redacted] coordinates several courses at the Built Environment Institute, such as the Sustainable Transfo [redacted] ovation (120EC) specialist course. He lectures on Zero Energy home renovations, his specialist area.

[redacted] (M) Architecture and Construction Engineering at the University of Applied Sciences Utrecht, followed by Architecture and Construction Engineering at the Delft University of Technology. In 2017, he obtained a doctorate at the Delft University of Technology with his thesis *Future-proof Renovation*. He has worked at the University of Applied Sciences Utrecht since 2002, as senior lecturer in Future-proof Building and Living, Innovation Lab and minor Asset Management researcher, and Master of Urban Engineering project manager.

[redacted] graduated as physical geographer at the Institute for Biodiversity and [redacted] ynamics of the University of Amsterdam. He is specialized in developing and coordinating sustainable innovation projects that start off from the Utrecht region, contributing to the transition towards sustainable urban regions, nationally and internationally. The Utrecht region is characterized by many knowledge institutions and companies providing sustainable solutions. By linking their knowledge to regional sustainability ambitions, complex issues can be solved in an integrated manner. [redacted] works in close cooperation with knowledge centres, governments, businesses and societal organizations, bringing these parties together in research and innovation projects leading to smart and sustainable approaches related to the strategic reserves of energy, water and materials in urban areas. [redacted] s project manager and Lighthouse City Site Manager in the IRIS Smart Cities (https://irissmartcities.eu/) demonstrating solutions at district scale integrating smart homes and buildings, smart renewables and closed-loop energy positive districts. Also, demonstrating smart energy management and storage solutions targeting grid flexibility and demonstrating integrated urban mobility solutions increasing the use of environmentally-friendly alternative fuels. [redacted] is also site manager of the project Inside Out (https://tki-inside-out.nl/), in which a consortium is developing and testing a modular renovation system to create positive energy high-rise apartment buildings. The Inside Out consortium integrates installations into multifunctional building components on the outside of the building.

Relevant publications, and/or products, services, or other achievements

- Oostra, Mieke, *De circulaire energietransitie van de gebouwde omgeving, verkenning voor woongebieden* (The circular energy transition of the built environment, exploration for living areas), to be published in 2021, study for Enpuls
- Oostra, Mieke, *Nieuwe Energie, Energietransitie van de gebouwde omgeving als onderdeel van complexe maatschappelijke transformatie; Applied Urban Energy Transition, Energy transition of the built environment as part of complex societal*

transformation, inaugural lecture, Utrecht University of Applied Sciences, Utrecht, 2019. https://centreofexpertise.mett.nl/publicaties/downloads_getfilem.aspx?id=1120470&forcedownload=true
- Oostra, M. 'Smart Open Retrofitting', proceedings *CIB World Building Conference 2019 Constructing Smart Cities*, June 17-21, 2019.
- Oostra, Mieke & Civic architects, *Circulaire Stations*, Spoorbeeld inspiratie, Spoorbouwmeester, Utrecht, 2019
- Oostra, Mieke, 'Democratising Large-Scale Retrofitting of Housing', proceedings *UIA Conference*, Seoul, 2017

Relevant previous projects

1. **Energy Poverty in the rented sector (H2020).** This Horizon 2020 project aims supporting the policies for alleviating energy poverty in specifically the rented sector in various European Member states.
2. **Smart Solar Charging (EFRO).** A sustainable energy system at district level: with Smart Solar Charging, locally generated solar energy is stored in (shared) cars via a smart and dynamic system (Vehicle2Grid). The University of Applied Science is investigating the desirability of this service for users. What are the needs, wishes and fears of the citizens? How could citizens be engaged to support the charging system?
3. **De stroomversnelling (Energiesprong).** The research group Applied Energy Transition was part of several projects part of Energiesprong (Energy Leap), a programme commissioned by the Dutch Ministry of the Interior. In these projects owner-occupants and three consortia of companies were supported in their quest to make privately owned homes energy-neutral. The Living Lab One-Stop-Shop was developed to support the consortia with research necessary for the development of industrial renovation concepts, modular building components, service concepts and reconfiguration of their supply-chains for row housing.
4. **Future Factory (MMIP3 & 4)**. Based on a programmatic approach, in this project the consortium is developing the Future Factory, which manufactures modules to make housing sustainable on a large scale. Through developments in three generations the necessary system change is made in order to realize large-scale mass production: generation 1 (current production facilities) to prototype, generation 2 production facilities and ultimately the 3rd generation the realization of a production facility that can supply 25,000 homes per year. https://future-factory.nl
5. **IRIS Smart Cities (H2020)**. The European Innovation Partnership on Smart Cities and Communities (EIP-SCC) brings together cities, industry and citizens to improve urban life through more sustainable integrated solutions, including applied innovation, better planning, a more participatory approach, higher energy efficiency, better transport solutions, intelligent use of Information and Communication Technologies (ICT). The IRIS project is strongly committed to actively participate in the 6 'Action Clusters' set by the EIP-SCC.

Significant infrastructure and/or technical equipment

TESTING FACILITIES OF THE PROFESSORSHIP

The professorship has direct access to the following TechLabs:

- Energy Lab
- Climate Chamber
- Sustainable Energy Lab – a roof for testing of renewable energy generating modules
- Innovation Lab – for assembling and testing building components
- Wonen 3.0 – e.g. biobased & energy neural homes that can be used for testing

Test labs of the University of Applied Sciences Utrecht

Via our contacts at the University of Applied Sciences, we also have access to:

- Co-design Labs

- ProtoSpace Lab, where technological innovation concepts can be converted to proofs of concept by means of rapid prototyping and 3D printing, among other things
- Block Chain Lab
- iLabs – Life Sciences lab facilities

Operational capacity of legal entity/partner organization

n/a

15. Housing Europe
HE | BE

Website:
https://www.housingeurope.eu/

PIC number: 991142024

Number of employees: 10

Brief description of legal entity/partner organization

HOUSING EUROPE is the European Federation of Public, Cooperative & Social Housing. Housing Europe is based in the Belgian capital of Brussels and is registered as an NGO (AISBL under Belgian law). Since 1988, Housing Europe has developed a network of 45 national & regional federations bringing together 43,000 housing providers in 24 countries. Together, we manage roughly 27 million homes, about 11% of the dwellings in Europe.
Social, public, and co-operative housing providers have a vision of a Europe that provides access to decent and affordable housing for all residents in socially, economically and environmentally sustainable communities and where everyone is enabled to reach their full potential. For Housing Europe, the priority of the European Union and its member states in the field of sustainability, energy, and climate in the next decade should be to develop a positive business environment for the reduction of energy consumption in the housing sector, with specific attention paid to the affordable-housing sector.
Housing Europe has participated successfully in more than a dozen Horizon 2020 projects as Project Coordinator (Power House), Work Package leader (Syn.ikia) and as Partner in several Work Packages, often including Communication, Dissemination, Replication, Policy Recommendations and Research activities.

Contribution to Work Packages and Tasks in the project

WP 1 Management: Sorcha Edwards with the assistance of Clara Mafé will ensure effective project management and implementation.

WP 2 Framework for effective planning, design, construction and operation of CPCC: Dara Turnbull and Clara Mafé will draw from their experience in contributing to already existing assessment frameworks for Sustainable Plus Energy Neighbourhoods (www.synikia.eu), especially referring to social key performance indicators.

WP 3 Community, environment, and well-being: Sebastien Garnier and Clara Mafé will draw from their experience in producing user acceptance and satisfaction renovation survey for HEART (https://heartproject.eu/) and the creation and development of Living Labs in under H2020 smart city projects.

WP 7 Efficient operation and flexibility: Dara Turnbull and Clara Mafé will support and follow the progress in this WP to increase the replicability potential of innovations across the Hosing Europe community.

WP 9 Market uptake: Dara Turnbull, Sébastien Garnier and Clara Mafé will contribute to the design innovative financial instruments for energy positive real estate and communities.

WP 10 Communication, dissemination and training: Diana Yordanova, Clara Mafé and Sorcha Edwards will guarantee effective stakeholder outreach and engagement thanks to the well-established networks and communities of Housing Europe and will ensure content alignment withing and beyond the consortium through the development of appropriate online platforms and dissemination material.

Profile of key personnel in the project

[redacted] (F) is the Secretary General & Energy Coordinator of Housing Europe and is in charge of the so-called CECODHAS Energy Expert Network, a group within Housing Europe gathering experts from 20 national housing federations from all across Europe. She led the POWER HOUSE EUROPE Project, an initiative aimed at creating National and European Platforms of key stakeholders to promote energy efficiency and sustainable energy in housing. [redacted] is currently coordinating the POWER HOUSE Nearly Zero Energy Challenge project, aimed at engaging local housing organisations to share experiences and identify avoidable mistakes to meet the nearly-Zero obligations outlined in the Energy Performance of Building Directive. After her Communication & Language degree during which she studied a year in Germany, she completed a Master in European Policies at the University of Leuven, Belgium. She has also worked for the Irish Institute for European affairs developing training seminars on EU policies and to the TACIS EU Technical Assistance Office to monitor the implementation of the TACIS programme. [redacted] speaks English (mother tongue), French, German and Spanish.

[redacted] (F) is Communications Director at Housing Europe. She is responsible for the external and internal communications work of the federation, including its online presence, press relations, event curation, and European projects-related communication activities. She is in charge of curating the organisation's publications and preparing the bi-weekly newsletter. Before joining Housing Europe, [redacted] was leading the communication team of a Brussels-based trade association where she gained experience in communicating complex and technical EU issues in a simple and engaging way, media campaigns, and brand awareness. Having been part of a communication consultancy, she also specialised in social media campaigns for DG Environment. [redacted] holds a bachelor degree in Journalism from UNWE, Sofia and a Master Degree in New Media and Society in Europe from Vrije Universiteit Brussel. A native Bulgarian, [redacted] lso speaks English and French fluently.

[redacted] (F) is a Junior Project Manager at Housing Europe. She has been mostly working H2020 projects related to the energy transition through innovation actions related to sustainable plus energy neighbourhoods and circular deep renovation in the housing sector. Besides, she also manages Housing Europe's "Our Homes, Our Deal" initiative to benchmark the work done by the public, cooperative, and social housing sector on building and renovation in an energy- and resource-efficient way. Before joining Housing Europe in 2020, she gained experience on user-centred innovation, co-creation and Living Labs at the European Network of Living Labs (ENoLL). [redacted] holds a BSc in Economics from the University of Valencia (Spain) and a MSc in Urban and Regional Planning at the University of Birmingham (UK). She speaks Spanish (mother tongue), English (C2) and is currently learning French (B1).

[redacted](M) is responsible for the expansion and management of the Housing Europe network of members, while he deals with the events organised by the Federation. At the same time, he is feeding into the work related to migration and integration policy and involved in the Triple A reno project on adequate, affordable and attractive deep renovations through gamified end-user cantered business models.

[redacted](M) is the Research Coordinator at Housing Europe, bringing together various strands of our work. This includes the preparation of research for the Observatory, coordinating knowledge sharing with and between our members, as well as working with our Innovation & Projects manager in ensuring the successful participation of Housing Europe in a number of EU level projects. An economist by training, [redacted] also brings five years of expertise in the area of finance to bear on analysis of issues concerning the financing of social housing and of national and EU funding schemes related to the provision of non-market housing solutions.

[redacted](M) is Housing Europe's Innovation and Project Manager. He has been working for almost ten years in the social and affordable housing sector. First as advisor in the Financial and Public Affairs departments of Aedes - the Dutch federation of social housing providers and its 300 members. He was later responsible for managing the European affairs for the Brussels office of Aedes during six years. During three years, he was chair of the Social Affairs working committee of Housing Europe. He has also been actively involved in the Housing Partnership of the EU Urban Agenda, the International Social Housing Festival and co-created the Housing Evolutions Hub that maps the sector's innovations in Europe.

[redacted] (M) is Housing Europe's Deputy Secretary General & Policy Coordinator, coordinating the policy work of Housing Europe, monitoring all relevant political developments, and drafting the position papers of the organisations. [redacted] coordinates the work of all Committees and makes the link between them and the day-to-day work in Brussels. He also represents Housing Europe in various events, delivering a wide range of presentations.

Relevant publications, and/or products, services, or other achievements

1. The future of Smart Energy Homes in 32 Words - A Housing Europe HEART Glossary, April 2019: https://www.housingeurope.eu/resource-1264/the-future-of-smart-energy-homes-in-32-words
2. Impact of the revised Energy Performance of Buildings Directive on affordable housing providers - Housing Europe Policy Brief, June 2018: https://www.housingeurope.eu/resource-1123/impact-of-the-revised-energy-performance-of-buildings-directive-on-affordable-housing-providers
3. The financing of renovation in the social housing sector - A comparative study in 6 European countries, June 2018: https://www.housingeurope.eu/resource-1124/the-financing-of-renovation-in-the-social-housing-sector
4. Decarbonisation of the building stock: a two-front battle, A Housing Europe position paper, April 2018: https://www.housingeurope.eu/resource-1096/decarbonisation-of-the-building-stock-a-two-front-battle
5. From blind gambling to visible impact - Making housing finance work for society, October 2017: https://www.housingeurope.eu/blog-1020/from-blind-gambling-to-visible-impact

Relevant previous projects

1. **HEART (H2020 - No 768921)**

   Period: 2017-2022
   Overall budget: € 6 638 687,50

   The HEART toolkit incorporates different components and technologies, which cooperate to transform an existing building into a smart building. In developing this toolkit, the project advances and improves energy efficiency and the use of renewable energies in buildings across Europe, particularly in Central and Southern Europe, where climate change is leading to increased electricity consumption both during summer and winter seasons.

   Our role in the project is to supervise demonstration activities in case studies with the specific support on the assessment of monitored data and users' acceptance, while strongly supporting exploitation/dissemination activities.

2. **syn.ikia: Sustainable Plus Energy Neighbourhoods (H2020 – No 841850)**
   Period: 2020 – 2024

   Overall budget: € 7 435 278,75

   The syn.ikia innovation project within the EU Horizon 2020 framework involves 13 partners from six countries and aims to enable the development of sustainable plus energy neighbourhoods in different climates, contexts and markets in Europe. Over the course of the project, four real-life plus-energy demo neighbourhood projects tailored to four different climatic zones will be developed, analysed, optimized, and monitored, demonstrating the functionality of the plus-energy neighbourhood concept for the rest of Europe. Our role in the project involves leading the work package of communication, dissemination and stakeholder engagement. We ensure content alignment within and outside the project by tailoring syn.ikia's message to diverse audiences of urban professionals, policymakers and residents who are in a position to spread the word and push the plus energy neighbourhood concept a step further. We are also responsible for establishing and developing an online community of stakeholders that want to learn more about with syn.ikia and similar research and projects in Europe. Our contribution to the project also entails the design and development of neighbourhood scale user engament systems and social key performance indicators for the demo neighbourhoods.

3. **HIROSS4ALL/OpenGela (H2020 - No 846707, 2019-2022)**

   Period: 2019-2022

   Overall budget: € 1 786 766.25

   "Creating One-Stop-Shops for integral urban regeneration in vulnerable districts" is a Horizon 2020 project that develops and implements new integrated home renovation services (IHRS) for private residential buildings in two districts in the Basque Country (Spain). Together with the public housing actors, it will be replicated the economically viable business model within the region and bring together active citizen engagement and an innovative financial instrument, making the service suitable for vulnerable populations. We put our network of organizations involved at the service of HIROSS4ALL for the

development of two main tasks: To contact with other One-Stop-Shop initiatives running in Europe and learn from their best practices (WP2), and to disseminate the project results among the Public and Social Housing stakeholders for replication purposes Europe wide.

4. **TRANSITION ZERO (H2020 - No 696186)**

   Period: 2016-2018

   Overall budget: € 3 570 438,75

   TRANSITION ZERO will make Net Zero Energy (E=0) refurbishments a market reality in the UK, France and The Netherlands. Energiesprong brokered a deal between housing associations and builders to refurbish 111,000 houses to E=0 levels in the Netherlands of which the roll-out will be further supported. Building on the same methodology and the inspiring example, a similar innovation trajectory will be facilitated through deals for 5,000 houses in the UK and France and building a pipeline of more demand.

   In this project we disseminated the lessons learnt and market conditions realized through our network of members as well as to national and EU policy makers.

5. **Triple-A-Reno (H2020 - No 784972, 2018-2021)**

   Period: 2018-2021

   Overall budget: € 1 999 933,88

   To make nZE (nearly Zero Energy) renovations attractive for consumers TripleA-reno wants to come up with clear information and communication on the real energy usage, indoor quality and personal health by developing an open and end-user-centered gamified (application of game-design elements and game principles) platform for decision support, quality validation / proven quality and community building. As a Brussels-based umbrella organisation representing the interests of our affiliated organisations, our tasks involved, amongst others, informing members and promoting the exchange of best practices form all across the EU and raise the profile of the sector to the broader public. All Housing Europe members will benefit from the project results once available.

Significant infrastructure and/or technical equipment

n/a

Operational capacity of legal entity/partner organization

We bring together 46 national and regional federations which together gather about 43,000 public, social and cooperative housing providers in 25 countries. Altogether they manage around 25 million homes.

Social, public and co-operative housing providers have a vision of a Europe which provides access to decent and affordable housing for all in communities which are socially, economically and environmentally sustainable and where everyone is enabled to reach their full potential.

Therefore, they do not just provide affordable homes but a number of other services such as:

- Domiciliary care and support services for residents with specific needs

- Additional services for tenants (kindergardens, community centres, employment and training services, financial advice)
- Neighbourhood services
- Management of other types of ‘sheltered’ accommodation
- Urban development and urban regeneration.

Our impact:

- 43,000 local housing organisations
- 24,936,000 dwellings
- roughly 200,000 new dwellings completed each year
- over 200,000 dwellings refurbished each year
- roughly €40bn in new investment per year
- 7,500+ staff employed directly by the federations
- 300,000+ staff employed by local housing providers.

BURO DE HAAN	**16. Buro de Haan (BURO DE HAAN) | NL**
	Web site: www.bdh.nl **PIC number: 898384222**
	Number of employees: 64

Brief description of legal entity/partner organization

Buro de Haan is a dynamic company specialized in housing issues and building systems. We offer architectural knowledge, from initiative to implementation, to realize building plans.
Our knowledge and skills combined with advanced design and engineering tools enable clients to build better by giving them a realistic picture of their plans. Our distinctive capacity is thinking along throughout the construction process and the amount of insight we give a client to make the right decisions. We operate from six business units with our central mission: "Build Beter". Our units are: area development, architecture, engineering, construction, measurement and information technology.

Contribution to Work Packages and Tasks in the project

WP 5 Resource efficient manufacturing and construction workflows:
Our experience in industrialisation and digitization will be applied for fast, comfortable and scalable renovations. Our digitalization expertise in point cloud technology, engineering, image recognition and "file2factory" approach, enlarged with a geo/district approach helps reducing costs in several stages of the process, in design and engineering as well as off site production.

Renovation design/ engineering is currently a relatively non-collaborative process. In large construction projects, owners typically contract with a firm to create a concept or front-end design that is then handed to contractors to further detail. The latter have little say on the initial design, and this can result in on-site complexities and constructability issues being solved late in the process rather than at the outset.

The process of design needs to be streamlined and made more collaborative,
and the repeatability of designs encouraged in order to drive scale in the production of
elements used in construction projects. Zero engineering has great potential to
influence the eventual cost of a project. Reducing overdesign, improving coordination,
removing ambiguity, and creating a cost-efficient constructible design that maximizes the
amount of components that can be produced off-site will have a significant impact on the
rest of the construction process.

Zero Engineering
Digital data harvesting using point-cloud scanning and image recognition that enables us to classify the buildings. Our development off AI-algorithms can recognise shape and generate the new surface on top of the existing building. By giving building owners access to this technique by means of configurators, one is able to customize the appearance format of the new components.

WP 6 Renewable energy and storage:
Expertise for integrating storage in building components and total concepts / propositions.

WP 9 Market uptake:
Experience in actual market dynamics, uptake and business models.

Profile of key personnel in the project

[redacted] graduated from TUDelft, from the Faculty of Architecture. He is specialized in more analytical form of design. His personal passion is in the digital design world in the field of programming and modeling.
In the activities of his team Zero Hours Engineering at buro de haan, automation based on parametric models and processing of datasets are central. In other words: informed design based on data analysis. Within the company we have built up knowledge to make the BIM process more efficient and streamlined by additional tools such as Grasshopper and programming languages such as Python and Java. Where the traditional BIM process is characterized by manual data entry, we believe in an automated process, where the design and its model are designed as a whole by using parametric models. Within the team we work according to the D2RPO (design to robotic production & operation), which means that all elements of the design are designed with the possibilities of modern technologies such as mass customization in mind. All parametric models have been set up in such a way that even during the implementation phase, it is possible to respond flexibly to possible hiccups in the production process, and, if necessary, to act quickly and adequately.

[redacted] (M) graduated from Windesheim University of Applied Sciences in Zwolle, from the Faculty of Architecture. He is the founder of Buro de Haan, and has the core task of managing the various teams as well as bringing the entire company further with the mission “Build Better”. In addition to this role, he also fulfills the task of technical developments within the company RcPanels. Due to the insight into the work required for renovation projects, as well as the knowledge of the teams of Buro de Haan / RcPanels and the high degree of interest in new techniques, he often acts as a driver to explore a next level in engineering and production. He takes part in this project to make good connections between the required end result and technical possibilities.

Relevant publications, and/or products, services, or other achievements

Beyond 2020
Upscaling the housing renovation market through far-reaching Industrialization
Y Decorte, M Steeman, U B Krämer, C Struck, K Lange, B Zander and A de Haan
https://iopscience.iop.org/article/10.1088/1755-1315/588/3/032041

BIM and Factory
Buro de Haan is the supplier of the engineering and production system of RcPanels. At the start of the factory, drawings were produced by employees of Buro de Haan and the machines manually provided with data. Due to developments in the field of BIM, Pull Planning and Warehouse Management, we have been able to reduce the manual actions to less than 30%. Currently the customer, machines, planning and coordination on the building site are operated from a BIM model.

BIM acts as a single-information resource for the entire project and supports all personnel who can access the BIM applications. This integration of information is made possible through involving 3D models of the building plans, the 'as-built facility,' as well as data related to subsequent building upgrades or for conceptualizing ways of solving problems that may be encountered once the building is put to use. Therefore, BIM becomes a way to virtualize construction, design, and management of a building throughout the life cycle of the building.

Pull planning / LPS are developed by those who later also founded the Lean Construction Institute, the method is a planning monitoring and control system that follows the principles of lean construction. Its ultimate goal is to enable more reliable and predictable production of projects as well as support a seamless workflow throughout the project, promote collaboration and trust within the project team and deliver safe & quality results with a faster turnaround time. Due to the completely seamless integration

between the LPS planning and the data from the BIM models, RcPanels is able to balance the factory on production and all employees can at any time access the latest data regarding product or production status.
https://www.youtube.com/watch?v=E97LRybwIy4

Relevant previous projects

Indu Zero
The North-Sea Region alone consists of 22 million outdated dwellings built between 1950 and 1985 that are in high need of renovation. Nowadays, the renovation industry applies mainly manual on-site renovation techniques, resulting in a low renovation pace, relatively high labour costs and a long duration. To tackle the urgent need for rapid renovations, six countries of the North-Sea Region collaborate to upscale the current renovation process in the Interreg project INDU-ZERO "Industrialization of house renovations toward energy-neutral". The project focuses on modular prefabricated renovation packages with fully integrated HVAC technologies to arrive at energy-neutral dwellings. The project researches the possibilities of far-reaching automated and industrialized production processes. A smart factory blueprint will be designed to speed up the renovation pace to a target of 15,000 renovation packages per year per factory while cutting the current price with 50%.

Future factory
Based on a programmatic approach, the consortium is developing the Future Factory, a production, supply and sales company with which homes and residential buildings can be made more sustainable on a large scale. Three generations are working on the system change that is necessary for this unprecedented scale. The upscaling from generation 1 (current production facilities) to prototype generation 2 production facilities and ultimately the 3rd generation production facility that can supply 25,000 homes per year. The customer interaction takes place within the program. However, not every product is suitable for mass production. The necessary research and development of the building components is done along the lines, roof module, facade module and installation module.

Significant infrastructure and/or technical equipment

Projectportals
A project collaboration portal has been developed within Buro de Haan with the insight Connect everyone. Manage better. Communicate and report in real time on the same digital tool with all those involved in the construction project. Construction projects have a major risk factor to control this, we divide projects into phases and we have tools in the sector to monitor the phases in the following areas:
- Money
- Risk
- Organization
- Time
- Information
- Quality

This platform now relieves us in projects and delivers its value on a daily basis. We are developing this further to offer more and more management tools to our own employees / affiliated parties and customers. In the context of this project, where the ambition is to speed up the process, it is important that this platform is in-house. Here we can use it to structure the data input between users and AI algorithms with are designing the buildings.

Measurement equipment

One of our departments is measurement. Further automated engineering process demands a higher accuracy of the input, because the human check will disappear. This course will also change craftsmanship off this department and probably has an impact on equipment. Because we own this company, we can more easily implement changes in equipment or work processes than with dependence on other suppliers with not sharing the same interests.

Bimpact
We also partly own Bimpact. This company sells software to automatically check within BIM software whether the building complies with laws and regulations. This knowledge and expertise has been developed within Buro de Haan and we will be sorely needed in the automatic generation of renovation packages.

Operational capacity of legal entity/partner organization

n/a

centerdenmark intelligent energy	**17. Center Danmark/EU Digital Innovation Hub** **CENTER DENMARK | DK**
	Web site: **www.centerdenmark.com** **PIC number:** 894818114
	Number of employees: 6

Brief description of legal entity/partner organization

Center Denmark provides a Trusted Data Sharing Platform with focus on data intelligence and integrated energy systems for Identification and utilization of flexibilities on demand side across energy systems.

Center Denmark is an independent, self-owned and non-profit organization working to promote development of digitally integrated energy systems in order to enhance society's transition to renewable energy sources and reduce environmental impact. Center Denmark contributes to establishing a national framework to promote research, education, innovation & development, testing and demonstration in connection with the transition to a fossil-free green society, building the foundation for a Danish "Silicon Valley" of energy systems.

The members of Center Denmark's Board of Directors are Associate Dean at Aalborg University Jakob Stoustrup, Associate Dean at Aarhus University Brian Vinter, Chief Consultant SDU Niels Langvad, Director of digitalization at Energinet Nicolaj Peulicke, CEO of Thorsen Invest Henrik Thorsen, CTO of HOFOR Bjarne Korshøj, CEO of Aalborg Forsyning Søren Gais Kjeldsen, Professor at DTU Henrik Madsen (deputy chairman) and CEO of EWII Lars Bonderup Bjørn (chairman).

Contribution to Work Packages and Tasks in the project

WP 1 Management: Experienced in large scale European projects

WP 3 Community, environment, and well-being: We can deliver digital user-interface for user feedback and smart control

WP 6 Renewable energy and storage: Digital infrastructure for real-time data and real-time control of when to store or consume energy so it serves the overall performance of the building in terms of lowering CO2 emission

WP 8 Monitoring and evaluation: We can fetch IoT-data and deliver monitoring systems and data dashboards that can give intelligent insights in the building performance and user behaviour

WP 9 Market uptake: Center Denmark can put the digital solutions for disposal to the industry through our digital Trusted Data Sharing Platform.

Profile of key personnel in the project

Primary responsible:

Søren Skov Bording (M), Director of Center Denmark.

Staff:

[redacted] (M), Senior Project Manager and computer scientist.

[redacted] (M), Software Engineer.

[redacted](F), Data Scientist.

[redacted](M), Data Scientist.

+ 2 new software engineers that are being on-boarded just now.

Relevant publications, and/or products, services, or other achievements

- Center Denmark is providing digital infrastructure and has part of the Danish Innovation Fund Project Flexible Energy Denmark, developed the very first Data Lake that can handle real time streaming of consumption data from electricity, heat and water sector.
- Bi-directional setup which can send back control signals with real-time capabilities.
- Approved Digital Innovation Hub by the EU-commission.
- Approved as Digtial Platform Provider and Living Labs and Test Beds by ERA-net Smart Energy Systems.

Relevant previous projects

Key partner in the Danish Innovation Fund project: **Flexible Energy Denmark**, www.flexibleenergydenmark.dk

Key partner in the Danish Innovation Fund project: **HEAT4.0**. Focus on continue developing digital infrastructure for district heating.

Key partner in the Danish Innovation Fund project: **Cool-Data Flexible Cooling of Data Centers**

Significant infrastructure and/or technical equipment

Center Denmark own and maintain our own servers situated at DTU in Denmark.

Operational capacity of legal entity/partner organization

n/a

	18. Sonderborg Andelsboligforening **SAB | DK**
	Web site: www.sab-bolig.net **PIC number: 929565842**
	Number of employees: 30

Brief description of legal entity/partner organization

SAB is a non-profit independent and private social housing company established as a cooperative member organisation of the residents (tenants), who own the organisation. The tenants are organised in housing departments, which have an individual economy and make their own decisions concerning their own housing department. For each department there is a board, and SAB has a main board for the whole organisation. SAB can only work with activities related to housing of their tenants.
SAB has 46 departments with totally 3,400 apartments in the Municipality of Sonderborg, DK.

Contribution to Work Packages and Tasks in the project

WP 3 Community, environment, and well-being: *Building owner, maintenance of buildings*
WP 4 Sustainable building design: *Planning of energy retrofitting activities and new construction projects*
WP 6 Renewable energy and storage: *Owner of several PV plants on different buildings*
WP 7 Efficient operation and flexibility: *Planning of energy retrofitting activities, maintenance of buildings, building owners*
WP 8 Monitoring and evaluation: *Experienced in pilot and demonstration projects within housing associations*
WP 10 Communication, dissemination and training: *Experts in communication and training of tennants in housing associations, citizens awareness*

Profile of key personnel in the project

[redacted]
Technical Director for SAB
Email:
Phone: [redacted]

[redacted] (M)
Technical inspector for SAB Department 22
Email:
Phone: [redacted]

Relevant publications, and/or products, services, or other achievements

Relevant previous projects

- Partner in H2020/SCC-01-2015 No 691883: SmartEnCity. Proposal successful.
- Partner in H2020/EE-2017-CSA No 785147: HAPPI. Leader of Work Package WP2: Energy Screening and Feasibility Studies

Significant infrastructure and/or technical equipment

n/a

Operational capacity of legal entity/partner organization

n/a

	19. Green Digital Finance Alliance GDFA | CH	
	Web site: https://greendigitalfinancealliance.org **PIC number: 893237208**	**Number of employees: 3**

Brief description of legal entity/partner organization

The GDFA is a not-for-profit organization with a mandate to scale finance for the Paris agreement through fintech enabled innovation. We catalyse partner innovation by enabling them to deploy the new capabilities of fintech to address current barriers to scale green finance (barriers include size of green assets, high cost of structuring green assets and issue debt, insufficient green metrics from the real economy and more). The work is guided by three strategic pillars of 1) thought leadership 2) enabling green digital investor ready metrics 3) experimentation to scale. GDFA has been knowledge partner to the G-20 Working Group on Sustainable Finance and to the UN SG's Task Force for Digital Financing of the SDGs as part of its thought leadership work. In this work the GDFA has worked closely with several European jurisdictions to identify innovative financing models to deliver on national green objectives these include BMU in Germany, The Central Bank of Spain, and the Central Bank of the Netherlands. The GDFA has a network of relations to FI's and FI associations (e.g., European Banking Federation) in the Union to be leveraged in the project. The GDFA has a global catalogue of innovative financing models for scaling energy efficiency and renewable energy supply, which is an asset of emerging practices to be leverages in the project. The work of the GDFA is guided by its high-level advisory board, which will also be an asset in the ARV project. GDFA links its knowledge and results of the thought leadership and experimentation to scale work into the network of UNEP FI, which has 350 FI member institutions. GDFA experimentation to scale work demonstrate scalable green digital financing instruments through experimentation at market level and use validated innovative financing vehicles in dialogue with FI partners to enable adaptation across jurisdictions through standardised frameworks.

Contribution to Work Packages and Tasks in the project

WP 9 Market uptake:

Green Digital Finance Alliance (GDFA) has been knowledge partner to the G-20 Working Group on sustainable finance and to the UN SG's Task Force for Digital Financing of the Sustainable Development Goals. Here the GDFA has worked across jurisdictions with policy makers, regulators, and financial service institutions via innovation processes to develop new concepts on innovating green finance with fintech. The GDFA works on "Experimentation to Scale" projects that brings together partners to design and test innovative green digital financial instruments. Hence, GDFA brings with it a toolbox and processes to design innovative financial instruments that are digitally enabled. The GDFA was co-founded by UNEP and works closely with the UNEP Finance Initiative, as the digital finance arm that informs the work of its 350 member organizations. The GDFA has a large network to financial service institutions in the European Union and has collaborated with banks to design green digital bond concepts. The GDFA brings the capabilities of its high-level Advisory Board into the work which include but are not limited to MIT Media Lab, the European Climate Foundation, as well as relations outside of the Advisory Board to for instance the Central Bank of the Netherlands, the Central Bank of Spain, the European Banking Federation and more.

Profile of key personnel in the project

[redacted] (F): Director of the Green Digital Finance Alliance. [redacted] projects with banks (incl. HSBC) on innovation of financial instruments via automation, she has spearheaded the design of a data measurement framework for policy makers and regulators to guide avenues to scale green finance with fintech, she has designed approaches to innovation in finance under the GDFA. She has managed a knowledge partnership with the UN SG's Task Force for Digital Financing of the SDGs. Marianne holds an M.Sc. in Environmental science and additional certificates in digitization of finance.

Green Finance Specialist (to be engaged): This specialist will be identified by drawing from the was network of our Co-chair UNEP FI to identify the best match of a green finance specialist. Key capabilities and skills will include in-depth knowledge of structuring financial instruments to scale flexible energy finance linked to different real-estate asset classes.

[redacted]: Business Model and Finance Officer. Has dedicated his career to business model and financial instrument design. Has been mention at several accelerator programs incl. Growth Train. Has built a fintech business to structure fund investments using tokenization of assets. Has engaged as expert and consultant to renewable companies incl. Ørsted supporting innovation of finance of flexible energy and to financial service institutions. Including experience with tokenization as part of design of prosumer markets. Holds a B.Sc. in Business and Finance and an M.Sc. from London School of Economics.

Relevant publications, and/or products, services, or other achievements

1. *Blockchain – Gateway to Sustainability linked Bonds*. Collaboration between GDFA and HSBC.
2. *Fintech for Sustainability – German Country Report.* Collaboration between GDFA and Fair Finance, Institute for Social Banking, and Conscious Fintech.
3. *Fintech for Sustainability* – Spain Country Report.
4. *Fintech for Sustainability* – The Netherlands Country Report.

Relevant previous projects

- Pathfinder Initiative under the UN Secretary General's Task Force on Digital Financing of the SDGs. Developing a country measurement framework for sustainable digital finance.
- Innovating climate finance with technology – collaborative project between the CAFI trust fund, CUFE University in China and the GDFA.

Significant infrastructure and/or technical equipment

n/a

Operational capacity of legal entity/partner organization

n/a

bo-ex | thuis in Utrecht	**20. Stichting Bo-Ex '91** **BOEX | NL**	
	Web site: **www.boex.nl** **PIC number: 934165485**	**Number of employees:** **90**

Brief description of legal entity/partner organization

Stichting Bo-Ex '91 is a housing corporation under Dutch Law, the Housing Act, established in 1907. Their main task is to provide low income households with sound quality and affordable housing. Bo-Ex cannot be selective in admitting households to its dwellings, except for income (there is a maximum). Bo-Ex is the owner of more than 9,000 dwellings in the city of Utrecht. Bo-Ex has a very ambitious refurbishment programme. In the period 2020–2025 more than 1,000 dwellings will be refurbished. And also Bo-Ex works on the realization of several new-build projects: in the period 2020-2025 more than 500 new-build houses will be realized.

Contribution to Work Packages and Tasks in the project

WP 3 Community, environment, and well-being:
Bo-Ex contributes to this Work Package on the following aspects:

- Social renovation: the involvement and engagement of tenants in the existing apartment buildings to develop a plan which will be supported by the tenants and to develop a plan for a sustainable community after the refurbishment has taken place.
- Bouw = Wouw (Human capital program): the involvement of (local) students into the realization of the refurbishment works.
- Energy Transition: the involvement and coaching of tenants to understand the energy concept and possibilities of their dwellings. With a better understanding, tenants can guide their energy usage.

WP 4 Sustainable building design:
Bo-Ex contributes to this Work Package by participating in an innovation forum which aims a better scalable solution for renovation works with a high degree of energy efficiency.

WP 5 Resource efficient manufacturing and construction workflows:
Bo-Ex contributes to this Work Package by elaborating on a resource efficient design for the refurbishment of apartment buildings.

WP 6 Renewable energy and storage:
Bo-Ex contributes to this Work Package by elaborating on a BIPV design for maximizing solar energy harvesting combined with local and district electricity storage providing support to the grid and EV-V2G.

WP 7 Efficient operation and flexibility:
Bo-Ex contributes to this Work Package by elaborating on the following demonstrations:

- Building Energy Management Systems
- Smart grids at district and city scale

WP 8 Monitoring and evaluation:
Bo-Ex contributes to this Work Package by gathering information and monitoring data coming from the tenants behaviours and energy performance of the refurbished apartment buildings.

WP 9 Market uptake:
Bo-Ex contributes to this Work Package by contributing to bankable business models for new replicable initiatives.

Profile of key personnel in the project

[redacted] (M) – project manager and real estate developer of several refurbishment and new construction housing projects. [redacted] has a broad experience within utility and housing projects for more than 10 years. Furthermore, [redacted] is involved in the Horizon 2020 project IRIS as project coordination and Work package leader for two WP's. [redacted] will be responsible for one of the selected refurbishment projects.

[redacted] (M) – project manager and real estate developer of several refurbishment and new construction housing projects [redacted] has a broad experience within housing corporations in several functions for more than 10 years. [redacted] will be responsible for one of the selected refurbishment projects.

Relevant publications, and/or products, services, or other achievements

Bo-Ex has experiences with the following products/services:

- Maintenance of dwellings / apartment buildings
- Refurbishment works of dwellings / apartment buildings
- Energy performance data of dwellings / apartment buildings
- Re-use of materials within new initiatives for dwellings / apartment buildings

Relevant previous projects

Bo-Ex participates currently in the following innovation projects:

1. European innovation project: IRIS – Horizon2020 project (2018-2022)
   District of Kanaleneiland-Zuid, Utrecht
2. National innovation project: TKI (2018-2021) – Henriettedreef
   District of Overvecht in Utrecht

Significant infrastructure and/or technical equipment

n/a

Operational capacity of legal entity/partner organization

n/a

RCPANELS	**21. RC Panels** **RCP | NL**	
	Web site: www.rcpanels.com **PIC number: 892078931**	**Number of employees: 23**

Brief description of legal entity/partner organization

Rc Panels is an innovative market leader in prefab facades for zero-energy renovations in The Netherlands and moving fast recently adding roofs and new built to the portfolio as well. It is a front runner in industrialization and digitization, running a "file2factory" process. The mission of Rc Panels is to make energy-neutral living profitable. The focus is on attractive "right first time" renovations with far-reaching energy savings, making them flexible for practically all types of fossil-free energy systems. By investing heavily in knowledge development, combined with a different view of the construction process, Rc Panels has developed a technological lead supported by patents. Rc Panels has knowledge and track record in developing and executing smart manufacturing.

Contribution to Work Packages and Tasks in the project

WP 1 Management: experience in core team roles managing both national innovation program and international innovation project, and managing own part of it as well.

WP 4 Sustainable building design: As a front runner in sustainable building and renovations, our expertise in design of integrated products (including hvac and pv installation integration in building components), in total concepts as well as in manufacturing (including DFM) ensures solutions that are both feasible and scalable for larger impact.

WP 5 Resource efficient manufacturing and construction workflows: Our experience in industrialisation and digitization will be applied for fast, comfortable and scalable renovations. Our "file2factory" approach helps reducing costs in several stages of the process. Front runner in off site production. Innovative far-reaching prefabrication and integration saves time, costs and inconvenience on site. Experience and expertise for manufacturability of the developed solutions as well as feasibility, circularity and scalability.

WP 6 Renewable energy and storage: Expertise for integrating storage in building components and total concepts / propositions.

WP 8 Monitoring and evaluation: Expertise in realisation of renovations, in innovation programs and pilots, in high performance methods, LCA and gap analyses.

WP 9 Market uptake: Experience in actual market dynamics, uptake and business models as well as innovation within those and new roles / system innovation.

WP 10 Communication, dissemination and training: experience in communicating both technical and non-technical topics expanding to policy makers, (future) clients, other bunisses, 139pprox.139t institutes as well as training of students.

Profile of key personnel in the project

[redacted] (F). Manager Business Development. 25+ years of experience in innovation, management, renewable energy and sustainable construction. Trained as a technical physicist and coach. Skilled in creating coalitions and merging interests, including those of the customer. Bridges the social, economic, environmental and technical innovations and the realization of feasible and scalable renovations. Lead in core team of national innovation program Future Factory.

[redacted] Innovation manager. 25+ years of experience with various contractors and one of the pioneers of Nul Op de Meter (zero energy) renovations from the very beginning. Trained in both engineering and economics, he has an eye for what can be done in construction. His many years of experience as both an innovator and realisator gives him even more eye for what is not yet possible but can be done, with which he, together with his innovation team at Rc Panels, works both structured and fast on new generations of products.

Relevant publications, and/or products, services, or other achievements

Relevant products: highly insulating and prefabricated facades (including doors, windows, finishing etc.) for net-zero renovations, fast and convenient and thus suitable for renovations in occupied condition.
Publications:

1. https://www.cobouw.nl/innovatie/nieuws/2020/04/de-renovatiefabriek-van-lemelerveld-we-kunnen-al-hele-huizen-maken-101283670
2. The “recovery façade”, prefab integrated heat recovery ventilation in façade, is nominated for the national Rabobank innovation award. Published a.o. in: https://www.bouwmagazine.nl/nominaties-rabobank-innovation-challenge-2020-bekend/
3. RC Panels is covered in several video’s and films on renovation and innovation. An example can be found here: https://www.youtube.com/watch?v=yy6-rZFE4JY Also featuring in the documentary made for the national renovation 139pprox.139tion program: https://youtu.be/KwLEk2k85lI

Relevant previous projects

Previous:

***Inside Out*:** Rc Panels delivered the end façade of the Inside Out apartment building, renovating it prefab with our high insulation value. The façade is fitted with PV panels.

Previous and ongoing:

Several energy renovation projects (140pprox.. 1000 dwellings/year), all with our industrialized prefab highly insulating facades.

Ongoing:

***Future Factory*:** Dutch national mission oriented innovation program investing 30 mio Euro's, 180 interconnected innovation projects, 29 coalition members. Rc Panels is one of the three leading parties and manages the program in the core team. Results of this R&D program can be demonstrated and tested in the Utrecht demo (following up TRL levels). Rc Panels andUAS Utrechtserve as linking pins.

***MustBe0*:** EU Interreg project aiming at kick starting a market for net zero energy retrofits for apartment buildings. Rc Panels is one of the partners. Experience from this project can be used and further developed in the Utrecht demo.

***INDU ZERO*:** EU Interreg project aiming at making a blue print for a mega-factory for net zero energy retrofits. Rc Panels was advisory board member at the start. The need for their expertise was so high that this was changed to being a participant. Delivering expertise for renovation package and the factory, the showcases and realising the Dutch showcases (low rise building) including integrating HVAC system in building components. Experience from this project can be used and further developed in the Utrecht demo.

Significant infrastructure and/or technical equipment

Rc Panels has a factory that is capable of producing a.o. prefab facades for realizing the renovation of the demonstration apartment buildings. Rc Panels has an innovation lab for off site development and research on new or integration of materials, components and products.

Operational capacity of legal entity/partner organization

n/a

Utrecht University	**22. Utrecht University** **UU | NL**
Web site: https://www.uu.nl/en PIC number: 999985805	Number of employees: 6500 Number of students: 30000

Brief description of legal entity/partner organization

Utrecht University (UU), founded in 1636, is an internationally renowned research university. The quality of research at the University is demonstrated by positive research evaluations and a high position in international league tables. The 2020 Shanghai Rankings of world-class universities put Utrecht University in first place in the Netherlands and 52nd worldwide. The Faculty of Geosciences has leading international positions in academic research into sustainability, solar energy and urbanisation. The extensive and internationally oriented research of the faculty makes a major contribution to the Shanghai ranking. The department Copernicus Institute of Sustainable Development in the faculty aims to contribute to improved knowledge related to all Sustainable Development Goals (SDGs) as set by the United Nations in 2015. The research group Energy & Resources (E&R) of the Copernicus Institute will be involved in the ARV project **(**https://www.uu.nl/en/research/141anagement-institute-of-sustainable-development)

The research group Energy & Resources (E&R) is the major group in the Copernicus Institute of Sustainable Development, with about 60 staff and researchers. Its research focus is the transition towards sustainable energy and resource systems, with special attention to integrating efficient use of energy and resources with renewable energy supply solutions, at various scales. It is the ambition of E&R to boost the transition towards a sustainable energy and circular resource system. The scientific quality of the E&R group has been evaluated in the latest national quality assessment by an external committee and has been awarded 19 out of 20 points, reflecting its international scientific top-level position. E&R addresses a number of grand challenges for the transition to a sustainable society. The ever-growing energy and materials demand of our society puts enormous pressure on our natural resources, renewable and non-renewable, reducing the environmental quality and increasing the constraints on resource availability. The response to these challenges requires a different approach to fulfil the energy services demand by society, including efficient use of energy and materials, shifting to renewable energy sources, mitigating risks of and adapting to climate change, reducing unsustainable land use change, and redirecting industrial metabolisms. This transformation is a multi-disciplinary process with a large number of stakeholders, requiring understanding and inputs from a variety of disciplines to come to collaborative solutions. The E&R group offers a unique multi-disciplinary environment to develop knowledge and collaborative science projects in this complex field. One of its research focus areas is smart grid development, large-scale penetration of photovoltaics and the need of flexibility in our energy grids. The research activities address integration of photovoltaics and other intermittent renewable sources in the energy system, predominantly applied in urban environments. Research includes data management platforms for smart energy and mobility solutions in cities, as well as monitoring, evaluating and optimizing these solutions in practice. Four senior and twelve junior researchers are specialists in this area.

Contribution to Work Packages and Tasks in the project

WP 4 Sustainable building (re)design:
UU contributes to this Work Package by participating in an innovation forum which aims for a better scalable solution for renovation works with a high degree of energy efficiency. UU also contributes to this Work Package by demonstrating BIPV design principles in flexible renovation building components
WP 5 Resource efficient (pre)manufacturing and construction workflows:
UU contributes to this Work Package by integrating PV in plug and play building components that are prefabricated in a factory.
WP 6 Innovative renewables and storage systems:
UU contributes to this Work Package by elaborating on a BIPV design for maximizing solar energy harvesting combined with local and district electricity storage providing support to the grid and EV-V2G.

WP 7 Efficient operation and flexibility:
UU contributes to this Work Package by elaborating on the following demonstrations with focus on forecasting and flexibility services through aggregation entities for both market and grid optimisation purposes:

- Building Energy Management Systems
- Smart grids at district and city scale

WP 8 Monitoring, evaluation and impact assessment:
UU contributes to this Work Package by gathering information and monitoring data coming from the BEMS focusing on optimal energy performance of the refurbished apartment buildings.
WP 10 Communication, dissemination and stakeholder outreach:
UU contributes to this Work Package by publishing important results and dissemination knowledge at conferences.

Profile of key personnel in the project

[redacted] (M), -Faculty Geosciences, Copernicus Institute of Sustainable Development. [redacted] graduated from Utrecht University, the Netherlands, with a M.Sc. in [redacted]ntal Physics in 1985, with a M.Sc. thesis on measurement and analysis of I-V characteristics of c-Si cells. He received his Ph.D. from Nijmegen University, the Netherlands; the topic of his Ph.D. thesis was III-V solar cell development, modelling and processing. He then spent 7 years as a post-doc/senior researcher at Utrecht University and specialized in a-Si:H cell deposition and analysis. He is an expert in Plasma Chemical Vapour Deposition, both rf and Very-High Frequency. After an assistant professor position at Nijmegen University, where he worked on III-V solar cells, he returned to Utrecht University, with a focus on (single molecule) confocal fluorescence microscopy of nano-crystals. In 2002 he moved to a position as assistant professor at the research group Science, Technology and Society of the Copernicus Institute at Utrecht University, the Netherlands. Since 2012 this group moved to the Geoscience faculty and was renamed Energy & Resources, where he was appointed associate professor in 2014. He was appointed full professor Integration of Photovoltaic Solar Energy in 2018. He now performs and coordinates research on next generation photovoltaic devices incorporating nanocrystals, e.g., luminescent solar concentrators, as well as photovoltaic performance and real-time forecasting, smart grid development including Evs, V2G, congestion management, life cycle analysis, socioeconomics, and policy development. He is member of WG digitalisation of the ETIP-PV, and Dutch representative in IEA PVPS Task 13 (performance and reliability of PV systems), Task 15 (BIPV), and Task 16 (solar resource). He is associate editor of Elsevier's Solar Energy journal, as well as of Frontiers in Energy Research. He is of various organizing committees of EU, IEEE, and SPIE PV conferences. He is (co-)author of over 300 peer-reviewed journal and conference paper publications and book chapters. He has (co-) edited five books.

[redacted] (F) – Faculty of Geosciences, Copernicus Institute of Sustainable Development. She is a full professor in the area of Integration of Intermittent Renewable Energy in the Energy & Resources group. [redacted] received her PhD in Electrical Engineering from University of Washingt[redacted] 2003. Her research interests are in the modelling and simulation of power systems and electricity markets with a large penetration of renewable energy sources. Since 2004, [redacted]scu has worked in the Netherlands in various academic capacities at TU Delft, TU Eindhoven, and Utrecht University, leading research in smart grids and system integration of wind energy and solar photovoltaics. Selected topics include long-term network planning under severe uncertainty, cross-border balancing, machine learning methods for predicting and deploying flexibility in energy communities, demand response from commercial/industrial consumers, market-based control of storage systems, new concepts for local electricity markets and TSO-DSO coordination. She was a member of the IEA Wind Task 25 expert group "Design and Operation of Power Systems with Large Amounts of Wind Power" (2009-2014). In 2015, she was a member of the Local Organizing Committee in charge of Public Relations for the IEEE P[redacted]nference held in Eindhoven, with a record attendance of more than 600 participants. [redacted] has been interim director and co-PI of the 6-year programme funded by the I-TTW

Perspective fund, Smart Energy Systems in the Built Environment (2014-2020). [redacted] is the co-author of over 200 peer-reviewed journal and conference articles and book chapters.

[redacted] (F) – Faculty of Geosciences, Copernicus Institute of Sustainable Development. [redacted] holds a M.Sc. in Nuclear Engineering from Politecnico di Milano, Italy and a Ph.D. in Energy Engineering from the University of Padua, Italy. The focus of her thesis was on the development of an incentive regulatory framework for electricity networks. As a post-doctoral researcher, she worked at Politecnico di Milano where she continued her career to become an associate professor of Energy Economics with the Dep. Of Management, Economics and Industrial Engineering and has held coordinating positions at MIP, Politecnico di Milano's Business School. In September 2018 she joined the group Energy & Resources at the Copernicus Institute of Sustainable Development and, after a long period of collaboration, became Part-time Professor at the European University Institute, Florence School of Regulation, Section Energy and Climate. Besides regulatory economics, her research interests include competition in electricity markets, electricity market design, and technology policy and diffusion. In those areas she has carried out data-driven, statistical analyses, worked with optimization models, and performed comparative studies of alternative policy approaches. She has been involved, as principal or co-principal investigator, in several research and consultancy projects for the Italian Regulatory Authority for Energy, Networks and Environment (ARERA), the Avvocatura dello Stato (Italian State Lawyers), the Italian Power Exchange, and a number of energy companies. She is active as a peer reviewer for international journals (Energy Economics, Energy Journal, Energy Policy) and as a member of scientific committees in international conferences. She is (co-)author of over 70 peer-reviewed journal and blications, and one book.

[redacted] M) is assistant professor at Energy & Resources (E&R) group of the Copernicus Institute, Utrecht University. Ioannis holds a Dipl. Ing. Degree from the department of Electrical & Computer Engineering, National Technical University of Athens, a M.Sc. degree (cum laude) in Sustainable Energy Technology from Delft University of Technology, and a Ph.D. degree in Electrical Energy Systems from Eindhoven University of Technology. He has worked as a project engineer at Siemens Greece in the area of integrated command and control solutions, and at the Department of Innovation of Enexis, a Distribution System Operator in the Netherlands, where he conducted one of the first-of-their-kind studies on the effect of charging the batteries of electric vehicles on low voltage distribution grids. His research interests are in the areas of planning and operation of power systems, demand side management, demand response, aggregated flexibility services and integration of renewable energy sources in the power system. He has performed research for several projects including H2020, EU FP7, ERA-NET and Dutch Top Sector Energy projects. He is an IEEE Senior Member and a member of the Working Group for developing the IEEE Smart City Planning and Technology P2784 standard.

Relevant publications, and/or products, services, or other achievements

- Ioannis Lampropoulos, Machteld van den Broek, Erik van der Hoofd, Klaas Hommes, Wilfried van Sark, A system perspective to the deployment of flexibility through aggregator companies in the Netherlands, Energy Policy, Volume 118, July 2018, Pages 534-551.
- W. L. Schram, T. AlSkaif, I. Lampropoulos, S. Henein and W. G. J. H. M. van Sark, "On the Trade-Off Between Environmental and Economic Objectives in Community Energy Storage Operational Optimization," in IEEE Transactions on Sustainable Energy, vol. 11, no. 4, pp. 2653-2661, Oct. 2020.
- Lampropoulos, I., Alskaif, T., Schram, W., Bontekoe, E., Coccato, S., van Sark, W. (2020) *Review of energy in the built environment*, Smart Cities, 3, pp. 248–287.
- Brinkel, N. B.G., Gerritsma, M. K., AlSkaif, T. A., Lampropoulos, I., van Voorden, A. M., Fidder, H. A., van Sark, W. G.J.H.M. (2020). Impact of rapid PV fluctuations on power quality in the low-voltage grid and mitigation strategies using electric vehicles. *International Journal of Electrical Power and Energy Systems*, 118, 105741.

- Brinkel, N. B.G., Schram, W. L., AlSkaif, T. A., Lampropoulos, I. & van Sark, W. G.J.H.M. (2020). Should we reinforce the grid? Cost and emission optimization of electric vehicle charging under different transformer limits. *Applied Energy*, 276, 115285.

Relevant previous projects

Selected projects:

IRIS Smart Cities (EIP-SCC): IRIS is a H2020-funded project (2017-2022).The project has been developed around three lighthouse cities – Utrecht (The Netherlands, coordinator), Nice (France), and Gothenburg (Sweden) – who will work as collaborators and test-beds for follower cities Vaasa (Finland), Alexandroupolis (Greece), Santa Cruz de Tenerife (Spain) and Focsani (Romania). Each city will draw upon a mix of universities and research organisations, local authorities, innovation agencies and private expertise to accelerate entire communities to adopt ambitious energy, mobility and ICT initiatives. In the light of such a transiting environment, the need for strategies that help cities to smartly integrate technological solutions becomes more and more apparent. Given this condition and the fact that cities can act as large-scale demonstrators of integrated solutions and want to contribute to the socially inclusive energy and mobility transition, IRIS offers an excellent opportunity to demonstrate and replicate the cities' great potential. By demonstrating smart solutions that integrate energy, mobility and ICT, rooted in a City Innovation Platform, IRIS quantifies their value, and connects interests of many different stakeholders in innovative business models, allowing for upscale and replication of integrated solutions for sustainable cities across Europe and world-wide. UU's role is to define and manage KPIs of the whole project.

PV Prosumers4Grid is a H2020-funded project (2018-2020), Development of innovative self-consumption and aggregation concepts for PV Prosumers to improve grid load and increase market value of PV. Project duration: 11/2017-4/2020, H2020-LCE-2017-RES-CSA, 12 partners. Objectives: to develop and implement innovative self- consumption and aggregation concepts and business models for PV prosumers that will help integrating sustainable and competitive electricity from PV in the electricity system. Benefits will be a.o. to further support the deployment PV systems for electricity generation with focus on physical and financial grid interactions, and to provide PV Prosumers (households and industries) wit competitive and sustainable electricity innovative self-consumption and aggregation concepts and business models. UU's role is to assess the Dutch situation and analyse self-consumption effects on GHG emissions.

PARENT: *PARticipatory platform for sustainable Energy 144anagement* (2016-2019, funded by ERA- NET Co-fund Smart Cities and Communities programme). This project focused on energy savings in households through the application of innovative information technologies. A software-based solution becomes an extensible, reusable, socially acceptable and marketable platform, incorporating real-time energy information, novel gaming and other reward mechanisms to achieve energy efficiency by stimulating behavioural change. Tasks of UU were to develop behavioural change strategies for prosumers, with PV installations, in a 100-household pilot.

CESEPS: *Co-Evolution of Smart Energy Products and Services* (2015-2019, funded by ERA-NET Smart Grids Plus programme). This project aimed to develop a viable market for residential smart energy systems, and focuses on interdisciplinary research on stakeholder's practices, users' energy behaviour, local trading of energy, customer driven products, demand side management, local production of sustainable electricity, e-mobility and forecasting techniques in the Netherlands and Austria. UU's tasks are to analyse dataflows in smart grid pilots including PV and EV.

PEARL-PV (reliability of PV performance), COST Action (2018-2022).

Significant infrastructure and/or technical equipment

UU operates an outdoor PV test facility with capacity of testing 50 standard sized PV modules simultaneously. It is fully equipped with meteorological sensors, an all-sky imager and a spectroradiometer. I-V curves of all modules can be measured at sub-minute time resolution. This will be used for BIPV component testing. A 1.2

MW university PV system is monitored as well, and ~200 regional small PV systems are monitored in order to develop forecasting. Data access to pilots using PV and EV is secured via various projects. Data and (PV) models use the extensive cloud-based ICT solutions present at the Faculty and University level.
Operational capacity of legal entity/partner organization
n/a

City of Utrecht	**23. Municipality of Utrecht** **UTR | NL**
Web site: www.utrecht.nl **PIC number: 998300818**	**Number of employees: 4 350**

Brief description of legal entity/partner organization

Gemeente Utrecht (Municipality Utrecht) is the fourth largest municipality in the Netherlands. The city's population is growing from 339,000 today to 400,000 in 2028. Utrecht is home to the largest university in the Netherlands (Utrecht University), as well as many other renowned (applied) research institutes, such as the University of Applied Sciences HU. The municipality highly values multi-stakeholder collaboration, combining technical and social innovation. This is illustrated by the title of its coalition agreement "Utrecht we make together", and the participation of Gemeente Utrecht in many European networks, most notably EUROCITIES (all for a, co-chair of the Working group Air quality, climate change, and energy efficiency), the EIP Smart Cities and Communities (notably the chair of the SCC-01 Task Group on Replication), the Open and Agile Smart Cities network (OASC), Climate-KIC (Europe's largest public-private innovation partnership for climate change), Energy Cities, ERRIN, POLIS, and the European Institute of Innovation & Technology. Due to the city's natural role as transportation hub, the municipality of Utrecht for decades already prioritizes sustainable mobility, renewable energy, and energy efficiency. The first Sustainable Energy Action Plan (SEAP) was submitted in 2008. Gemeente Utrecht is committed to be a climate neutral city in 2030. By 2020, we will have reduced CO2 emissions by 30% compared with 2010 and increased the share of renewable energy to 20%.

Contribution to Work Packages and Tasks in the project

WP 1 Management:
Municipality of Utrecht brings extensive experience as partner in many European projects, including FP7 and H2020 projects, a.o. in the fields of energy and mobility, and as coordinator, we coordinate the H2020 IRIS Smart Cities (2017-2022, total project budget 20.4 million Euro).

WP 2 Framework for effective planning, design, construction and operation of CPCC:
As public authority with a legal mandate for spatial planning the Municipality of Utrecht has deep expertise on integrated urban planning, urban planning policy frameworks, legislation.

WP 3 Community, environment, and well-being:
As public authority we have deep expertise and experience on community and citizen engagement and safekeeping public values such as liveable environment, public health and well-being. In the demonstration district of Overvecht an integrated public engagement program called 'Samen voor Overvecht' (Together for Overvecht) allows for innovative approaches in involving local residents in the renewal of the district.

WP 4 Sustainable building design:
Specific expertise regarding implementation of building codes, regulations, energy performance of buildings and welfare.

WP 5 Resource efficient manufacturing and construction workflows:
City of Utrecht is the fastest growing city in Netherlands with many inner city densification projects. Utrecht has experimented with new approaches to construction logistics and construction hubs that offer more efficient construction workflows.

WP 6 Renewable energy and storage:

Expertise and legal role in the approval of energy production and storage infrastructures in public environment. Furthermore coordinating the energy transition by bringing together all societal stakeholders towards joint objectives.

WP 7 Efficient operation and flexibility:
Municipality of Utrecht participates in different smart grid demonstration projects with innovative SMEs, energy companies and grid operator.

WP 8 Monitoring and evaluation:
As public authority the municipality has their own research department offering policy evaluations, dashboard for Sustainable Development Goals and other censor research tools.

WP 9 Market uptake:
As public authority we collaborate with the regional Economic Board Utrecht in scaling the solutions in our region as well as attracting companies to the Utrecht region.

WP 10 Communication, dissemination and training:
As public authority we have a direct communication mandate towards our residents and companies with deep expertise and experience in messaging and campaigning.

Profile of key personnel in the project

[redacted] (M) is senior policy advisor energy transition in the built environment with specific attention to social housing corporations. [redacted] is responsible for the coordination of social housing and energy transition affairs in city of Utrecht. [redacted] will mainly be involved in the WP4 and WP5 offering the project team support in connecting to the different organizational units in the municipality.

[redacted] (F) is a social geographer and urban planner; she is the Manager Energy Transition at the municipality of Utrecht. Previously she was program manager Housing and Neighborhoods at Platform31, where she managed knowledge programs about the housing market, the neighborhood approach, shrinking regions and the energy transition. [redacted] will be senior strategic advisor to the project team mainly for the tasks in WP4 and WP5.

[redacted] (M) Innovation advisor to the urban development department of the municipality of Utrecht. Currently [redacted] is leading the H2020 IRIS Smart Cities-project as project coordinator. IRIS is an EU-wide project of 43 partners funded by the European Commission and led by the City of Utrecht in the field of sustainable urban development, energy positive districts, electric mobility and innovative IT services. [redacted] will be senior strategic advisor to the project team and be involved in WP1, WP9 and WP10.

Relevant publications, and/or products, services, or other achievements

Relevant publications:

- Energy plan (2015): drafted by 165 individuals appointed by drawing lot for this task.
- Energy agendas 2016-2020.
- Vision on the heating solutions for the city (2017)
- Sustainable Energy Action Plan (SEAP) approved by the Convenant of Mayors.

Relevant achievements:

13% of roofs are fitted with solar panels (2019); 1607 public electric vehicle charging points (2019); New Sustainable Energy Action Plan (2016-2020) drafted by 165 randomly selected citizens – a ground-breaking innovative experiment with aleatoric participatory democracy.

Relevant previous projects

- **H2020 IRIS Smart Cities**: Integrated and Replicable Solutions for Co-creation of Sustainable Cities (H2020-SCC-01-2017 – Smart Cities and Communities, IA, 2017-2022). The Municipality of Utrecht is project coordinator of the IRIS lighthouse project 'Integrated and Replicable solutions for co-creation In Sustainable cities'. The project accelerates integration of initiatives in the areas of energy, mobility and ICT into 'communities'. IRIS develops and stimulates energy and mobility services based upon user needs. Municipality of Utrecht participates in the Board of Coordinators and chairs the Task Group Replication to support scale-up of smart city solutions throughout Europe.
- **H2020 FosterREG**: Fostering public capacity to plan, finance and manage integrated urban REGeneration for sustainable energy uptake (H2020-EE-07-2014 – Enhancing the capacity of public authorities to plan and implement sustainable energy policies and measures – CSA, 2015-2017). Municiapilty of Utrecht was one of the three public authorities participating in the FosterREG project aimed at enhancing public capacity at local, regional and national levels to plan, finance and manage integrated urban regeneration for sustainable energy uptake, through capacity building, promotion and articulation of effective multilevel coordination, and national as well as European network strengthening.
- **URBACT URGE**: circular building cities (URBAN Action Planning Network, 2019-2022). Municipality of Utrecht is lead partner. URGE, standing for 'circUlaR 148uilding citiEs' is an Action Planning network on circular economy in the construction sector – a major consumer of raw materials. As there is a gap in circular economy principles' implementation in this sector, URGE brings together nine cities and their stakeholders to inspire and learn from each other in developing their integrated urban policy. This supports integration of circularity in the construction tasks, thus contributing to sustainable cities

Significant infrastructure and/or technical equipment

- *Urban Data Platform:* Utrecht deploys a well-functioning City Information Platform with over 200 data sets publicly available via www.utrecht.dataplatform.nl. Utrecht uses CKAN as an open data platform for several years now. It cooperates with a large number of Dutch cities on Dataplatform. It´s a proven solution for collecting, storing and providing open data. Utrecht has integrated Dataplatform with internal processes to streamline data publishing. One example is the integration of public issue management based on Open311.
- *Digital Twin*: Utrecht's current 3D version of the city – it's 'Digital Twin' – is **based on the widely known and used open gaming platform Unity**, and visualizes urban data from (currently) 125 datasets through SPOTINFO, with ArcGIS (a commercial tool by ESRI) being used for geographical analysis of the data. The Digital Twin has object-related information in it, so that it can calculate, create simulations and interact with users.

Operational capacity of legal entity/partner organization

n/a

	24. Bos Installatiewerken B.V. **BOS GROEP | NL**	
	Web site: **www.bosgroep.com** **PIC number: 892047406**	**Number of employees:** **55**

Brief description of legal entity/partner organization

Bos Installatiewerken B.V. is a Building Services contractor / Technical contractor established in 1939.
Our main task is to provide clean water, sufficient ventilation and sustainable building services.
The past couple years Bos has had a major role in the renovation concept Inside Out.
The renovation concept focusses on creating energy sufficient / zero-energy apartments buildings. We think that it is necessary for a sustainable built environment that the focus shifts from projects to concepts that focus on prefabrication, less labor cost at site and industrialization.

Contribution to Work Packages and Tasks in the project

WP 4 Sustainable building design:
Bos contributes to this Work Package by elaborating on solutions for energy efficient building designs. Smarter buildings that can be linked to local en district energy infrastructures. This will help with efficient energy management. Bos will help to design and enhance modular installation infrastructures and components used in the Inside Out concept.

WP 5 Resource efficient manufacturing and construction workflows:
The focus within Bos and Inside Out is integrated installation infrastructures in prefabricated modules to enhance industrialization processes and reduce on-site construction. Bos will contribute to the automated integration in BIM and has experience in occupant-friendly construction processes. This also has a link to minimizing on-site construction for all contractors and subcontractors.

WP 6 Renewable energy and storage:
Bos has experience in creating a low-temperature heating infrastructure in high-rise buildings. Bos will help in expanding the knowledge and creating solutions for integration of low-temperature district heating in high rise buildings. Besides integration of heating infrastructure Bos will elaborate on integration of BIPV and the BIPV infrastructure in high-rise buildings.

WP 7 Efficient operation and flexibility:
Bos contributes to this Work Package by elaborating on the following demonstrations:

- Building Energy Management Systems
- Smart grids at district and city scale

WP 8 Monitoring and evaluation:
Bo-Ex contributes to this Work Package by gathering information and monitoring data coming from the Inside Out and other demonstration projects.

WP 9 Market uptake:
Bos contributes to this Work Package by contributing to bankable business models for new replicable initiatives

Profile of key personnel in the project

[redacted] Msc. Bsc. (M) – director [redacted] Installatiewerken B.V. – [redacted] has erience in HVAC-systems, solar/BIPV and NZEB buildings. Moreover, [redacted] is one of the leading figures in the realization of the first energy surplus high-rise building Inside Out. Bos Installatiewerken is a pioneer in net zero energy high-rise buildings.

[redacted] (M) – Project manager and project development of several innovative Inside Ou[redacted]ect where a high-rise building is renovated to a NZEB with a surplus. In this project [redacted] was responsible for a part of the design, research and construction process of the renovation.

[redacted] Msc. Bsc (M) – Project manager and concept developer – [redacted] has worked as project manager for the realization of the Inside Out concept. [redacted] has played a major role in the design and research page, and has written his master thesis on Linking transition theory to a multiple case-study to investigate the upscaling potential of net zero energy retrofit concepts for high-rise buildings.

Relevant publications, and/or products, services, or other achievements

Bos has experiences with the following products/services:

- HVAC systems for dwellings / apartment buildings
- Smart grid energy production and storage
- Energy performance data of dwellings / apartment buildings
- Integration of installation infrastructures for modular and prefabricated components such as facades or heating systems.
- Experience in the realization of a NZEB with the project Inside Out.

Relevant previous projects

National innovation project: TKI (2018-2021) – **Henriettedreef District of Overvecht in Utrecht**

Significant infrastructure and/or technical equipment

n/a

Operational capacity of legal entity/partner organization

n/a

	25. iWELL B.V. **iWELL | NL**	
	Web site: www.iwell.nl **PIC number: 892079707**	**Number of employees: 11** **Number of students: 1**

Brief description of legal entity/partner organization

iwell is a private company.
Clean and affordable energy for everyone; one of the greatest challenges of our time. The energy transition is begging for change. That is why many parties have endless conversations about how things can and should be done differently. But all this takes so much time.

We are accelerating the energy transition and building tomorrow's energy supply today. Together we make the world a better place. More sustainable, cleaner and greener. Today we are already taking steps towards a better world with our smart batteries.

Contribution to Work Packages and Tasks in the project

WP 6 Renewable energy and storage:
Smart battery

WP 7 Efficient operation and flexibility:
Smart Energy Management Cloud

Profile of key personnel in the project

[redacted] (M)
I prefer to change the energy world as an entrepreneur, because I believe that this is how I can make the most impact. And preferably with a practical and concrete approach. Do not keep talking about 2050 but work together on solutions that make the world a better place today!

[redacted]
How can we do things smarter, better, faster and above all more sustainably? After years of working as a consultant in the built environment and government, the making of concrete products that contribute to the energy transition is a welcome change. My knowledge of building installations and decisions within the government comes in handy here!

[redacted]
Look at the history of humanity and you will see that technology affects us more than the other way around. Soon after the penny fell where people come from, as a young lad, I realized that evolution theory doesn't just apply to biology. The future is determined by the few who dare to change technology and I think I have come to the right place at iwell as a technical physicist!

[redacted]

[redacted] love to come up with innovative solutions as a team, optimize processes and ontinuously improve them. I can apply my experience in developing software nd cloud solutions well. Pioneering together for a faster and smoother energy ransition!

[redacted] t is good to see that more and more attention is being paid to the impact that we as humans have on the environment and climate. The consequences are becoming more and more obvious. But then the question is: "how do we solve the problems?". While we can all do our bit, I believe that the real change will be driven by innovative companies that offer practical and cost-effective solutions. iwell is such a company that dares to think further. I like to use my technical knowledge for that!

[redacted]

Believe me, the transition to clean energy will be faster than you think! Less waste, smart use of renewable energy and ensuring reliable sources of electricity are my spearheads. We are going to bring about that change together with great enthusiasm!

[redacted]

With an entrepreneurial eye I create as much optimization as possible within iwell. It is essential for the energy transition that the current and future cubes operate as efficiently as possible. As a business developer I strive for continuous innovation in order to create the most innovative system.

Relevant publications, and/or products, services, or other achievements

Products and services:

https://iwell.nl/producten/
Cube – Delivering high peak power for peakshaving the elevator – over 100+ clients al ready
Power Cube – connected with charging poles, electrical cooking or machines to deliver high peak power
Mega Cube – stabilising the grid with large battery systems
VPP- Virtual Power Plant delivering energy grid services to TSO & DSO with our batteries
Ultra fast peak shaving algoritme – software to peakshave the grid connection ultra fast so that fuses don't break

Publications:
https://www.duurzaambedrijfsleven.nl/energietransitie-business/35063/iwell-batterij-thuis

https://www.bouwinvest.com/news/latest-news/2020/smart-battery-stores-renewable-energy-when-and-where-it-s-needed/

https://iwell.nl/stedin-mitros-en-iwell-maken-werk-van-decentrale-batterij/

https://www.alteravastgoed.nl/en/nieuws/altera-launches-iwell-collaboration-with-two-cube-battery-systems/

Relevant previous projects

Second place in the EU proptech competition 2020 for scale ups -
https://www.proptechhouse.eu/the-winner-of-proptech-startup-and-scaleup-europe-awards-2020/

Winner of the STEDIN challenge on delivering a solution to electrical peakdemands in apartment buildings:
https://iwell.nl/stedin-mitros-en-iwell-maken-werk-van-decentrale-batterij/

Winner of the challenge by the province of Drenthe by delivering a solution for a Football club with ambition to generate renewables to the grid with congestionproblems:
https://energeia.nl/energeia-artikel/40089629/batterijsysteem-helpt-icoonproject-vv-nieuw-buinen-uit-de-brand

Winner of BNG + VNG challenge on SDG of UN in 2019 -
https://www.bngbank.nl/Pages/Over%20BNG%20Bank/Duurzame-groei-voor-BNG-Duurzaamheidsfonds-en-iwell.aspx
https://www.bngduurzaamheidsfonds.nl/initiatieven/batterijsysteem-iwell/

Significant infrastructure and/or technical equipment

See attached leaflets Cube and PowerCube + Cloud software
We have a testing facility (in old coal factory in Utrecht) where we can do testing.

Operational capacity of legal entity/partner organization

n/a

26. MEX architects b.v
MEX | NL

Web site: www.mexarchitects.nl

PIC number: 892092802

Number of employees: 4

Brief description of legal entity/partner organization

Mex architects is an architecture firm with emphasis on architecture and its technical elaboration. In addition to healthcare projects mex architects is specialized in renovating residential buildings from the 1970s.

Mex architects is a technical architectural firm with an expert and enthusiastic team that is responsible for the realisation of a wide variety of projects. We work closely with a network of experienced external advisors and partners.
Clients include care institutions, housing corporations, project developers and private individuals.

Mex Architects is a flexible party. A team player who is able to coordinate large processes without losing sight of the details. With a great sense of responsibility for the entire process. From design to delivery and aftercare.

Mex Architects translates client requirements into a suitable design that occupies the right position in its surroundings. At Mex Architects, budget, planning and feasibility are at least as important as design.

By using the BIM (Building Information Model) method, Mex Architects is able to manage complex processes.

Contribution to Work Packages and Tasks in the project

WP 4 Sustainable building design:
Design of modular architecture, architectural conscience, connection between partners.
Architectural design of basic building components.

WP 5 Resource efficient manufacturing and construction workflows:
Design of modular architecture, architectural conscience, connection between partners.
Architectural design of building typologies.

WP 6 Renewable energy and storage:
Gathering knowledge for WP4 & WP5

WP 9 Market uptake:
Architectural conscience

nel in the project

[redacted] MSc (M) – Director Mex Architects. Architect, BIM modeller, 3d visualization, architectural research into building typologies.

Relevant publications, and/or products, services, or other achievements
Inside Out project
Relevant previous projects
Inside Out project
Significant infrastructure and/or technical equipment
n/a
Operational capacity of legal entity/partner organization
n/a

	27. Stichting Mitros **MITROS | NL**	
	Web site: www.mitros.nl **PIC number: 892081356**	**Number of employees: 250**

Brief description of legal entity/partner organization

Mitros is a Dutch housing corporation. We provide housing for low-income households in the Utrecht region. Mitros owns 30.000 dwellings, have done so for the last 100 years and will continue to do so. We aim to grow in order to keep up with the growth of te city. We build new projects and renovate older ones. We also sell some of our real-estate and even demolish some in order to build more and better new houses.

Contribution to Work Packages and Tasks in the project

WP 3 Community, environment, and well-being:
Mitros contributes to this Work Package on the following aspects:

- Social renovation: the organisation of support for the tenants on many aspects of their lives. To set up and maintain co-operation with many partners in the social domain.
- Community center: to support the social renovation we aim to create a place where people can meet for various activities, in co-operation with local government and many partners in the social domain as well as partners in energy-coaching. The involvement and engagement of tenants can also take place here.
- Bouw = Wouw (Human capital program): the aim is to raise the interest of students and unemployed people in working in the construction and refurbishment sector. We create starter-jobs and internships and work closely together with schools.
- Energy Transition: the involvement and coaching of tenants to understand the energy concept and possibilities of their dwellings. With a better understanding, tenants can guide their energy usage.

WP 6 Renewable energy and storage:
Mitros contributes to this workpackage by:

- participating in the research into integrating PV-panels in the refurbishment of the 10-story flats;
- participating in the research into lower temperature district heating: what measures are necessary to lower the input-temperature?
- participating is the research into decentralised ventilation solutions, possibly combined with heat-recovery solutions.

WP 7 Efficient operation and flexibility:
Mitros participates in the research and pilot with batteries to level out peaks in electricity-demand. This package aims to build an energy management system and contribute to a smart grid at district and city scale.

WP 9 Market uptake:
Mitros' main contribution here is the size and scale of our refurbishments of 10-story flats.

WP 10 Communication, dissemination and training:
Mitros will contribute to this work package by involving tenants in the programme. This may involve small-scale workshops in a model-apartment, individual visits, flyers and newsletters and wider publicity in local media and online.

rsonnel in the project
[redacted] (M), senior real-estate developer, has a broad experience with planning and organizing large-scale renovation projects and creating support from tenants as well as decisionmakers. [redacted] will engage in work package 3 and 10. [redacted] (M), senior project-manager, has a wide experience in new construction and renovation works [redacted] has a technical background and will engage in work package 6 and 7. [redacted] work together as a team on the 10-story apartment building renovations in Overvecht. This programme involves the renovation of 1800 apartments that started in 2018 and will be finished in 2025.
Relevant publications, and/or products, services, or other achievements
Relevant previous projects
Significant infrastructure and/or technical equipment
n/a
Operational capacity of legal entity/partner organization
n/a

	28. Statutory city of Karviná **KARV | CZ**
	Web site: https://www.karvina.cz/ **PIC number:** 918490867
	Number of employees: 303 (12/2020)

Brief description of legal entity/partner organization

Location: northeast of the Czech Republic; Moravian-Silesian Region. At the same time, half of the city's border forms the border with Poland. From a historical point of view, Karviná is located in the territory of Těšín Silesia.
Area: 57.48 km 2
Population: 52,998 (as of 1/1/2019)
Settlement structure of the city: the city includes nine city districts named Karviná-Fryštát, Karviná-Doly, Karviná-Lázně Darkov, Karviná-Ráj, Karviná-Staré Město, Karviná-Nové Město, Karviná-Mizerov, Karviná-Hranice, Karviná-Louky.

Department of Education and Development
Ensures and coordinates the elaboration of a draft strategic plan for the economic development of the city. Its scope includes mining and the environment and transport. The list of activities also includes marketing of the city, including the development of tourism, ensuring the organization and promotion of city-wide cultural and sports events, subsidy policy and project management of selected projects of the statutory city of Karviná and education.

Contribution to Work Packages and Tasks in the project

WP 1 Management: project management, coordination of demo-site activities.

WP 2 Framework for effective planning, design, construction and operation of CPCC: knowledge of demo-site location, local stakeholder involvement and coordination, provide input data and feedback on the CPCC KPIs in local conditions.

WP 3 Community, environment, and well-being: energy transition, community engagement, citizen and student education and citizen and stakeholder involvement, promotion solutions.

WP 4 Sustainable building design: experiences in building design and legislation processes, coordination demo-site activities

WP 5 Resource efficient manufacturing and construction workflows: experiences in construction phase in deep retrofit projects, workflow validation on demo-site, provide municipal real estates for testing automated energy performance analyses

WP 6 Renewable energy and storage: cooperation and coordination with RES and storage system implementation within demo building.

WP 7 Efficient operation and flexibility: supervision of the building operation, responsible for communication of demo-site operation to tenants as well for their education.

WP 8 Monitoring and evaluation: involvement of city energy manager to monitoring and evaluation of the demo-site, coordination of monitoring activities within demo building.

WP 10 Communication, dissemination and training: PR department involvement to communication and dissemination of the project and demo-site results.

Profile of key personnel in the project

[redacted] (M) is the Deputy Mayor for City Development, Subsidy Policy, Spas and Tourism

As a project leader, he participated in the implementation of a number of investment and non-investment projects financed from ESIF and national resources, he was also involved in Czech-Polish cross-border cooperation projects.
With his competencies, he guarantees the presentation of the project plan at the level of the city management and represents in the project team persons with decision-making authority of the statutory city of Karviná.

[redacted]

[redacted] (M) is an officer in the Strategy and Planning Department of the Department of Education and Development of the Statutory City of Karviná and acts as a project manager for grant programs and projects co-financed from ESIF or national resources.
Within the project, he will perform the function of project manager and project administrator for the statutory city of Karviná..

[redacted]

Relevant publications, and/or products, services, or other achievements

Relevant previous projects

- **Strategic documents of statutory City of Karviná**
  Funded by Operational programme Employment - CZ.03.4.74/0.0/0.0/17_080/0009841
  The following documents will be created within the project implementation:
    - Strategic city development plan
    - Sustainable Urban Mobility Plan
    - concept of greenery in the city

- **Adaptation strategy of city of Karvina for Climate Change**
  Funded by Norway Grants, project no: 3194100020

- **Facade insulation of house no. 871, U Lesa, Karviná-Ráj**
  Funded by combination of sources:
    - Integrated regional operational programme - CZ.06.2.11/0.0/0.0/17_097/0011752
    - National Envrionmental Fund, project no. – 04381961
    - Karviná´s city budget

- **Energy savings in buildings owned by City of Karviná**
  Funded by Operational programme Environment - CZ.1.02/3.2.00/09.04823

- **Revitalisation of the City police Building in Karviná**
  Funded by Operational programme Environment CZ.1.02/3.2.00/09.04821

Significant infrastructure and/or technical equipment

The statutory city of Karviná provides the project with the building of the polyclinic at 2379 Žižkova St in Karviná (postal code 733 01) as an input. The city will acquire the ownership of this building (January 2021) from the Moravian-Silesian Region based on Resolution No. 16/1924 of 4 June 2020. The building has long been used to provide health service. The polyclinic building was built and put into use in 1993. The building has four floors and three wings with a basement, the area of the standard floor is about 1850 m^2. The building comprises the hospital pharmacy, rehabilitation premises, incl. swimming pool, doctors' surgeries, ophthalmic optics, cosmetics, massages, travel agency, etc. In the centre of the building there is a central staircase with a pair of elevators. On the building roof there are engine rooms for elevators and

air conditioning. It is in the interest of the Statutory city of Karviná to continue to use the above-mentioned property to provide health care not only to the citizens of Karviná, but also to the citizens of the wider area. Within the ARV project, this building will be used for the joint creation of innovative technologies and processes to reduce and optimize the energy performance, which will lead to zero or plus energy performance of the demonstration building.
Operational capacity of legal entity/partner organization
n/a

	29. Dolomiti Energia Solutions Srl **DOL | IT**	
	Website: www.de-solutions.it **PIC number: 911841032**	**Number of employees: 17**

Brief description of legal entity/partner organization

Dolomiti Energia Solutions Srl was born from the merger of Dolomiti Energia Rinnovabili with Nesco, already established companies in the field of renewable energies and energy efficiency. The company is a leader in Trentino for the management of energy efficiency services in the public and private sectors, in the production of energy from renewable sources and in cogeneration. The development activities are proposed in ways of sharing the risk with the customer, in order to directly guarantee the optimization of the results.

Contribution to Work Packages and Tasks in the project

Dolomiti Energia Solutions' main role will be in WP3.

Profile of key personnel in the project

[redacted] (M) holds a degree in electrical engineering from the university of Padua (Italy); he has been working since 2007 in the ESCO sector and in the design of energy saving solutions and production from renewable sources. Since 2007, he has worked for NESCO as CEO, an ESCO company acquired by the Dolomiti Energia group in 2017, and subsequently transformed into Dolomiti Energia Solutions in 2019, where he holds the position of Deputy Director. Since July 2019 he has been president of NEOGY, a company dedicated to electric and sustainable mobility, born from a jont venture between the Dolomti Energia Group (TN) and the Alperia group (BZ). Since 2020 he has been Energy manager of Dolomtit Energia Holding.

[redacted] (M) graduated in Electrical Engineering at the University of Padua in 2009. He is the manager for DES of the Energy management sector, with the role of development and management of consumption data of the Dolomiti Energia group and of private customers. He coordinates and develops the entire incentive area.

[redacted] (M), qualified building expert. He is the head of the Energy Efficiency sector of Dolomiti Energia Solutions, with a specific focus on the management of technological systems serving buildings. He develops energy saving projects in the ESCO formula, with guaranteed results and coordinates their implementation and the measurement and verification of results

Relevant previous projects

STARDUST (2017-2022): The project is funded under the European Union's Horizon 2020 Smart Cities and Communities Lighthouse Programme. This is a highly interdisciplinary project made possible by 29 partners from 8 countries, all of whom will be working together to transform carbon supplied cities into smart, highly efficient, intelligent and citizen-oriented cities using technical green solutions and innovative business models coupled with a strong replication strategy. Activities will be first demonstrated in Pamplona (Spain), Tampere (Finland), and Trento (Italy) and will be re-applied in the following cities. The Stardust project aims to transform present day cities to smarter cities through a holistic replication model. It will be combining expertise of the different consortium partners on smart buildings, energy efficiency, ICT, and e-mobility, coupled with innovation and social engagement coming from the locals. By doing so, it will raise awareness between the citizens of Pamplona, Tampere and Trento on the possibility of using their cities as "innovation islands" or urban incubators of technological, social, regulatory and market solutions, for other interested cities around the world.
Significant infrastructure and/or technical equipment
District heating network
Operational capacity of legal entity/partner organization
n/a

habitech IL DISTRETTO ENERGIA AMBIENTE	**30. Habitech** **DTTN | IT**	
	Web site: www.habitech.it **PIC number: 955168313**	**Number of employees: 18**

Brief description of legal entity/partner organization

Habitech – the Energy and Environment District promoted by the Autonomous Province of Trento and recognized by the Italian Ministry of University and Research, is the leading national center for green building, renewable energy and innovation: since 2006 Habitech operates in these areas and strives for a market transformation towards sustainable solutions.
Habitech is a non-for profit organization and a network of more 120 members which represents both private and public sectors: it is not only the point of reference for all of its members when it comes to R&D, innovation and sustainable practices, but it has also become a beacon for many other industries in Italy and abroad.
Habitech's mission is to change the way to consider sustainability towards a strategic tool for business innovation and development, and to drive public and private clients in providing consultancy for high standard performances.
Habitech promotes and coordinates integrated and innovative processes to improve buildings and real estate assets through specialized activities: energy audits, sustainability assessment, retro commissioning and dynamic modeling; it works together with the construction and manufacturing industries in order to insert sustainability in an effective and profitable way over the entire design, construction and operation processes.

Contribution to Work Packages and Tasks in the project

In ARV, Habitech will lead the activities in the Demo Project in Trento and will closely work with EURAC and UNITN, especially in WP4 and WP5.

Profile of key personnel in the project

[redacted] (F) has been working in Habitech since 2009 and is currently EU funded projects responsible in which Habitech is involved. She is the PM of the activities and involves the technical competences from the colleagues where necessary, planning the activities with the adequate skills requested. She also manages the institutional relations of the CEO, involving Habitech members in all the initiatives, activities and projects that are planned during the year. She will manage the whole project within Habitech. She has already been involved in the coordination and management of many EU projects, ensuring the correct execution of their activities and their compliance with the consortium EC contractual obligations (STARDUST, OptEEmAL, INSTRUCT, etc.).

[redacted] (M) is an engineer and from January 2020 is the CEO of Habitech. He was previously the Technical Director of the LEED, BREEAM, WELL and ARCA services within Habitech. He is also the first LEED AP of the first school certified LEED (Gold level) in Europe and has managed the technical area and several projects under the different certification systems. In 2017 he gained the title of LEED Fellow from GBCI. He has gained work experience in Europe and the United States, where he still collaborates actively with a Michigan company.

[redacted] (M) is an engineer and he has been working at Habitech since January 2012 in the area of timber buildings. In particular, he follows the management of ARCA certifications both for New Construction and for Elevations and Expansions. He supports, in the technical contents, the area dedicated to the training of ARCA Academy wood professionals.

[redacted] (F) is an architect and has been working in Habitech since 2008. She is LEED Accredited Professional BD+C and since 2016 she is G4 Training certificate holder of Global Reporting Initiative (GRI), international standard for sustainability reporting. She has promoted the implementation of the Charrette and she was Coordinator of the Standards Committee GBC District of GBC Italia. She is responsible for the "Greenmap" project, which fosters sustainability as a strategic tool to innovation and development, and involves the economic chain that contributes to the realization of products always aware of the use of resources, places, people and business cultures.

Relevant publications, and/or products, services, or other achievements

- Action plans for sustainable energy (**PAES**): the Province of Trento has started a virtuous process to achieve the objectives set by the European Union within the 2020 Climate and Energy Package. Habitech has been identified by the provincial agency APIAE (Provincial Agency for the stimulation of economic activities) as a consultant for the verification of the SEAPs of the municipalities of Trentino. There are about seventy PAES analyzed by Habitech, including those of the City of Trento, Rovereto, Pergine, Arco.
- **Odatech** is Habitech's qualification and certification body. There are three areas in which it focuses its activities: the qualification of energy certifiers in the Province of Trento, the skill's certification in the sustainable construction sector and the management of the ARCA certification - Quality certification for timber constructions.
- **Greenmap** is Habitech program for industries - manufacturing and services. It fosters sustainability as a strategic tool to innovation and development. It supports the clients' orientation towards their corporate mission by structuring new projects; involving the economic chain to realize sustainable products, being aware of the use of resources, places, people and business cultures. The activities that Habitech proposes to the market are customer specific objectives, based on a product rating and analysis method in terms of processing and in terms of comparison with the competitors.
- **Training services supporting sustainability policies for businesses**. The choices of sustainability are often accompanied by the need to raise awareness among employees - technicians, agents and sales people, managers, administrators, etc. - on "green" issues, often associated with the standards of the major certification systems (eg LEED and BREEAM, ARCA Academy). Habitech training service derives from the analysis of the needs of the clients, finding together instruments and methods appropriate to objectives, recipients, space-time constraints. Habitech offers active and experiential methods, aiming for maximum involvement of the participants. The staff is composed of LEED-AP experts, BREEAM Assessor, BREEAM Auditor and ARCA with teaching skills.
- Energy Performance Contract – **EPC**: Habitech has experience of optimization of energy performance of both individual buildings and entire real estate assets outside the voluntary seaway protocols. These are independent Energy Audit activities, as well as efficiency measures through the application of Energy Performance Contract (EPC) with the support of Energy Service Company (E.S.Co.).

Relevant previous projects

OptEEmal – H2020, 2015-2019. Partner. OptEEmAL has developed an Optimized Energy Efficient Design Platform able to design energy efficient retrofitting projects that are based on different energy conservation measures to improve the behaviour of a district. The tool reduced time delivery and uncertainties and result in improved solutions when compared to business-as-usual practices. Partners have worked on delivering an optimized, integrated and systemic design tool based on an Integrated Project Delivery approach for building and district retrofitting projects.

STARDUST – H2020, 2017-2022. Partner. STARDUST's objective is to introduce low carbon, highly efficient, intelligent, and citizen-oriented cities. This will be done by providing green technical

solutions and innovative business models to address the urban challenges identified by the cities involved. These challenges have got to do with the environment, society, mobility, energy, economy and the cities' visibility. Stardust is set to light up cities across Europe by creating a blueprint for replication using its innovative solutions in ICT, energy, mobility and citizen engagement.

BUILD IN WOOD – H2020, 2019-2023. Partner. It aims to develop a sustainable and innovative wood value chain for construction of multistory wood buildings, in order to meet the immediate global and European challenges of reducing the GHG emissions from the construction sector. It will develop the materials and components as well as structural systems and façade elements for multistory wood buildings for both new construction and retrofitting applications. The project will deliver a Design Guide – a dynamic co-created online toolbox of documented materials and components. At the end of the project in 2023, it will have demonstrated full-scale digital case projects and a test system for prototypes.

Made in Italy – Architettura della Performance – H2020, 2011-2017. Coordinator. The "Made in Italy - Architecture of performance" is a project launched by the Ministry of Economic Development - Industry 2015 - concerning the objective area "strategic supervision of the markets". Habitech was the first proponent of the project and collaborated with 13 partners (7 of which are District Members - 8 private companies and 5 research centers).

Significant infrastructure and/or technical equipment
n/a
Operational capacity of legal entity/partner organization
n/a

UNIVERSITÀ DI TRENTO	**31. University of Trento** **UNITN | IT**
	Web site: www.unitn.it **PIC number: 999841954**
	Number of employees: 1.470 **Number of students: 16.868**

Brief description of legal entity/partner organization

UniTrento is a dynamic, middle-size University (about 16,000 students) located in the North East of Italy. Founded in 1962, it has constantly pursued the improvement of the quality of research and teaching and the strengthening of its international dimension, networking with qualified universities and research centres from all over the world, making its campuses international and encouraging the presence in Trento of foreign visiting professors, researchers and students. The strong commitment in international research and mobility projects have boosted its attractiveness and position in both national and international rankings.
The university is structured in 14 Departments and Centres (Economics&Management, Law, Sociology&Social Research, Humanities, Psychology&Cognitive Science, Civil Environmental & Mechanical Engineering, Industrial Engineering Information Engineering & Computer Science, Physics, Mathematics, International Studies, Integrative Biology, Mind/Brain Sciences, Agriculture Food Environment) that promote, coordinate and manage the university teaching and research activities.
The broad academic offer is complemented by a proven experience in the organization of double, multiple and joint degrees, international Master and PhD programmes, student and staff mobility, summer schools, workshops, joint projects shared with partners over the years also under different EU schemes (e.g. Erasmus+, Bilateral Programmes etc.). UniTrento participates also to 3 EIT KICs: EIT Digital, EIT Raw Materials and EIT Climate. International Research activity records outstanding levels with 117 FP7 and 119 Horizon 2020 research projects, out of which 32 ERC projects , about 10% of international students, widespread international exchange mobility thanks to EU and international programmes and a significant number of bilateral agreements with prominent institutions and organizations all over the world.

The primary objective of DICAM (Department of Civil Environmental and Mechanical Engineering) is the development of research and teaching in important fields of engineering and architecture. The research and teaching activities are developed in six main subject areas, aimed at enhancing the individual and society well-being where they are developed and applied. Within this framework they focus on the quality of the urban and natural environments, the enhancement of the quality of life, security and the harmonious development of society, through the innovation of products.
The work of DICAM in all these sectors pursues high level scientific and teaching objectives, regarding research and training, in line with the most important research-intensive universities. The Department also promotes significant interrelations with public authorities and private companies, at local, national and international level.
The mission of the Department is laid down in the following specific targets:
a) The promotion of research in key areas of Engineering, Planning and Applied Sciences, such as Environmental Protection, Landscape, Architecture, Natural Renewable Resources, Energy, Biomedical Sciences, Smart Structures and Materials, Risk Prevention, Infrastructures and Efficient and Sustainable Structures, Building and Estates, Service Networks and Territory.
b) The training of professionals (engineers and architects) and researchers of the future generations, able to contribute to the economic and cultural growth of society, in an innovative and creative way, in all the above-mentioned fields.

Contribution to Work Packages and Tasks in the project

WP 4 Sustainable building design: **timber construction design, passive design for heating and cooling, monitoring and management of IEQ, LCA and C2C analysis**

WP 6 Renewable energy and storage: **passive and active Energy systems design, envelope-system integration**

WP 8 Monitoring and evaluation**: IEQ and energy consumption monitoring campaigns, technical survey, POE**

Profile of key personnel in the project

[redacted]M), civil engineer and PhD in "Engineering for building recovery and ation", is Full Professor of Building Construction at the University of Trento and head of the Laboratory of Building Design at the Department of Civil Environmental and Mechanical Engineering. His research is mainly focused on issues related to comfort in indoor spaces, bioclimatic design for the use of passive solar systems for heating and cooling of indoor environments also with the help of building automation systems, timber constructions, evaluation of the environmental footprint of buildings in terms of life cycle analysis and sustainability of the project for the reuse and recycling of components, development of rating systems for the assessment of sustainable building. It actively participates in national and international research projects (including H2020, Leonardo da Vinci Programme, Cost Action, Interreg Alpine Space). He is a teacher at several training courses organized by professional associations and public and private bodies on the issues of environmental energy sustainability in the construction sector. He is author of over 135 publications including monographs, articles in scientific journals, conference proceedings. Last International projects: "Energy efficiency and renewable energies in the building sector" - European Territorial Cooperation – Alpine Space (2009-2012), "Pearls - PLANNING AND ENGAGEMENT ARENAS FOR RENEWABLE ENERGY LANDSCAPES" (H2020-MSCA-RISE-2017), "SHELDON – Indoor living space improvement: Smart Habitat for the Elderly" (Cost Action CA16226)

Relevant publications, and/or products, services, or other achievements

- D'Alonzo V, Novelli A, Vaccaro R, Vettorato D, Albatici R, Diamantini C, Zambelli P, 2020, A bottom-up spatially explicit methodology to estimate the space heating demand of the building stock at regional scale. DOI: 10.1016/j.enbuild.2019.109581. In ENERGY AND BUILDINGS vol. 206
- Lovati M, Salvalai G, Fratus G, Maturi L, Albatici R, Moser D, 2019, New method for the early design of BIPV with electric storage: A case study in northern Italy. DOI:10.1016/j.scs.2018.12.028. In SUSTAINABLE CITIES AND SOCIETY vol. 48
- Polastri A, Giongo I, Angeli A, Brandner R, 2018, “Mechanical characterization of a pre-fabricated connection system for cross laminated timber structures in seismic regions”, Engineering Structures, vol. 167, 705-715
- Prada A, Gasparella A, Baggio P, 2018, On the performance of meta-models in building design optimization. doi:10.1016/j.apenergy.2018.04.129. In Applied Energy, 225: 814–826
- Loss C, Piazza M, Zandonini R, 2016, Connections for steel–timber hybrid prefabricated buildings. Part II: Innovative modular structures. DOI: 10.1016/j.conbuildmat.2015.12.001. In Construction and Building Materials vol. 122 (796–808)

Relevant previous projects
• "Renew-wall – prefab timber solutions for building retrofit", National project, years 2019-2022 • "Planning and Engagement Arenas for Renewable Energy Landscapes – PEARLS" – H2020-MSCA-RISE-2017, years 2018-2022 • DPC-ReLUIS (the Network of University Laboratories for Seismic Engineering) - "Seismic Risk and Vulnerability Center – WP5, Integrated retrofit interventions (seismic strengthening and energy efficiency) of fast execution and little impact", years 2019-2021 • "FLEXHEAT - The energy FLEXibility of enhanced HEAT pumps for the next generation of sustainable buildings", National project PRIN, years 2019-202 • "Energy efficiency and renewable energies in the building sector" - European Territorial Cooperation – Alpine Space, years 2009-2012
Significant infrastructure and/or technical equipment
Climate chamber, steel portal for timber structure seismic characterization
Operational capacity of legal entity/partner organization
n/a

POLITECNICO DI TORINO	**32. Politecnico of Turindi Torino POLITO | IT**	
	Web site: www.polito.it	**Number of employees: 1850**
	PIC number: 999977754	**Number of students: 35000**

Brief description of legal entity/partner organization

The Regio Politecnico di Torino (Royal Turin Polytechnic) was founded as institution in 1906, but its origins go back further. It was preceded in 1859 by the foundation of the Scuola di Applicazione per gli Ingegneri (Technical School for Engineers) and in 1862 by the Museo Industriale Italiano (Italian Industry Museum). In 1859 Valentino Castle (Castello del Valentino) was given to the Technical School for Engineers, nowadays Politecnico di Torino, which owns the Castle. Over the decades, Politecnico di Torino became one of the most important research and academic institutions in Italy with its continuously growing community. Politecnico expanded in November 1958 in the big complex in Corso Duca degli Abruzzi and further with the Cittadella Politecnica, where classrooms, laboratories, education, research, and services to the town coexist in a modern, lively and creative campus. The Politecnico over its more than 150 history has become an international school, where traditions and future, past and modernity are all interlinked.

The Department of Structural, Geotechnical and Building Engineering (DISEG) is the head of the schools for Civil Engineering and Building Engineering. The Department of Architecture and Design (DAD) is the leading branch of learning of the Turin Polytechnic focusing on the art and science of design, architectural and urban buildings, and product and cultural heritage design. The DISEG promotes, coordinates and manages basic and applied research, training, technology transfer and services to the local community in the fields of structural mechanics, structural engineering, geotechnical engineering, building technology, building production, drawing and representation. On the contrary, the DAD verges these objectives with regards to architectural and urban design including its sustainability, economics and financial aspects, as well as restoration, enhancement and management of architectural, urban and landscape heritage, and industrial, graphic and virtual design.

Contribution to Work Packages and Tasks in the project

Politecnico di Torino (POLITO) will contribute to **WP 4** regarding the design of sustainable buildings by studying the best options for the integration of geothermal heat supply in the neighbourhood that will be constructed. Options that embed the energy systems in the building will be supported by the POLITO expertise in real applications design and feasibility studies both in terms of BIPV (Building Integrated Photovoltaics) and of energy geostructures (foundation slabs and walls as well as energy tunnels).
This activity is strictly related to **WP 6** where the expertise will be employed to provide demonstration of seasonal storage capability by accurate management of different heat exchangers in the energy tunnels (lining exchangers and borehole heat exchangers), realising an Underground Thermal Energy Storage (UTES) system, completely fed by renewable sources.
All the demonstration is based also on the acquisition of a set of monitoring data that will allow to study, understand and control the most influential parameters on the performances of the system, on the buildings and on the environment. These activities can be regarded as part of **WP 8**.
The POLITO team will be available for some of the One stop Shop activities, with digital engagement processes aiming at studying the perceptions and acceptance of end users on design of new technologic solutions. Design solutions will be matched against cost-time effective choices and building processes in comparison to traditional reference cases. It will also be put in place activities of knowledge transfer and networking (experts stakeholders), in order to support future scale up developments of positive energy strategies. Dissemination activities will include publications on scientific peer-reviewed international journals, presentation at selected international conferences and training/summer schools addressed to undergraduates and/or graduates.

Due to the large experience in teaching, dissemination and public debate, POLITO also ensures the results of the aforementioned activities to gain visibility.

Profile of key personnel in the project

[redacted](M) is a Ph.D. in Geotechnical Engineering, Associate Professor at the Politecnico di ng Numerical modelling in geotechnical engineering for Ms students. He is a distinguished academic with international and local recognition based on scientific achievements and active involvement in several management activities. He is the Rector's Advisor for Sports, President of ELGIP (the European Large Geotechnical Laboratories Platform), member of the Board of IACMAG (the International Association for Computer Methods and Advances in Geomechanics) and Chair of the 16th IACMAG international conference.
He has more than 20 years' experience in coordination or participation to national/international research projects and activities at the Politecnico with reference to the swelling behaviour of rocks and soils, laboratory testing, numerical modelling in geotechnical engineering, discontinuum and combined numerical methods, tunnelling, microtunnelling, structural and geotechnical monitoring, ground based radar interferometry, deep and shallow geothermal energy, slope stability problems. He also bestowed extensive practical experience as a consultant on projects related to slope stability, tunnelling, sewage systems, foundations, monitoring of geotechnical structures and ground investigation and as expert for the Turin Public Prosecutor's Office. In 2013 he founded Resolving Srl, a Politecnico di Torino spin-off company, which turned into a full engineering company, Geosolving srl., in 2016.
He patented a new tunnel energy segment, is author of a textbook, of almost two hundreds of scientific papers on international and national journals, on conference proceedings, as well as editor of conference proceedings. He currently is the Editor in Chief of the ASCE International Journal of Geomechanics, member of the Editorial Board of Tunneling and Underground Space Technology and served as Assistant Editor for the Rock Mechanics and Rock Engineering journal.
[redacted](F) Architect graduate of the Faculty of Architecture - Politecnico di Torino, Ph.D. in Building and Environmental Renewal, she is Full Professor in Technology of Architecture and is Vice-Head of DAD (Department of Architecture and Design, Politecnico di Torino). Full Professor of Technology of Architecture, vice-Head of Department of Architecture and Design (DAD), Politecnico di Torino, Italy.
Her main fields of research are the landscape safeguard and valorization, low environmental impact components and materials for eco-buildings, architectural and technological refurbishment of traditional and contemporary architecture. She is author of numerous publications concerning these topics.
In the last years she has developed the research in the field of the maintenance, rehabilitation and energy refurbishment of traditional buildings on the point of view of environmental sustainability. Recently, she has conducted research in the definition of operating guides for the maintenance and recovery of the traditional building in Piedmont area and she was the project leader of the research called "Current Architecture and Landscape – between Tradition and Innovation" funded by the European Commission as part of the Community Culture 2000 Project and involved three countries -Italy, France and Poland – with five work units split up between co-organizers and partners. She is president of Landscape Observatory of Mongioie, associated to Landscaper Observatory network.
[redacted](M) holds a Ph.D. in Architecture and Building design and is Associate Professor of 'Technology of Architecture' at the Politecnico di Torino; Coordinator of the 2nd level Masters course in 'Wood Construction Architecture' and vice-chairman of the Ph.D. course in 'Architecture. History and Project' at the Doctoral School of the Politecnico di Torino (ScuDo). He is the co-founder of the IAM Research Center at the Institute of Mountain Architecture, based at the Politecnico di Torino. He teaches in the MSc degree program in 'Architecture Construction and City', the MSc degree program in 'Architecture for Sustainability Design' and in the degree course 'Design and Visual Communication'.
His research activity centers on technological innovation in architecture, with a particular interest in technological transfer and the development of experimental architecture projects, including the

construction of a number of residences including the Rifugio Carlo Mollino; a Zero Emission Building, energy efficient and built according to the standards of the protocol CasaClima Oro (Gold) exhibited during the XXIII UIA World Congress, Torino 2008 as one of the main Off Congress projects; the Biosphera 2.0. residential module that was the focus of a European Roadshow with the aim of scientifically defining the level of psycho-physical well-being of the users within a residential unit in very different environments.
He has also acquired extensive practical experience as a consultant on industrial development projects, including Naturwall© and his research is the basis for the development of a project finalized in the design and subsequent development of a façade component for retrofit used in a first experimental Eco-Home building with project PEFC™ certification.
In 2014 he founded Be-eco for sustainable construction S.r.l., at the Politecnico di Torino, a spin-off company, which turned at the end of the incubation period in 2019. During the spin-off activity he built 12 single-family homes and designed a biophilic building.
[redacted] (M), is a nationally scientific qualified Professor in Urban Design and Planning, holds a PhD in architecture and design practices, is a licensed architect and master environmental engineer and from 2003 research fellow and scientific advisor at the School of Architecture and Urban Planning of Politecnico di Torino. He has got international training and professional experiences in urban design and spatial planning (C.T.H and K.T.H of Sweden). He has received awards from European educational bodies and has published articles on design decision support systems and scenario making processes. He is an expert in urban analyses ranging from socio-economic- environmental GISbased analyses to sustainable community-based design development. He is a consultant for architectural offices, private companies and public authorities. Since 2008 he has been responsible for local landscape and environmental committees in the area of Turin, has published numerous scientific articles and was editor of a book.
[redacted] (F) is a research assistant at the Politecnico di Torino (Italy) since 2019. She got d Environmental Engineering at Politecnico di Torino and Université Paris-Est in 2020, with a thesis on energy geostructures. She is an expert in numerical modelling of Thermo-Hydro-Mechanical coupled problems and her current research activities are mainly devoted to GSHP and thermoactive geostructures. Recently, she also developed an interest in research related to adaptation to climate change of geoinfrastructures, tunnelling in difficult conditions and fiber optics monitoring of debris flows. Since two years she is also working as a consultant for Geosolving srl., where she is active in energy geostructures design, numerical modelling of geotechnical problems and monitoring data interpretation. She has experience in teaching as supervisor of master students and assistant for the course of Numerical Methods in Geotechnical Engineering. She is author of several scientific publications on international journals and on conference proceedings.
[redacted] M) is a research assistant at the Politecnico di Torino where he got his Ph.D. in Civil and Environmental Engineering with a thesis on the management and planning of shallow geothermal resources in urban areas. His main expertise are on numerical modelling with specific focus on coupled Hydro-Thermal analyses, hydro-geological conceptual modelling, GIS data processing and environmental and structural monitoring. Current research activities are mainly devoted to GSHP and energy geostructures. He also gained practical experience as a consultant for Geosolving srl on projects related to energy geostructures design, slope stability and design of structures and infrastructures. He supervised several master students, deposited an Italian patent for a new energy wall modular system and authored several scientific publications on international journals and on conference proceedings.

Relevant publications, and/or products, services, or other achievements

- Insana A., Barla M. (2020). Experimental and numerical investigations on the energy performance of a thermo-active tunnel, Renewable Energy, vol. 152, pp. 781–792.
- Development of the patent ‘An improved tunnel precast segmental lining equipped to exchange heat with the ground in order to heat and cool adjacent buildings (ENERTUN)’, deposited at Ufficio Italiano Brevetti e Marchi on 29/2/2016 and granted on 20/8/2018 at Italian and European level (Number: 102016000020821). Inventors: Barla, M. (60%) and Di Donna A. (40%).

- Bottero, M., Ambrosini G., Callegari G., (2017). Valuing the Impact of Social Housing Renovation Programs: An Application of the Social Return on Investment (SROI), Green Energy and technology, pp. 291-302, ISBN: 9783319496757.
- Fregonara E., Lo Verso V., Lisa M., Callegari G. (2017). Retrofit scenarios and economic sustainability. A case-study in the Italian context. Energy Procedia, pp. 245-255, ISSN: 1876-6102.
- Development of the patent 'Multifunctional energy efficient façade system', deposited at Ufficio Italiano Brevetti e Marchi on 24/11/2014 and granted on 15/2/2017 at Italian and European level (Number: 102014902311769). Inventors: Callegari, G. (50%), Spinelli A. (45%) and Miroglio M. (5%).

Relevant previous projects

- **ENERTUN**: Le gallerie metropolitane come fonte di energia geotermica/Metro tunnels as geothermal energy sources. Feasibility study funded by the Regione Piemonte (Polo di Innovazione Regionale Enermhy) with the collaboration of Desa Srl, Torino. 2014-2015 (12 months). Funding : 57.000€
- **GEOTHERMSKIN**: Sistema energetico contro terra e metodo per scambiare calore tramite tale sistema. Proof of Concept study funded by the Links Foundation 2020-2021 (6 months). Funding: 43.000€.
- Consulting contract "**Study on the integration of low temperature heat from energy tunnels in district heating systems**", funded by Iren SpA, 38.000 €.
- **OPTISOUNDWOOD.** Development, experimentation and realization on industrial scale of new panels and composites based on plywood made from regional timber. Feasibility study funded by the Regione Piemonte (PSR is co-financed by the European Agricultural Fund for Rural Development) with the collaboration of Be-eco for sustainable construction S.r.l. 2010-2013 (18 month). Funding: 60.000 €.
- **ECO WOOD SKIN** - Environment Carbon Offset Wall for Retrofit. Development of a model that will make the chain of building recovery a tool for the progressive decarbonisation of the residential sector, making use of environmentally friendly products in the form of high-performance building components for energy retrofit. Feasibility study funded by the Regione Piemonte (PSR is co-financed by the European Agricultural Fund for Rural Development) with the collaboration of Be-eco for sustainable construction S.r.l. 2017-2018 (12 month). Funding: 35.000 €.

Significant infrastructure and/or technical equipment

POLITO has gained large experience on the design and management of energy geostructures thanks to the development of two distinct experimental sites in significant environment.
The first realisation refers to the installation of two complete rings of the ENERTUN energy tunnel segmental lining in the South extension of Torino Metro Line 1. The prototype was at first intended to test the technology only during the construction phase of the infrastructure. Due to the excellent results obtained, the usage of the system has become permanent.
The latter realisation refers to the installation of three modules of the GeothermSkin energy wall system in the Energy Center Research Building in Torino. The experimental site has been intended to test the technology and is now being enlarged with the integration of different renewable energy sources such as the solar energy to provide a total solution for buildings energy needs.

Operational capacity of legal entity/partner organization

POLITO administrative offices have large experience in managing large project teams at international (European and not European) and national levels.
The organization has more than 20 years of experience in European projects, working with Public Authorities on sustainable development processes, urban design, infrastructure design and environmental projects. The team was also involved in Life funded projects ("TiRec4life" which was supporting PA dealing with the topic of reuse of rubber for the development of new eco-road

pavement), Interreg projects (Alcotra-"Co&Go" which was supporting PA in planning incentives for boosting sustainable mobility), H2020 projects ("STEVE" which is supporting European cities in defining their policies for e-maas) as well as in cooperation COST Action projects (GABI TU1405 – Geothermal applications in buildings and infrastructures).

Oslo	**33. Oslobygg KF** **OBF | NO**	
	Web site: *(no website yet)* **PIC number:** 994216051	**Number of employees:** 174nviron. 600

Brief description of legal entity/partner organization

Oslobygg KF is a municipal enterprise, which is sorted under the City Council Department for Industry and Ownership. We are one of the country's largest property managers with almost 3 mill. Square meters in portfolio, which consists of schools, kindergartens, sport halls, public library, cultural buildings, hospitals, fire stations, social housing, residential care homes and other municipal disabilities.

Our organization have 174nviron. 600 employees, consisting mainly of construction engineers and developers, property managers, operators and advisors.

Contribution to Work Packages and Tasks in the project

Bodil Motzke is the the link between the Norwegian demonstration project and the EU-project coordination, and participate in the EU-network together with Romeo Apetrei Thomassen, who has previous experience with similar EU-projects.

WP 1 Management: Project management, facility management

WP 2 Framework for effective planning, design, construction and operation of CPCC: climate emission calculations and other 174nvironmental subjects, energy measurements, economy, LCC-analyses, law, early project design phase, social sustainability.

WP 3 Community, environment, and well-being: project design phase, social sustainability.

WP 4 Sustainable building design: measurements, economy, LCC-analyses,

WP 5 Resource efficient manufacturing and construction workflows: economy, project management

WP 6 Renewable energy and storage: energy measurements, renewable energy production

WP 7 Efficient operation and flexibility: energy measurements, renewable energy production

WP 8 Monitoring and evaluation: climate emission calculations and other 174nvironmental subjects, indoor climate and emissions from the building site

WP 9 Market uptake: economy and law

WP 10 Communication, dissemination and training: facility management

Profile of key personnel in the project

[redacted] (M)
E-mail: [redacted]
Mob.: [redacted]

[redacted] has an MBA in Leadership and Sustainable Economy and double Bc degree within Business Economics and Sustainability Engineering. With a 15 year experience in environment, energy efficiency and innovation within the field, his role is to strengthen the collaboration with the market on the innovation segment. He is the key person in several Horizon 2020 project with different topics, all of them covering the strategic environmental goals for Oslo City government.

[redacted] (F)
E-Mail: [redacted]
Mob.: + [redacted]

[redacted] is a civil engineer in energy and environmental science. She has long experience with within the field of environmental issues in the building sector as well as responsible for the strategic work and environmental management systems. She has in depth knowledge with LCA, energy efficiency and renewable solutions, and circular construction materials.

Relevant publications, and/or products, services, or other achievements

Experience in initiating and taking part in several science and innovative projects, with several players in the market. Through the collaborations, several publications have been published. We provide strong expertise, pilot projects and an impressive project portfolio.

Relevant previous projects

Zero Emission Building Sites EU Big Buyers collaboration
The project is a common effort from many European cities to join forces, exchange knowledge and strengthen the work with green procurement. The main goal is to achieve de-carbonization though engaging the marked in distance themselves from use of fossil driven machinery and change the profile to an emission free one.

Pilot -E project (2018 – 2020)
The Pilot-E project emission-free excavator will develop, design, produce, test and put into operation a prototype beltless excavator in the class 25 tons.

FME SUSOLTECH (2017 -2024)
FME SUSOLTECH give access to expertise from world class, laboratory infrastructure and production capacity along the entire value chain too crystalline silicon-based solar power systems, as well as in solar energy systems.

User-driven innovation arena (BIA) program – Re-use of concrete (2019-2023)
Societal challenges related to sustainability, including circular economics with a focus on zero / low emissions and recycling are a professional prioritization for the Research Council. Key Information Reuse of concrete with a focus on hexavalent chromium. The main goal of the project is to increase the recycling of different types of waste by looking at new methods to improve the physical and chemical properties of the materials so that they can be utilized

Building Integrated Photovoltaics for Norway (BIPV Norway) (2018 – 2021)
The BIPV project is a R&D project. BIPV is just a small niche market in Norway today, and knowledge and expertise on this field is missing. The purpose of the BIPV project is to gather the necessary knowledge in all parts of the value chain, from manufacturers of BIPV products, contractors, consultants, architects, building owners and all the way to the research community.

Significant infrastructure and/or technical equipment
n/a
Operational capacity of legal entity/partner organization
OsloBygg KF has several departments whose activities are in line with the project activities. The involvements of employees and advisors from other departments will be considered if needed, based on the workload of the tasks in which OsloBygg is involved. This to avoid disruptions and delays of the project development.

NANO POWER	**34. Nano Power** **NANO | CZ**	
	Web site: www.nanopower.eu **PIC number: 892082714**	**Number of employees: 10** **Number of students: 1**

Brief description of legal entity/partner organization

Integrator of transportation battery packs and energy storage systems and dedicated distributor of Altairnano and Yinlong LTO batteries in Europe.

Contribution to Work Packages and Tasks in the project

WP 6 Renewable energy and storage

- Potential usage of second life batteries
- Optimalization of battery performance vs. battery size with target of cost optimization
- Potential of reduction fixed energy costs

Profile of key personnel in the project

[redacted]

- Experienced in the market of energy storage (battery systems of various sizes and technologies) and renewable sources, experience with the development of custom solutions

[redacted])

- Project Manager
- Experienced Innovator & Designer with a demonstrated history of working in the automotive & railway industry. Skilled in Engineering, Customer Service, Sales, Continuous Improvement and Project Management. Strong entrepreneurship professional with a Doctor of Philosophy (Ph.D.) focused on innovative powertrain solutions from Czech Technical University in Prague.

[redacted]

- Electrician
- experience with testing, installation and service of (not only) battery systems

[redacted]

- Sales Manager
- experience in sales of (stationary) electricity storage and the renewable energy market

[redacted] l Design Engineer, student

- Experience with student projects from the Technical University of Glasgow, participation in the development of the product flash charge battery titanium rapid

[redacted]

- Back Office Manager
- administrative support

Relevant publications, and/or products, services, or other achievements

1. https://nanopower.eu/en/emergency-charging-not-only-for-electric-cars/
2. https://nanopower.eu/en/the-whitelee-wind-farm-and-its-battery/
3. https://nanopower.eu/en/the-potential-of-a-domestic-photovoltaic-power-plant-for-charging-an-electric-car/
4. https://nanopower.eu/en/battery-life/
5. https://nanopower.eu/en/conference-smart-city-in-practice-battery-technologies-for-urban-mobility-and-energy/

Relevant previous projects

1. Supply of 102 kWh LiFePO4 battery energy storage system for connection to a photovoltaic power plant, Poland
2. Supply of 82 kWh LTO battery energy storage system, project “second life of batteries” designed from batteries which are no longer able to

Significant infrastructure and/or technical equipment

Battery components (cables, bms, structures, modules, controls), installation: power supply, load, battery tester, multimeter, common tools, ensuring the transport of the battery to the site

Operational capacity of legal entity/partner organization

n/a

AIGUASOL	**35. AIGUASOL** **AIGUA | ES**	
	Web site: **www.aiguasol.coop** **PIC number: 995438057**	**Number of employees:19**

Brief description of legal entity/partner organization

AIGUASOL is a Spanish SME that provides engineering, consultancy and research services, promoting innovative solutions to reduce the impact associated to the use of energy. Operating as a working cooperative, with a horizontal work structure participatory management, AIGUASOL pursues organizational transformation and focuses on social responsibility, innovation, training and quality. AIGUASOL combines scientific knowledge, practical experience and management skills, which are essential to successfully reach the objectives of the project. Furthermore, AIGUASOL most important addition to the project is a versatile approach that integrates engineering, consultancy and research.

Founded in 1999, the AIGUASOL provides engineering, consultancy and research services, promoting innovative solutions to reduce the impact associated to the use of energy. Operating as a working cooperative, with a horizontal work structure participatory management, AIGUASOL pursues organizational transformation and focuses on social responsibility, innovation, training and quality. The AIGUASOL team is made up of nineteen high-level scientific and technical professionals, including PhDs, engineers and physicists, who have a wealth of experience in the energy sector, both in private companies and research centres.

AIGUASOL has extensive experience in several areas: engineering and integration of energy concepts (renewable, heat pump, waste management, etc) into advanced applied systems; modelling, design, monitoring and control of bespoke energy solutions; and commercialization of energy systems from a demonstration stage to a real operational environment. The capacity of AIGUASOL to effectively work in the project is based on the long-term experience of its members coordinating European projects (POSHIP), and leading work packages in FP7 and Horizon2020 projects.

AIGUASOL has extensive experience in both bioenergy engineering projects and digitalisation tools, specially those related with the provision of energy services, including the creation of an Energy Services Company (ESCO) as start-up.

More recently, AIGUASOL has elaborated the Spanish guide for the promotion of Citizen Energy Communities, promoted by the Spanish Institute for Energy Diversification and Savings (IDAE).

Contribution to Work Packages and Tasks in the project

In ARV, AIGUASOL is primarily involved in WP2 and WP4, focusing on using and testing tools for the implementation of CPCCs and integrating circular design in the Spanish demo project.

Profile of key personnel in the project

[redacted] M), Mechanical Engineer and Economist, senior expert – Since 2006 he manages projects at AIGUASOL in areas related to energy system modelling, solar thermal energy, solar cooling, district networks, energy efficiency and cogeneration. He has participated in TASK 25 and TASK 38 of the IEA Solar Heating&Cooling Program. He has managed the EU Projects PV-SALSA, H-SAPS and PV-DOMSYS. He has coordinated the EU projects Indus3Es, CRESMED, POSHIP, ST-ESCOS, SAHC, and has contributed technically to the HIGH-COMBI project.

[redacted](M), Sustainability PhD, senior expert – Since 2019, as projects director, he manages several engineering and R&D projects related with RE-based energy generation and distribution, both off-grid and grid-connected. He has participated in numerous local, national and international projects focused on the design of integrated energy solutions based on sustainability schemes from the technical, social, regulatory, organizational and economic aspects, for public, private and multilateral clients. At the technological level, he specializes in photovoltaic (autonomous, grid-connected, self-consumption), biomass (thermal, electrical and polygeneration) and electric micro-grid solutions.

[redacted]F): expert in air quality criteria and bioclimatism. [redacted] has devoted her entire paces, doing air quality audits and developing projects under WELL standards. She is, at the moment, leading the dissemination WP of the Nanosens project, related to the development of low price air quality sensors. She has developed a COID-free methodology for the offices of Ferrer group in Barcelona.

Relevant publications, and/or products, services, or other achievements

- González, A., Riba, J. and Rius, A. (2016). Combined heat and power design based on environmental and cost criteria. Energy, 116, pp.922-932.
- González, A., Riba, J. and Rius, A. (2015). Optimal Sizing of a Hybrid Grid-Connected Photovoltaic–Wind– Biomass Power System. Sustainability, 7(9), pp.12787-12806.
- Carrera, A., Cámara, O., Casanova, M., Farré, M. and Serra, I. (2011). New calculation methodology for solar thermal systems. ISES Solar World Congress 2011, Kassel (Germany)
- Arranz, P., Bellot, O., Gavaldà, O., Kemausuor, F. and Velo, E. (2016). Trigeneration based on biomass. Specific field case: agricultural residues from smallholder farms in Ghana. Energy Procedia, 93, pp.146-153.

Relevant previous projects

INTEGRIDY - inteGRIDy aims to integrate cutting-edge technologies, solutions and mechanisms in a scalable Cross-Functional Platform connecting energy networks with diverse stakeholders, facilitating optimal and dynamic operation of the Distribution Grid (DG), fostering the stability and coordination of distributed energy resources and enabling collaborative storage schemes within an increasing share of renewables. AIGUASOL develops thermal-electrical models to evaluate the different measures to be undertaken and will design the monitoring scheme and its integration with the existing SCADA system and engineering, commissioning and follow-up (IPMVP).

INDUS3ES - Indus3Es project aims to recover and revalue non-recovered low-exergy surplus heat in energy intensive industrial processes by the use of Absorption Heat Transformer (AHT) Technology. Indus3Es System will upgrade low temperature waste heat streams to process heat streams at higher temperature levels and then use them in internal industrial process, reducing primary energy consumption of the industry. AIGUASOL is in charge of the engineering design of the integration infrastructure of the AHT at the pilot site, monitoring and control of the system, data transfer and development of a web-based tool to analyse the feasibility of AHT solutions

HOUSEFUL - HOUSEFUL proposes an innovative paradigm shift towards a circular economy for the housing sector. The main goal is to develop and demonstrate an integrated systemic service (HOUSEFUL Service) composed of 11 circular solutions co-created by stakeholders in current housing value chain. The HOUSEFUL Service will aim at the circular management and efficient use of water, waste, energy and material resources for all stages of European building's life-cycle. AIGUASOL holds WP leadership. Most relevant tasks include: development of a tailored-fit Building Circularity Methodology and Optimization of Passive and Active Energy systems of Demo cases implementation, monitoring solutions design and business modelling and exploitation strategies development, as well as detailed engineering of the final solution.

PLUG-N-HARVEST - Passive and active multi-modal energy Harvesting systems, circular economy by design, with high replicability for Self-sufficient Districts & Near-Zero Buildings. AIGUASOL will contribute by defining the boundary conditions related to the end-user's patterns, and the overall energetic behaviour of the buildings, considering too the implementation of new advanced and smart facades and control and management systems solutions, under circular economy business models. AIGUASOL holds two WP leadership. Most relevant tasks include: definition of project's end-users and business requirements, development of LCA/LCC of developed products and

creation of innovative CE-based business models (e.g. Pay per Service (PPS), Pay per Performance (PPP), for ESCO). **Montjuic project**: detailed design for all installations for the Montjuic Castle in Barcelona, including HVAC, electricity, sanitation and fire protection.
Significant infrastructure and/or technical equipment
n/a
Operational capacity of legal entity/partner organization
n/a

4.2. Third parties involved in the project (including use of third party resources)

NTNU, ACE, CVUT, DTU, DANFOSS, EURAC, SINTEF, MET, UAS Utrecht, HOUSING EUROPE, Buro de Haan, Center Denmark, SAB, GDFA, UU, BOSGROEP, iWELL, MEX, KARV, DOL, UNITN, POLITO, OBF, NANO, AIGUASOL: No third parties involved. For the other participants, please see the following tables:

The beneficiaries must base their contracts/subcontracts according to the principles for best value for money and absence of any conflict of interest (according to Articles 10, and 13 of AMGA). Beneficiaries that are 'contracting authorities' or 'contracting entities' (within the meaning of the EU public procurement Directives 2004/18/EC and 2004/17/EC or any EU legislation that replaces these Directives) must moreover comply with the applicable national law on public procurement.

ENFOR

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Y
Total amount to be subcontracted: €30 000 *We will require support from an IT consultant in terms of IT-security measures, and data integration in a secure form (authentication, encryption), and apply the relevant mechanism to secure data and data transfer. This also includes SCADA and PCL integration work. Since the cost is allocated for IT integration services – especially IT security measures – the main part will be spent on T7.4, but adjustments and modifications in the services will have to be made to support other tasks, supporting the work in T6.2, T6.3, T6.4 , T6.6, T7.2, T7.6.* *Subcontractor t.b.d. The subcontract will be awarded according to the principles for best value for money and absence of any conflict of interest (according to Articles 10, and 13 of AMGA).*	
Does the participant envisage that part of its work is performed by linked third parties[55]	N
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
Does the participant envisage that part of the work is performed by International Partners[56] (Article 14a of the General Model Grant Agreement)?	N

PROJECTZERO

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Y

[55] A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the Model Grant Agreement).

[56] 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

Total amount to be subcontracted: €20 000 *Planning of training workshops and training seminars will be subcontracted, because partner PROJECTZERO does not have sufficient qualifications for these activities. The subcontractor will contribute to the planned technical workshops and training seminars. The subcontractor needs to have big experience planning and managing training sessions for technical building companies. The subcontractor will be working in WP10: Communication, Task 10.2 and Task 10.4.* *Subcontractor t.b.d. The subcontract will be awarded according to the principles for best value for money and absence of any conflict of interest (according to Articles 10, and 13 of AMGA).*

Does the participant envisage that part of its work is performed by linked third parties	N
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
Does the participant envisage that part of the work is performed by International Partners (Article 14a of the General Model Grant Agreement)?	N

PALMA

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Y

Total amount to be subcontracted: €130 000

(1) Private Company in charge of the management and coordination of the large-scale renovation process of the aggregated building demand in the Public Private Partnership (PPP) business model to be demonstrated in Palma de Mallorca (Task 3.3), which accounts for the renovation of 250 dwellings (400€/dwelling). The services/subcontracts will be awarded following the legal regulations and according to the principles for best value for money and absence of any conflict of interest, since PALMA has no internal resources with all the needed competences. This is a key role of the Business Model to accelerate the retrofitting of Urban District which cannot be performed by the Public Partner (PALMA) in the consortium, as one of the main innovations to be tested is the PPP model. The partner of the consortium is the Palma de Mallorca city council (the Public part in the PPP model) and the Private party will be selected according legal regulations that apply Public bodies. The estimated budget for this task is 100.000 €.

(2) Online platform for a P2P management, monitoring and visualization system for the energy flows between the PV installation(s) and the members of the Citizen Energy Community (CEC), including communications. The services/subcontracts will be awarded following the legal regulations and according to the principles for best value for money and absence of any conflict of interest and will enable correct implementation of the P2P CEC (Task 7.5 & 8.3). The estimated budget for this task is 30.000 €.

Subcontractor t.b.d. The subcontract will be awarded according to the principles for best value for money and absence of any conflict of interest (according to Articles 10, and 13 of AMGA).

Does the participant envisage that part of its work is performed by linked third parties	N
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
Does the participant envisage that part of the work is performed by International Partners (Article 14a of the General Model Grant Agreement)?	N

IBAVI

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Y

Total amount to be subcontracted: €229 172.97

Project manager team (architects, engineers and surveyors), author of the project of the demo building (35 Public Protection Homes for rent (PPH) located on Tous and Fornaris streets, La Soledad, Palma de Mallorca).

The project was chosen the best proposal based on suitability, architectural quality and technical, economic and constructive feasibility by a jury, following a transparent and non-discriminatory competitive selection procedure. The competitive selection was published in the supplement to the Official Journal of the European Union: https://ted.europa.eu/udl?uri=TED:NOTICE:171861-2020:TEXT:EN:HTML&tabId=1.

The subcontracting cost considered by the IBAVI partner includes the fees of the technicians for the control and supervision of the construction works of the experimental and innovative building, as well as the adaptation of the project so that it meets additional objectives described in The ARV project proposal (Task 4.4, Task 5.3, Task 5.4 -Subtask 5.4.2, Task 8.2 – Subtask 8.2.1 and 8.2.2).
Currently, the functions of the IBAVI technical department staff are managing and coordinating more than 40 public housing developments with more than 900 dwellings in The Balearic Islands, so the inner procedure to achieve the strategic goal requires subcontracting full external teams to draft most of the architectural projects and managing the construction works of the public housing buildings. These teams are always selected according to legal regulations that apply to Public bodies.

The construction works management will take 15 months, coinciding with the construction works. The cost includes all travel costs and related subsistence allowances, and they have been calculated as follows:

WORKS MANAGEMENT	COST (15 MONTHS)	COST PER MONTH
PROJECT MANAGER - ARCHITECT	110.703,66 €	7.380,24 €
CONSTRUCTION MANAGER - SURVEYOR	83.027,75 €	5.535,18 €
HEALTH AND SAFETY COORDINATION - SURVEYOR	19.171,20 €	1.278,08 €
TELECOMUNNICATION MANAGER - ENGINEER	2.100,00 €	140,00 €
PARKING ACTIVITIES MANAGER	3.100,00 €	206,67 €
ENGINEERING MANAGER	11.070,37 €	738,02 €
TOTAL COST OF WORKS MANAGEMENT	**229.172,97 €**	15.278,20 €

Subcontractor t.b.d. The subcontract will be awarded according to the principles for best value for money and absence of any conflict of interest (according to Articles 10, and 13 of AMGA).

Does the participant envisage that part of its work is performed by linked third parties[57]	N
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N

[57] A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the Model Grant Agreement).

Does the participant envisage that part of the work is performed by International Partners[58] (Article 14a of the General Model Grant Agreement)?	N

IREC

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Y
Total amount to be subcontracted: €40 000 *Programming tasks for the 3D district Virtual Reality (VR) model with the Unreal Engine for the demo in Palma de Mallorca (Task 2.5). A specialized company programming with Unreal Engine is necessary to perform this work, generating interactive visualization experiences and integrating results from the energy tools This specific knowledge is not available in the consortium.* *The services/subcontracts will be awarded following the legal regulations and according to the principles for best value for money and absence of any conflict of interest.* *Subcontractor t.b.d. The subcontract will be awarded according to the principles for best value for money and absence of any conflict of interest (according to Articles 10, and 13 of AMGA).*	
Does the participant envisage that part of its work is performed by linked third parties	N
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
Does the participant envisage that part of the work is performed by International Partners (Article 14a of the General Model Grant Agreement)?	N

[58] 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

BOEX

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Y

Total subcontracting: 170 000 EUR

1. *37 500 EUR (expected costs): Campaigns for Utrecht Living Lab community building by involving local change agents in reference to Task 3.3. The Utrecht district of Overvecht-Noord and Kanaleneiland has active local community groups that have extensive expertise in working and involving citizen and other local stakeholders in the energy transition. These community members serve as independent 'change agents' in the local community, because they are not connected to one of the institutional partners such as the social housing corporation Bo-Ex or the municipality of Utrecht. The ARV project will engage, co-create and empower local residents and tenants by hiring/contracting members of the local community groups to manage, expand and enrich the ARV activities around energy transition and build community that will continue to exist after the ARV project as a legacy. The following activities will be planned:*
   - *organising co-creation sessions with local residents, tenants and community members together with ARV partners (hiring trainer/facilitator)*
   - *coordinate the organisation of campaigns around the local energy transition (organisation/engagement support to the social housing corporation Bo-Ex)*
   - *implementation of this subcontract in coordination between the two involved social housing corporations Bo-Ex, Mitros. The budget is split over the two partners since each housing corporation has their own sub-community within the district.*
   - *Cost structure: it is expected that a total of 6 campaigns will be organised with a budget of 6 250 EUR each to be implemented by one change agent in the district.*
2. *37 500 EUR (expected costs): Energy Coaching for tenants of Bo-Ex retrofitted buildings to reduce energy poverty in reference to Task 3.3. The ARV project will coach the tenants of the retrofitted buildings to sustainably reduce their energy consumption and their energy bill by providing energy coaching advice. The ARV project will recruit energy coaches from the local community and local (student) companies. The energy coaches have specific expertise on measures to reduce energy consumption and knowledge of incorporating the smart metering output to workable advices. The specific expertise on tenant interaction in combination with didactic experience of working with people from the districts is not available at the project partner and should therefore be recruited. The following activities will be planned:*
   - *organisation of energy coaching sessions with tenants at the physical district hub (hiring trainer/facilitator)*
   - *one-on-one coaching advice at household level based on personalized data (organisation/coaching of tenants of social housing corporation Bo-Ex)*
   - *implementation of this subcontract in coordination between the three involved social housing corporations Bo-Ex, Mitros. The budget is split over the three partners since each housing corporation has their own tenants to provide coaching advice.*
   - *Cost structure: (1) it is expected that for the general energy coaching session a budget of 3 750 EUR is required. (2) It is expected that for each household coaching advice a budget of 150 EUR is required. In total it is expected to cover 225 households totalling to 33 750 EUR"*
3. *30 000 EUR (expected costs) To shorten retrofitting time of Bo-Ex building retrofits. The work cannot be performed in the consortium partners because the following expertise is not available and is very specific. Cost structure*
   - *15 000 EUR for external logistics consultant for construction logistics improvement*
   - *15 000 EUR for external social consultancy organisation to perform independent tenant satisfaction studies and propose improvements*
4. *50 000 EUR (expected costs) To demonstrate the building and grid flexibility service innovative battery storage systems are purchased. The following expertise is not available within the consortium partners and need to be procured:*
   - *50 000 EUR for subcontracting of an aggregator service to connect the battery systems to the bidirectional charging ecosystem / Smart Solar Charging.*
5. *15 000 EUR to implement small studies, design sprints with the aim to involve external to ARV contractors that design and implement the HeMuBo + Inside Out integrated retrofitting approach in reference to Task 4.3*

Subcontractor t.b.d. The subcontract will be awarded according to the principles for best value for money and absence of

Does the participant envisage that part of its work is performed by linked third parties	N
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
Does the participant envisage that part of the work is performed by International Partners (Article 14a of the General Model Grant Agreement)?	N

RC Panels

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Y

Total subcontracting: 35 000 EUR (expected costs)

To shorten the retrofitting time & prepare building components with the least amount of material to decrease the embodied energy. The work cannot be performed in the consortium partners because the following expertise is not available and is very specific. Cost structure:35 000 EUR for specialist on the integration of specific building facade components, specifically the integration of the balcony elements in the facade panels. The subcontracting is linked to WP3, Task 3.4.

Subcontractor t.b.d. The subcontract will be awarded according to the principles for best value for money and absence of any conflict of interest (according to Articles 10, and 13 of AMGA).

Does the participant envisage that part of its work is performed by linked third parties	N
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
Does the participant envisage that part of the work is performed by International Partners (Article 14a of the General Model Grant Agreement)?	N

City of Utrecht

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Y

Total subcontracting: 35 000 EUR

1. *35 000 EUR (expected costs): External support for setting up the regional the regional Utrecht Exploitation Board as part of Task 9.5. The Utrecht regional innovation cluster of ARV around energy and resource efficient retrofitting consists of many stakeholders (public authorities, housing corporations, construction branche organisations, installation branche organisations, architects) that have an interest in the scaling of the ARV solutions. To involve these stakeholders regional exploitation board meetings are organised for which specific expertise and knowledge on their constituencies are required. This expertise is not available within the consortium and is very specific.*

   Cost structure: 7x 5 000 EUR for the organisation of regional exploitation board meetings in collaboration with ARV partners involving site visits, transferability assessment and scale-up activities (contracting of external advisor specialised in regional scale-up activities) "

Subcontractor t.b.d. The subcontract will be awarded according to the principles for best value for money and absence of any conflict of interest (according to Articles 10, and 13 of AMGA).

Does the participant envisage that part of its work is performed by linked third parties	N

Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
Does the participant envisage that part of the work is performed by International Partners (Article 14a of the General Model Grant Agreement)?	N

Mitros

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	Y

Total subcontracting: 90 000 EUR

1. *37 500 EUR (expected costs): Campaigns for Utrecht Living Lab community building by involving local change agents in reference to Task 3.3. The Utrecht district of Overvecht-Noord and Kanaleneiland has active local community groups that have extensive expertise in working and involving citizen and other local stakeholders in the energy transition. These community members serve as independent 'change agents' in the local community, because they are not connected to one of the institutional partners such as the social housing corporation Mitros or the municipality of Utrecht. The ARV project will engage, co-create and empower local residents and tenants by hiring/contracting members of the local community groups to manage, expand and enrich the ARV activities around energy transition and build community that will continue to exist after the ARV project as a legacy. The following activities will be planned:*
   - *organising co-creation sessions with local residents, tenants and community members together with ARV partners (hiring trainer/facilitator)*
   - *coordinate the organisation of campaigns around the local energy transition (organisation/engagement support to the social housing corporation Mitros)*
   - *implementation of this subcontract in coordination between the two involved social housing corporations Bo-Ex, Mitros. The budget is split over the two partners since each housing corporation has their own sub-community within the district.*
   - *Cost structure: it is expected that a total of 6 campaigns will be organised with a budget of 6 250 EUR each to be implemented by one change agent in the district and the buildings to be renovated.*

2. *37 500 EUR (expected costs): Energy Coaching for tenants of Mitros retrofitted buildings to reduce energy poverty in reference to Task 3.3. The ARV project will coach the tenants of the retrofitted buildings to sustainably reduce their energy consumption and their energy bill by providing energy coaching advice. The ARV project will recruit energy coaches from the local community and local (student) companies. The energy coaches have specific expertise on measures to reduce energy consumption and knowledge of incorporating the smart metering output to workable advices. The specific expertise on tenant interaction in combination with didactic experience of working with people from the districts is not available at the project partner and should therefore be recruited. The following activities will be planned:*
   - *organisation of energy coaching sessions with tenants at the physical district hub (hiring trainer/facilitator)*
   - *one-on-one coaching advice at household level based on personalized data (organisation/coaching of tenants of social housing corporation Mitros)*
   - *implementation of this subcontract in coordination between the three involved social housing corporations Bo-Ex, Mitros. The budget is split over the three partners since each housing corporation has their own tenants to provide coaching advice.*
   - *Cost structure: (1) it is expected that for the general energy coaching session a budget of 3 750 EUR is required. (2) It is expected that for each household coaching advice a budget of 150 EUR is required. In total it is expected to cover 225 households totalling to 33 750 EUR.*

Subcontractor t.b.d. The subcontract will be awarded according to the principles for best value for money and absence of any conflict of interest (according to Articles 10, and 13 of AMGA).

Does the participant envisage that part of its work is performed by linked third parties	N
Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N
Does the participant envisage that part of the work is performed by International Partners (Article 14a of the General Model Grant Agreement)?	N

DTTN

Does the participant plan to subcontract certain tasks (please note that core tasks of the project should not be sub-contracted)	N
Does the participant envisage that part of its work is performed by linked third parties[59]	Y

[59] A third party that is an affiliated entity or has a legal link to a participant implying a collaboration not limited to the action. (Article 14 of the Model Grant Agreement).

ARMALAM S.r.l*. is a founding member of HABITECH and one of his owners is currently part of the HABITECH Board. One of the major strengths of Armalam S.r.l. is the knowledge and the capacity to manage all stages of the realization of wooden works, from intellectual conception up to the most delicate phases of realization. The company follows every phase of the work:*

- *i) preliminary processing of the idea in order to gather, together with the Client, the architectural and functional needs;*
- *ii) the executive design in order to identify the best technical solutions;*
- *iii) the organization of the industrial production of wooden structures in order to guarantee the quality of products;*
- *iv) the management of the execution work on site in order to ensure the perfect correspondence with the project.*

The applied methodology can be summarized in the term "INTEGRATED DESIGN" by the use of the BIM approach (Building Information Modelling). Armalam S.r.l. is then able to provide and to manage all the aspects of design: architectural, structural, and energy design in accordance, from the early stages, with the customer demands, and ensuring the certification of buildings with the most common protocols of the Green Economy. For this reason, ARMALAM S.r.l. will take over specific activities related to New Construction and refurbishment of the existing buildings.

Concerning the ARV project, ARMALAM S.r.l. will take part as a supporter entity throughout the different WPs where DTTN is also present, but will be mostly involved on an operational stage in the Italian Demo Case of Trento - Piedicastello Destra Adige (WP4-WP5). In particular, it will perform design and prototyping tasks linked to the new Positive Energy Building and to the retrofit of the existing buildings located in the area, as foreseen by the project.

Key Person of ARMALAM S.r.l. participating in the project actions: Fabio Ferrario, partner of ARMALAM S.r.l. and technical director of the R&I sector.

Fanti Legnami S.r.l. *was founded in 1956, as a small family-run craft company; over the years, it developed by adopting increasingly advanced processing techniques. It is a member of HABITECH since 2017. In recent years Fanti Legnami S.r.l. has become one of the main companies dealing with woodworking in the Italian region of Trentino. With more than 50 years of experience, Fanti Legnami S.r.l. has been able to choose and enhance the Trentino wood as the best material on the market, in order to produce structural elements and wooden roofs of great value and strength, which have been improved over the years and increasingly established in the demands of the craft market.*
According to the programs of use and care of fir, larch and pine forests at high altitudes, the Trentino wood is the only one that ensures cylindrical trunks with minimum conicity and excellent thin fiber, resistant, flexible, and characterized by well-proportioned growth rings: essential conditions for producing large wooden structures, wooden roofs, chalets and houses of the highest quality. Fanti Legnami S.r.l. also deals with the design and construction of energy-saving wooden roofs and houses. Today the company may count on 37 employees, including lumberjacks, workers, clerks, and a technical office. Moreover, it is in possession of the following certifications:

UNI EN ISO 9001:2015;
- CE marking of solid wood;
- CE marking of bi-lamellar and lamellar wood;
- PEFC forest management certification

Concerning the ARV project, Fanti Legnami S.r.l. will be involved on an operational stage within WP4-WP5, performing construction and installation activities in the framework of the Italian Demo Case of Trento – Piedicastello Destra Adige. In particular, the company will be involved in the construction stage of the new Positive Energy Building, being in charge of its envelope, and in the installation of the new prototype of timber based prefabricated, multi-functional and modular facades linked to the retrofit tasks foreseen by the project.

Key Person of Fanti Legnami S.r.l. participating in the project actions: Marino Fanti, administrator and legal representative of the company.

X-Lam Dolomiti S.r.l. – *member of HABITECH since 2018 - is the leading Italian manufacturer of XLAM-CLT structural panels as well as one of the most important interlocutors for the design and construction of buildings both in wood and mixed steel-wood technologies. Operating since 2010, with a share capital of 1,000,000 euros and a turnover of 15 million euros, XLAM DOLOMITI is composed of 50 employees and stands out in the market for the constant search for quality attested by the numerous certifications achieved: UNI EN ISO 9001: 2008, SALE, Organization Management and Control Model D.Lgs. 231/01, Cat 0G1 Class. VI, Cat 0S6 Class. III-BIS, Cat 0S32 Class. V, ARCA in addition to CE, ETA-12/0347, PEFC product certifications. Furthermore, its belonging to the Paterno Group, operational since 1986 and composed of over 500 employees, represents an important guarantee of financial soundness and reliability.*

The strong point of the company is the engineering and production of XLAM (or CLT, Cross Laminated Timber) structural panels that are large prefabricated panels (up to 13.5 mx and 3.5 m) made of glued cross-laminated boards which are delivered to the construction site, shaped and numbered, ready for assembly which is extremely fast and precise.

The technical-engineering department uses the collaborative design method BIM (Building Information Modeling) that allows to integrate in a single model the useful information in every phase of the design: architectural, structural, plant engineering, energy and management.

For particularly complex projects, which require great speed of realization and intense project management activities, XLAM DOLOMITI proposes itself as GENERAL CONTRACTOR. This means that XLAM DOLOMITI can operate by providing a service "turnkey" becoming the reference point for the realization of hotels, residence halls, multi-storey, holiday villages and residential complexes complete with the provision of furniture.

Within the ARV project, the company will be involved on an operational stage inside WP4-WP5, performing construction and installation activities in the framework of the Italian Demo Case of Trento – Piedicastello Destra Adige. In particular, the company will be involved in the construction stage of the new Positive Energy Building, being in charge of its supporting structure, and in the installation of the new prototype of timber based prefabricated, multi-functional and modular facades linked to the retrofit tasks foreseen by the project.

Key Person of X-Lam Dolomiti S.r.l. participating in the project actions: Albino Angeli, Legal Representative and Technical Director of the company.

Does the participant envisage the use of contributions in kind provided by third parties (Articles 11 and 12 of the General Model Grant Agreement)	N

Does the participant envisage that part of the work is performed by International Partners[60] (Article 14a of the General Model Grant Agreement)?	N
If yes, please describe the International Partner(s) and their contributions	

[60] 'International Partner' is any legal entity established in a non-associated third country which is not eligible for funding under Article 10 of the Rules for Participation Regulation No 1290/2013.

Section 5: Ethics and Security

5.1 Ethics

Compliance with national and European regulations is embedded in the activities and concept of ARV. Consideration to national and international regulations along with ethical and societal dimensions will be performed at all stages of the ARV project. All proposed ARV tasks are permissible under applicable laws and regulations and given proper observance of requirements. Necessary actions will be taken by the project management and all beneficiaries to ensure compliance with applicable European and national regulations and professional codes of conduct relating to personal data protection. This includes in particular Directive 95/46/EC regarding data collection and processing, the General Data Protection Regulation (GDPR, 2016/679) that entered into effect in May 2018, and respective national requirements, ensuring legal and regulatory compliance.

In order to fully comply with research ethics requirements, a Data Management Plan (DMP) will be provided at an early stage of the project (in WP1, T1.6/D1.8). Together with the Consortium Agreement, the Data Management Plan will cover the ethical aspects relevant for the planned research activities connected to the ethical requirements on Personal Data Protection.

The project does not involve any activities or is raising concern regarding:

- Human embryos & fetus
- Human cells & tissues
- Animals
- Environment, health & safety
- Dual use
- Exclusive focus on civil applications
- Potential misuse of research results

The ethics self-assessment, to be entered into the ethical issues table in the administrative forms of the proposal, identified two issues: 1) human participation, and 2) personal data collection and/or processing. These are described in below in Section 5.1.1 and 5.1.2.

- Involvement of human participants
- Collection and/or processing of personal data

5.1.1 Humans

ARV will involve **voluntary adults'** participation (citizen involvement). (see also 5.1.2 Personal Data). Voluntary participation of school children/minors from the age of 16 to 19 years is planned in at least three of the demonstration projects. The information asked from the school children will centre around topics of energy use and energy consumption. The minors and their legal representatives will be informed on the research, methods and procedures planned. The procedure of informed consent is followed. An information letter is provided, and the participants or/and their parents have to sign a consent form. The participants will be anonymized. The country specific law for involving minors (16 years and older), which may vary between participating countries, will be followed.

In the context of ARV demonstration activities, data will be collected through:

- Questionnaires/Online forms;
- Digital Systems (e.g. smart meters, IOT monitoring, City Information Platform etc.);
- Citizen Engagement Activities, such as workshops, co-creation activities, etc.

The consortium will ensure that all necessary procedures are followed, in particular with regards to the signing, collection, and storing of all necessary Informed Consent Forms prior to the collection of any data. These Informed Consent Forms will apply also for anonymous/online data collection, e.g. questionnaires. All involved stakeholders and users will be informed in detail about purpose of data collection, measures and the consortium will obtain free and fully informed consent. Details of recruitment, inclusion and exclusion criteria, and informed consent procedures will be prepared ahead of the start of any proposed measures. Adults unable to give an informed consent will not be involved in the project. Vulnerable groups/individuals will not be involved in the project activities.

5.1.2 Protection of personal data

Personal data of ARV beneficiaries

The consortium agrees that any Background, Results, Confidential Information and/or any and all data and/or information that is provided, disclosed or otherwise made available between the beneficiaries during the implementation of the Action and/or for any Exploitation activities ("Shared Information"), shall not include Personal Data as defined by the General Data Protection Regulation 2016/679 hereinafter referred to as the Data Protection Legislation. By exception to the principle described above, the beneficiaries may share Personal Data of individuals involved in the project for the purpose of executing the Consortium Agreement or the Grant Agreement including but not limited to; names, job titles, e-mail addresses, and other related tele-contact information ("Business Contact Information"). The beneficiaries agree that the Business Contact Information will be only processed to the limited extent required to manage the business relation between the members. Each beneficiary, its affiliated entities, and its contractors may, wherever they do business, store and otherwise process such Business Contact Information. Where notice to or consent by the individuals is required for such processing, each beneficiary, as applicable, will provide notice or obtain such consent as applicable.

Personal data of the third parties

The project implements several activities related to the personal data collection. All six demonstration projects in ARV will require data processing and evaluation involving human research subjects and the collection of personal data. As this project will include the participation of six real-life demo projects requiring multiple data measurements per project, the actual project beneficiaries, external stakeholders and users involved will vary between tasks. The ARV DMP (D.1.8) will refine all the necessary legal and regulatory requirements applicable for the type of data that will be collected and processed. In accordance with the DMP, an Informed Consent process and forms will be developed, and in respective tasks within the Work Packages, we will specify and implement approaches related to data collection, management, and processing measures that are most appropriate based on data avoidance, especially concerning personally identifiable aspects of datasets. Individual data collection will be handled by the involved partners in the work packages, keeping data processing close to the source and within the originating partner organizations.

The project will respect the privacy of all stakeholders and users and will seek free and fully informed consent where personally identifiable data is collected and processed, implementing suitable data handling procedures and protocols to avoid potential identification of individuals. This will include participants' data in activities that use techniques such as questionnaires, interviews, workshops, or mailing lists, as well as automatic building and energy data collection. Where necessary, the data will be anonymised and the mapping of the ID and the person will be safeguarded and will not be available to persons other than the ones working with the data. Results may be used in anonymised or aggregate forms of analysis and may subsequently be published in project reports and scientific papers. All beneficiaries will handle all material with strict care for confidentiality and privacy in accordance with the legal and regulatory requirements, without any harm to participants, stakeholders, or any unknown third parties.

The ARV consortium is aware of potential issues arising from data aggregation from different sources, scales, flows, and devices. Data collected in the project will be anonymised and aggregated as close to the source as possible. In certain cases, personal data avoidance and minimisation can eliminate and/or reduce identifiability. For example, energy consumption with a high temporal resolution can be used to identify personal daily patterns and routines when gathered at an individual household level. Aggregate data either with lower temporal resolution (e.g. once a day) or with a lower geographical resolution (e.g. energy consumption on a district level as is directly available for energy providers), mitigates this risk. Direct data transfers between beneficiaries will be planned on a limited basis, leading to a limited import and export of personal data to/from non-EU countries to the EU. The reason is that Norway is considered an Associated Country within the Horizon 2020 Framework Programme.

The consortium confirms that the ethical standards and guidelines of Horizon 2020 will be rigorously applied, regardless of the country in which the work is carried out, and that all data transfers will be permissible under all necessary legal and regulatory requirements. The project aims to make anonymised datasets public but will aim to strike a balance between publication of data and privacy and confidentiality issues. When in doubt, the consortium will refrain from publishing raw datasets and only report aggregate measures. Decisions will be made on a case-by-case basis by senior staff to ensure that privacy, anonymity, and confidentiality are not breached by publication of datasets or any other type of publication. In addition, on-going consultation with the relevant National Data Protection Offices will be ensured during the lifetime of the project.

The ARV project implies collecting different personal data from individuals during the project's implementation. During the project collection of personal data included collecting contact information (f.e. name, professional email that is already available online) this will be done only for the purpose of organizing the network community we are aiming to establish with this project. This data is only used to contact the participants and it is not used in the research and no further personal data is collected. The consortium will comply with the European and national directives on data protection and with any updates it might receive during the lifetime of the project. The scientific work will be fully based on publicly available data. All data will be handled and shared under an open-source philosophy and in a cooperative manner amongst the partners (cf. data management plan).

Primary data:

All partners in charge of network building and identification of experts for workshops, events or to be invited for other activities confirm that they will not gather any personal data, except publicly available contact information. In case that any personal data will be needed for the successful completion of the research, the respective ethical rules and committees of the involved countries and the EU will be respected.

Secondary use of some datasets:

We state that we will comply with the national and EU directives on data protection and with any updates it might receive during the lifetime of the project. In addition, we confirm that the ethical standards and guidelines will be rigorously applied, regardless of the country in which the research is carried out. In terms of data management, we refer to the data management plan.

Data Management:

All the data used within the project will be available using non-proprietary formats and documented accordingly via the use of extensive metadata descriptions and standard naming conventions. The metadata descriptions will contain the required elements to guarantee that data are easily discovered. Metadata will be containing key information such as ID, Title, Summary, Variable, Unit, Activity, Tags, Frequency, Period/Reference, Institution, Contact, etc. The ARV project aims for data transparency and harmonization. This can only be achieved by allowing anyone to

understand the work and to find the source of every data that will be used. Due to quick data emergence, it is important to keep track of the versions. Finally, every assumption/hypothesis that is made is influencing the final result of the analysis. Accordingly, they will be tracked and well explained. For further details please see Section 2.2 on Research Data Management (2.2.3.) and on IPR / Knowledge Management and Protection (2.2.4.)

Data anonymisation: The ARV consortium is aware of potential issues arising from data aggregation from different sources, scales, flows, and devices.

The project will respect the privacy of all stakeholders and users and will seek free and fully informed consent where personally identifiable data is collected and processed, implementing suitable data handling procedures and protocols to avoid potential identification of individuals. This will include participants' data in activities that use techniques such as questionnaires, interviews, workshops, or mailing lists. Where necessary, the data will be anonymised and aggregated as close to the source as possible, and the mapping of the ID and the person will be safeguarded and will not be available to persons other than the ones working with the data. Results may be used in anonymised or aggregate forms of analysis and may subsequently be published in project reports and scientific papers. All beneficiaries will handle all material with strict care for confidentiality and privacy in accordance with the legal and regulatory requirements, without any harm to participants, stakeholders, or any unknown third parties.

Data minimisation: The collected data are relevant to the ARV project and will be exclusively limited to the purposes of the successful implementation of the action. The type of data to be collected, and data collection processes are in accordance with **'data minimisation 'principle.** The data collection and processing will be done to serve these closely engaged stakeholders' interests and the society overall.

NTNU confirms that the Data Protection Officer (DPO) has been appointed and the contact details of the DPO will be made available to all data subjects involved in the research. For beneficiaries not required to appoint a DPO under the GDPR a detailed data protection policy for the project will be kept on file and submitted to the EC services upon request. Each beneficiary will submit a confirmation within this respect to the coordinator.

A description of the technical and organisational measures that will be implemented to safeguard the rights and freedoms of the data subjects/research participants and a description of the security measures that will be implemented to prevent unauthorised access to personal data or the equipment used for processing will be provided by NTNU. The following measures will notably be implemented:

- clear definition of roles and responsibilities regarding data processing operations (including collection, storage, access, sharing, protection, destruction), as part of the data management process;
- clear definition of the purposes of the processing and no further processing without specific new consent of data subjects or their legal representatives;
- notification of the data processing to relevant national protection authorities, if applicable;
- security of data and their processing (hardware, networks and physical businesses security, confidentiality agreements through which authorised persons will notably commit to use the data for the strict purpose of the project, access control and log records);
- clear separation, each time it will be possible, between the different categories of data according to their degree of accuracy or reliability, particularly between data based on facts and data based on personal or technological assessments;
- enhanced protection of sensitive data;
- mechanisms ensuring data deletion when they are not anymore necessary to the purposes for which they were processed;
- no transfer of personal data to another party without a specific consent given by data subjects and their legal representatives; no transfer to third parties that do not ensure the same level of personal data protection;
- set up of procedures to ensure the efficiency of data subjects' rights, including their right of access, communication, rectification, erasure and to object.

5.1.3 Self-assessment of ethical issues

Within ARV, the following potential ethical issues have been identified by the self-assessment:

- Involvement of human participants
- Collection and/or processing of personal data

The details related to each of the six demonstration projects are summarized in the following table:

Identified demonstration projects	**Human participants**	**Collection of personal data**
Residential, tertiary, and educational buildings, with both new construction and renovation activities, Palma, Spain [Demo 1]	X	X
Energy data, building level, [Demo 1]	X	X
Energy data, neighbourhood level, [Demo 1]	X	X
Community engagement, [Demo 1]	X	X
The demo case in Trento, Italy, consists of four areas: 1) the former Italcementi industrial site; 2) a social and private housing area from the 50s–70s; 3) the Piedicastello Galleries (former highway tunnels); and 4) a parking lot. The project covers both, new construction and renovation of existing buildings and structures, [Demo 2]	X	X
Energy data, building level, [Demo 2]	X	X
Energy data, neighbourhood level, [Demo 2]	X	X
Community engagement, [Demo 2]	X	X
The Dutch demo case consists of two clusters of residential buildings in the Overvecht-Noord district and the Kanaleneiland-Zuid district in the city of Utrecht [Demo 3]	X	X
Energy data, building level, [Demo 3]	X	X
Energy data, neighbourhood level, [Demo 3]	X	X
Community engagement, [Demo 3]	X	X
The Czech demo case encompasses the renovation of Karviná Mizerov Health Centre in the city of Karviná. [Demo 4]. The Living Lab will educate citizens such as students in an effective way, creating energy and resource efficient	X	X

neighbourhoods that increase citizen and stakeholder awareness and engagement		
Energy data, building level, [Demo 4]	X	X
Energy data, neighbourhood level, [Demo 4]	X	X
Community engagement, [Demo 4]	X	X
Residential buildings. The Danish demo case is called SAB Department 22, Kløvermarken/Hvedemarken and is located in the central part of the City of Sønderborg. It includes 19 apartment blocks of 3 floors, in total 432 apartments [Demo 5]	X	X
Energy data, building level, [Demo 5]	X	X
Energy data, neighbourhood level, [Demo 5]	X	X
Community engagement, [Demo 5]	X	X
The Norwegian demo case is the Voldsløkka School and Cultural area. The project includes the construction of a secondary school, a new culture hall, a dance hall, and rehearsal space. The project includes the construction of new buildings and the renovation of an existing listed building [Demo 6]	X	X
Energy data, building level, [Demo 6]	X	X
Energy data, neighbourhood level, [Demo 6]	X	X
Community engagement, [Demo 6]	X	X

5.1.4 Third countries (= non-EU countries)

No third countries are involved in the ARV project.

5.2 Security[61]

All activities were and will be in line with the current EU regulations and laws. The objective is to establish an open and transparent scientific model community that shares its data and models under the open access and open-source guidelines in a harmonized and structured way.

[61] See article 37 of the Model Grant Agreement. For more information on the classification of Information, please refer to the Horizon 2020 guidance: https://ec.europa.eu/research/participants/data/ref/h2020/other/hi/secur/h2020-hi-guide-classif_en.pdf.

The project will NOT involve activities or results raising security issues.

The project will also NOT involve 'EU-classified information' as background or results.

ESTIMATED BUDGET FOR THE ACTION

Associated with document Ref. Ares(2021)5317498 - 27/08/2021

	Estimated eligible[1] costs (per budget category)										EU contribution			Additional information		
	A. Direct personnel costs				B. Direct costs of subcontracting	*[C. Direct costs of fin. support]*	D. Other direct costs		E. Indirect costs[2]	Total costs	Reimbursement rate %	Maximum EU contribution[3]	Maximum grant amount[4]	Information for indirect costs	Information for auditors	Other information:
	A.1 Employees (or equivalent) A.2 Natural persons under direct contract A.3 Seconded persons *[A.6 Personnel for providing access to research infrastructure]*		A.4 SME owners without salary A.5 Beneficiaries that are natural persons without salary				D.1 Travel D.2 Equipment D.3 Other goods and services *[D.4 Costs of large research infrastructure]*	D.5 Costs of internally invoiced goods and services						Estimated costs of in-kind contributions not used on premises	Declaration of costs under Point D.4	Estimated costs of beneficiaries/ linked third parties not receiving funding/ international partners
Form of costs[6]	Actual	Unit[7]	Unit[8]		Actual	Actual	Actual	Unit[9]	Flat-rate[10] 25%							
	a	Total b	No hours	Total c	d	*[e]*	f	Total g	h = 0,25 x (a +b+c+f+g +*[i1]*[13]+*[i2]*[13]-n)	j = a+b+c+d +*[e]*+f+g+h +*[i1]*+*[i2]*	k	l	m	n	Yes/No	
1. NTNU	1 552 004.00	0.00	0.00	0.00	0.00	0.00	111 041.00	0.00	415 761.25	2 078 806.25	100.00	2 078 806.25	2 078 806.25	0.00	No	n/a
2. ACE	189 428.00	0.00	0.00	0.00	0.00	0.00	52 000.00	0.00	60 357.00	301 785.00	100.00	301 785.00	301 785.00	0.00	No	n/a
3. CVUT	599 319.00	0.00	0.00	0.00	0.00	0.00	443 500.00	0.00	260 704.75	1 303 523.75	100.00	1 303 523.75	1 303 523.75	0.00	No	n/a
4. DTU	631 843.00	0.00	0.00	0.00	0.00	0.00	19 000.00	0.00	162 710.75	813 553.75	100.00	813 553.75	813 553.75	0.00	No	n/a
5. DANFOSS A/S	209 700.00	0.00	0.00	0.00	0.00	0.00	106 750.00	0.00	79 112.50	395 562.50	70.00	276 893.75	276 893.75	0.00	No	n/a
6. ENFOR	308 770.00	0.00	0.00	0.00	30 000.00	0.00	6 250.00	0.00	78 755.00	423 775.00	70.00	296 642.50	296 642.50	0.00	No	n/a
7. PROJECTZERO	290 250.00	0.00	0.00	0.00	20 000.00	0.00	27 000.00	0.00	79 312.50	416 562.50	100.00	416 562.50	416 562.50	0.00	No	n/a
8. EURAC	285 600.00	0.00	0.00	0.00	0.00	0.00	30 000.00	0.00	78 900.00	394 500.00	100.00	394 500.00	394 500.00	0.00	No	n/a
9. SINTEF	1 263 220.00	0.00	0.00	0.00	0.00	0.00	78 000.00	0.00	335 305.00	1 676 525.00	100.00	1 676 525.00	1 676 525.00	0.00	No	n/a
10. PALMA	827 631.00	0.00	0.00	0.00	130 000.00	0.00	138 600.00	0.00	241 557.75	1 337 788.75	100.00	1 337 788.75	1 337 788.75	0.00	No	n/a
11. IBAVI	239 776.00	0.00	0.00	0.00	229 173.00	0.00	74 130.00	0.00	78 476.50	621 555.50	100.00	621 555.50	621 555.50	0.00	No	n/a
12. IREC	761 173.00	0.00	0.00	0.00	40 000.00	0.00	47 450.00	0.00	202 155.75	1 050 778.75	100.00	1 050 778.75	1 050 778.75	0.00	No	n/a
13. MET	160 230.00	0.00	0.00	0.00	0.00	0.00	70 250.00	0.00	57 620.00	288 100.00	70.00	201 670.00	201 670.00	0.00	No	n/a
14. UAS Utrecht	607 500.00	0.00	0.00	0.00	0.00	0.00	95 250.00	0.00	175 687.50	878 437.50	100.00	878 437.50	878 437.50	0.00	No	n/a
15. HOUSING EUROPE	205 804.00	0.00	0.00	0.00	0.00	0.00	63 550.00	0.00	67 338.50	336 692.50	100.00	336 692.50	336 692.50	0.00	No	n/a
16. Buro de Haan	117 500.65	0.00	271.50	9 999.35	0.00	0.00	41 250.00	0.00	42 187.50	210 937.50	70.00	147 656.25	147 656.25	0.00	No	n/a
17. Center Denmark	469 986.00	0.00	0.00	0.00	0.00	0.00	10 250.00	0.00	120 059.00	600 295.00	100.00	600 295.00	600 295.00	0.00	No	n/a
18. SAB	151 725.00	0.00	0.00	0.00	0.00	0.00	57 250.00	0.00	52 243.75	261 218.75	100.00	261 218.75	261 218.75	0.00	No	n/a
19. GDFA	559 482.00	0.00	0.00	0.00	0.00	0.00	37 000.00	0.00	149 120.50	745 602.50	100.00	745 602.50	745 602.50	0.00	No	n/a
20. BOEX	150 000.00	0.00	0.00	0.00	170 000.00	0.00	545 250.00	0.00	173 812.50	1 039 062.50	100.00	1 039 062.50	1 039 062.50	0.00	No	n/a
21. Rc Panels B.V.	189 960.95	0.00	35.00	1 289.05	35 000.00	0.00	6 250.00	0.00	49 375.00	281 875.00	70.00	197 312.50	197 312.50	0.00	No	n/a
22. UU	360 000.00	0.00	0.00	0.00	0.00	0.00	35 250.00	0.00	98 812.50	494 062.50	100.00	494 062.50	494 062.50	0.00	No	n/a
23. CITY OF UTRECHT	157 500.00	0.00	0.00	0.00	35 000.00	0.00	6 250.00	0.00	40 937.50	239 687.50	100.00	239 687.50	239 687.50	0.00	No	n/a
24. BOSGROEP	307 500.00	0.00	0.00	0.00	0.00	0.00	6 250.00	0.00	78 437.50	392 187.50	70.00	274 531.25	274 531.25	0.00	No	n/a
25. iwell	165 000.00	0.00	0.00	0.00	0.00	0.00	6 250.00	0.00	42 812.50	214 062.50	70.00	149 843.75	149 843.75	0.00	No	n/a
26. MEX	165 000.00	0.00	0.00	0.00	0.00	0.00	6 250.00	0.00	42 812.50	214 062.50	70.00	149 843.75	149 843.75	0.00	No	n/a
27. Mitros	127 500.00	0.00	0.00	0.00	90 000.00	0.00	186 250.00	0.00	78 437.50	482 187.50	100.00	482 187.50	482 187.50	0.00	No	n/a
28. KARV	90 801.00	0.00	0.00	0.00	0.00	0.00	5 000.00	0.00	23 950.25	119 751.25	100.00	119 751.25	119 751.25	0.00	No	n/a
29. DOL	87 330.00	0.00	0.00	0.00	0.00	0.00	258 000.00	0.00	86 332.50	431 662.50	70.00	302 163.75	302 163.75	0.00	No	n/a
30. DTTN	126 240.00	0.00	0.00	0.00	0.00	0.00	5 000.00	0.00	32 810.00	164 050.00	100.00	164 050.00	164 050.00	0.00	No	n/a
- Armalam	0.00	0.00	3 817.23	136 007.90	0.00	0.00	0.00	0.00	34 001.98	170 009.88	70.00	119 006.92	119 006.92	0.00	No	n/a

ESTIMATED BUDGET FOR THE ACTION

Associated with document Ref. Ares(2021)5317498 - 27/08/2021

	Estimated eligible[1] costs (per budget category)										EU contribution			Additional information		
	A. Direct personnel costs				B. Direct costs of subcontracting	*[C. Direct costs of fin. support]*	D. Other direct costs		E. Indirect costs[2]	Total costs	Reimbursement rate %	Maximum EU contribution[3]	Maximum grant amount[4]	Information for indirect costs	Information for auditors	Other information:
	A.1 Employees (or equivalent) A.2 Natural persons under direct contract A.3 Seconded persons *[A.6 Personnel for providing access to research infrastructure]*		A.4 SME owners without salary A.5 Beneficiaries that are natural persons without salary				D.1 Travel D.2 Equipment D.3 Other goods and services *[D.4 Costs of large research infrastructure]*	D.5 Costs of internally invoiced goods and services						Estimated costs of in-kind contributions not used on premises	Declaration of costs under Point D.4	Estimated costs of beneficiaries/ linked third parties not receiving funding/ international partners
Form of costs[6]	Actual	Unit[7]	Unit[8]		Actual	Actual	Actual	Unit[9]	Flat-rate[10] 25%							
	a	Total b	No hours	Total c	d	*[e]*	f	Total g	h = 0,25 x (a +b+c+f+g +*[i1]*[13]+*[i2]*[13]-n)	j = a+b+c+d +*[e]*+f+g+h +*[i1]*+*[i2]*	k	l	m	n	Yes/No	
- X-LAM DOLOMITI	64 825.00	0.00	0.00	0.00	0.00	0.00	454 000.00	0.00	129 706.25	648 531.25	70.00	453 971.88	453 971.88	0.00	No	n/a
- FANTI LEGNAMI	41 126.00	0.00	0.00	0.00	0.00	0.00	285 000.00	0.00	81 531.50	407 657.50	70.00	285 360.25	285 360.25	0.00	No	n/a
Total beneficiary	232 191.00	0.00	3 817.23	136 007.90	0.00	0.00	744 000.00	0.00	278 049.73	1 390 248.63		1 022 389.05	1 022 389.05	n/a	n/a	0.00
31. UNITN	308 000.00	0.00	0.00	0.00	0.00	0.00	5 000.00	0.00	78 250.00	391 250.00	100.00	391 250.00	391 250.00	0.00	No	n/a
32. POLITO	248 000.00	0.00	0.00	0.00	0.00	0.00	28 750.00	0.00	69 187.50	345 937.50	100.00	345 937.50	345 937.50	0.00	No	n/a
33. OBF	644 115.00	0.00	0.00	0.00	0.00	0.00	19 000.00	0.00	165 778.75	828 893.75	100.00	828 893.75	828 893.75	0.00	No	n/a
34. NANO	58 596.00	0.00	0.00	0.00	0.00	0.00	35 000.00	0.00	23 399.00	116 995.00	70.00	81 896.50	81 896.50	0.00	No	n/a
35. AIGUASOL SAEST	144 130.00	0.00	0.00	0.00	0.00	0.00	14 850.00	0.00	39 745.00	198 725.00	70.00	139 107.50	139 107.50	0.00	No	n/a
Total consortium	12 866 565.60	0.00		147 296.30	779 173.00	0.00	3 416 121.00	0.00	4 107 495.73	21 316 651.63		19 998 408.55	19 998 408.55			0.00

[1] See Article 6 for the eligibility conditions.
[2] Indirect costs already covered by an operating grant (received under any EU or Euratom funding programme; see Article 6.5.(b)) are ineligible under the GA. Therefore, a beneficiary/linked third party that receives an operating grant during the action's duration cannot declare indirect costs for the year(s)/reporting period(s) covered by the operating grant, unless it can demonstrate that the operating grant does not cover any costs of the action (see Article 6.2.E).
[3] This is the theoretical amount of EU contribution that the system calculates automatically (by multiplying all the budgeted costs by the reimbursement rate). This theoretical amount is capped by the 'maximum grant amount' (that the Agency decided to grant for the action) (see Article 5.1).
[4] The 'maximum grant amount' is the maximum grant amount decided by the Agency. It normally corresponds to the requested grant, but may be lower.
[5] Depending on its type, this specific cost category will or will not cover indirect costs. Specific unit costs that include indirect costs are: costs for energy efficiency measures in buildings, access costs for providing trans-national access to research infrastructure and costs for clinical studies.
[6] See Article 5 for the forms of costs.
[7] Unit : hours worked on the action; costs per unit (hourly rate) : calculated according to the beneficiary's usual accounting practice.
[8] See Annex 2a 'Additional information on the estimated budget' for the details (costs per hour (hourly rate)).
[9] Unit and costs per unit : calculated according to the beneficiary's usual accounting practices.
[10] Flat rate : 25% of eligible direct costs, from which are excluded: direct costs of subcontracting, costs of in-kind contributions not used on premises, direct costs of financial support, and unit costs declared under budget category F if they include indirect costs (see Article 6.2.E).
[11] See Annex 2a 'Additional information on the estimated budget' for the details (units, costs per unit).
[12] See Annex 2a 'Additional information on the estimated budget' for the details (units, costs per unit, estimated number of units, etc).
[13] Only specific unit costs that do not include indirect costs.
[14] See Article 9 for beneficiaries not receiving funding.
[15] Only for linked third parties that receive funding.

Annex 2a

Unit cost for SME owners/natural beneficiaries without salary

1. Costs for a SME owner not receiving a salary

Units: hours worked on the action

Amount per unit ('hourly rate'): calculated according to the following formula:

{the monthly living allowance for researchers in MSCA-IF actions / 143 hours}

multiplied by

{country-specific correction coefficient of the country where the beneficiary is established}

The monthly living allowance and the country-specific correction coefficients are set out in the Work Programme (section 3 MSCA) in force at the time of the call:

- for calls under Work Programme 2018-2020:
- for the monthly living allowance: EUR 4 880
- for the country-specific correction coefficients: see Work Programme 2018-2020 (available on the Participant Portal Reference Documents page)

For the following beneficiaries/linked third parties, the amounts per unit (hourly rate) are fixed as follows:

Beneficiary/linked third party	Monthly living allowance	Corrections coefficient	Hourly rate after application of correction coefficient
16. Buro de Haan	EUR 4 880	1,079 (NL)	EUR 36,83
21. RC Panels	EUR 4 880	1,079 (NL)	EUR 36,83
30. DTTN/Armalam	EUR 4 880	1,044 (IT)	EUR 35,63

Estimated number of units: see Annex 2

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

CONSEIL DES ARCHITECTES D'EUROPE (ACE), established in RUE PAUL EMILE JANSON 29, BRUXELLES 1050, Belgium, VAT number: BE0464884970, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('2')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

CESKE VYSOKE UCENI TECHNICKE V PRAZE (CVUT), established in JUGOSLAVSKYCH PARTYZANU 1580/3, PRAHA 160 00, Czech Republic, VAT number: CZ68407700, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('3')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

DANMARKS TEKNISKE UNIVERSITET (DTU), established in ANKER ENGELUNDSVEJ 1 BYGNING 101 A, KGS LYNGBY 2800, Denmark, VAT number: DK30060946, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('4')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

DANFOSS A/S (DANFOSS A/S), established in Nordborgvej 81, NORDBORG 6430, Denmark, VAT number: DK20165715, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('5')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

ENFOR AS (ENFOR), established in LYNGSO ALLE 3, HORSHOLM 2970, Denmark, VAT number: DK29421633, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('6')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

PROJECT ZERO A/S (PROJECTZERO), established in Alsion 2, Sonderborg 6400, Denmark, VAT number: DK29215642, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('7')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

ACCADEMIA EUROPEA DI BOLZANO (EURAC), established in VIALE DRUSO 1, BOLZANO 39100, Italy, VAT number: IT01659400210, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('8')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

SINTEF AS (SINTEF), established in STRINDVEGEN 4, TRONDHEIM 7034, Norway, VAT number: NO919303808MVA, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('9')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

AYUNTAMENT DE PALMA DE MALLORCA (PALMA), established in PLAZA DE CORT 1, PALMA DE MALLORCA 07001, Spain, VAT number: ESP0704000I, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('10')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

INSTITUTO BALEAR DE LA VIVIENDA (IBAVI), established in CALLE MANUEL AZANA 9 BAJOS, PALMA DE MALLORCA 07006, Spain, VAT number: ESQ5750001I, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('11')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

FUNDACIO INSTITUT DE RECERCA DE L'ENERGIA DE CATALUNYA (IREC), established in C/ JARDINS DE LES DONES DE NEGRE 1, SANT ADRIA DE BESOS 08930, Spain, VAT number: ESG64946387, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('12')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

METROVACESA, SA (MET), established in C QUINTANAVIDES 13 PARQUE EMPRESARIAL VIA NORTE ED 1 PLANTA 1, MADRID 28050, Spain, VAT number: ESA87471264, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('13')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

Stichting Hogeschool Utrecht (UAS Utrecht), established in PADUALAAN 99, UTRECHT 3584 CH, Netherlands, VAT number: NL806163185B01, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('14')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

COMITE EUROPEEN DE COORDINATION DE L'HABITAT SOCIAL AISBL (HOUSING EUROPE), established in SQUARE DE MEEUS 18, BRUXELLES 1050, Belgium, VAT number: BE0473324762, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('15')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

BURO DE HAAN INFORMATIE TECHNOLOGIE BV (Buro de Haan), established in ACHTHOEVENWEG 34, STAPHORST 7951 SK, Netherlands, VAT number: NL857548773B01, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('16')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

CENTER DANMARK DRIFT APS (Center Denmark), established in VENDERSGADE 74, FREDERICIA 7000, Denmark, VAT number: DK40868399, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('17')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

SONDERBORG ANDELSBOLIGFORENING (SAB), established in BYGTOFTEN 2, SONDERBORG 6400, Denmark, VAT number: DK45569810, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('18')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

GREEN DIGITAL FINANCE ALLIANCE (GDFA), established in CHEMIN DES ANEMONES 11-13, CHATELAINE 1219, Switzerland, VAT number: CHE496481826TVA, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('19')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

STICHTING BO-EX 91 (BOEX), established in JAN CORNELISZ MAYLAAN 18, UTRECHT 3526GV, Netherlands, VAT number: NL800519085B01, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('20')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

RC PANELS BV (Rc Panels B.V.), established in CONSTRUCTIEWEG 1, LEMELERVELD 8152 GA, Netherlands, VAT number: NL856857270B01, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('21')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

UNIVERSITEIT UTRECHT (UU), established in HEIDELBERGLAAN 8, UTRECHT 3584 CS, Netherlands, VAT number: NL001798650B01, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('22')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

GEMEENTE UTRECHT (CITY OF UTRECHT), established in STADSPLATEAU 1, UTRECHT 3521 AZ, Netherlands, VAT number: NL002220647B01, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('23')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

BOS INSTALLATIEWERKEN BV (BOSGROEP), established in TENNESSEEDREEF 17, UTRECHT 3565 CK, Netherlands, VAT number: NL801071197B01, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('24')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

IWELL BV (iwell), established in ATOOMWEG 7-9, UTRECHT 3542 AA, Netherlands, VAT number: NL856333268B01, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('25')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

ME X ARCHITECTS BV (MEX), established in SPOORLAAN 18, BILTHOVEN 3721 PB, Netherlands, VAT number: NL809748253B01, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('26')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

STICHTING MITROS (Mitros), established in KONINGIN WILHELMINALAAN 9, UTRECHT 3527 LA, Netherlands, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('27')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

STATUTARNI MESTO KARVINA (KARV), established in FRYSTATSKA 72 1, KARVINA FRYSTAT 733 24, Czech Republic, VAT number: CZ00297534, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('28')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

DOLOMITI ENERGIA RINNOVABILI SOCIETA A RESPONSABILITA' LIMITATA (DOL), established in VIA FERSINA 23, TRENTO 38123, Italy, VAT number: IT01840970220, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('29')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

DISTRETTO TECNOLOGICO TRENTINO SCARL (DTTN), established in PIAZZA MANIFATTURA 1, ROVERETO 38068, Italy, VAT number: IT01990440222, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('30')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

UNIVERSITA DEGLI STUDI DI TRENTO (UNITN), established in VIA CALEPINA 14, TRENTO 38122, Italy, VAT number: IT00340520220, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('31')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

POLITECNICO DI TORINO (POLITO), established in CORSO DUCA DEGLI ABRUZZI 24, TORINO 10129, Italy, VAT number: IT00518460019, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('32')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

OSLO KOMMUNE (OBF), established in RADHUSET, OSLO 0037, Norway, VAT number: NO958935420MVA, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('33')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

NANO POWER AS (NANO), established in TISKARSKA 599/12, PRAHA 108 00, Czech Republic, VAT number: CZ01719041, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('34')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ANNEX 3

ACCESSION FORM FOR BENEFICIARIES

SISTEMES AVANCATS D ENERGIA SOLAR TERMICA SCCL (AIGUASOL SAEST), established in CALLE ROGER DE LLURIA 29 3R 2E, BARCELONA 08009, Spain, VAT number: ESF62787692, ('the beneficiary'), represented for the purpose of signing this Accession Form by the undersigned,

hereby agrees

to become beneficiary No ('35')

in Grant Agreement No 101036723 ('the Agreement')

between NORGES TEKNISK-NATURVITENSKAPELIGE UNIVERSITET NTNU **and** the European Climate, Infrastructure and Environment Executive Agency (CINEA) ('the Agency'), under the powers delegated by the European Commission ('the Commission'),

for the action entitled 'Climate Positive Circular Communities (ARV)'.

and mandates

the coordinator to submit and sign in its name and on its behalf any **amendments** to the Agreement, in accordance with Article 55.

By signing this Accession Form, the beneficiary accepts the grant and agrees to implement it in accordance with the Agreement, with all the obligations and conditions it sets out.

SIGNATURE

For the beneficiary

ⓘ print format A4 landscape

MODEL ANNEX 4 FOR H2020 GENERAL MGA — MULTI

FINANCIAL STATEMENT FOR *[BENEFICIARY [name]/ LINKED THIRD PARTY [name]]* FOR REPORTING PERIOD [reporting period]

	Eligible[1] costs (per budget category)													Receipts	EU contribution			Additional information
	A. Direct personnel costs				B. Direct costs of subcontracting	*[C. Direct costs of fin. support]*	D. Other direct costs			E. Indirect costs[2]	*[F. Costs of …]*		Total costs	Receipts	Reimbursement rate %	Maximum EU contribution[3]	Requested EU contribution	Information for indirect costs :
	A.1 Employees (or equivalent) A.2 Natural persons under direct contract A.3 Seconded persons *[A.6 Personnel for providing access to research infrastructure]*		A.4 SME owners without salary A.5 Beneficiaries that are natural persons without salary			*[C.1 Financial support]* *[C.2 Prizes]*	D.1 Travel D.2 Equipment D.3 Other goods and services	*[D.4 Costs of large research infrastructure]*	D.5 Costs of internally invoiced goods and services		*[F.1 Costs of …]*	*[F.2 Costs of …]*		Receipts of the action, to be reported in the last reporting period, according to Article 5.3.3				Costs of in-kind contributions not used on premises
Form of costs[4]	Actual	Unit	Unit		Actual	Actual	Actual	Actual	Unit	Flat-rate[5] 25%	Unit		*[Unit][Lump sum]*					
	a	Total b	No hours	Total c	d	*[e]*	f	*[g]*	Total h	i=0,25 x (a+b+ c+f+*[g]* + h+ *[j 1]*[6] +*[j2]*[6] -p)	No units	Total *[j1]*	Total *[j2]*	k = a+b+c+d+*[e]* +*f* + *[g]* +h+ i + *[j1]* +*[j2]*	l	m	n	o	p
[short name beneficiary/linked third party]																		

The beneficiary/linked third party hereby confirms that:
The information provided is complete, reliable and true.
The costs declared are eligible (see Article 6).
The costs can be substantiated by adequate records and supporting documentation that will be produced upon request or in the context of checks, reviews, audits and investigations (see Articles 17, 18 and 22).
For the last reporting period: that all the receipts have been declared (see Article 5.3.3).

ⓘ Please declare all eligible costs, even if they exceed the amounts indicated in the estimated budget (see Annex 2). Only amounts that were declared in your individual financial statements can be taken into account lateron, in order to replace other costs that are found to be ineligible.

[1] See Article 6 for the eligibility conditions

[2] The indirect costs claimed must be free of any amounts covered by an operating grant (received under any EU or Euratom funding programme; see Article 6.2.E). If you have received an operating grant during this reporting period, you cannot claim indirect costs unless you can demonstrate that the operating grant does not cover any costs of the action.

[3] This is the *theoretical* amount of EU contribution that the system calculates automatically (by multiplying the reimbursement rate by the total costs declared). The amount you request (in the column 'requested EU contribution') may be less,

[4] See Article 5 for the forms of costs

[5] Flat rate : 25% of eligible direct costs, from which are excluded: direct costs of subcontracting, costs of in-kind contributions not used on premises, direct costs of financial support, and unit costs declared under budget category F if they include indirect costs (see Article 6.2.E)

[6] Only specific unit costs that do not include indirect costs

ANNEX 5

MODEL FOR THE CERTIFICATE ON THE FINANCIAL STATEMENTS

- **For options [*in italics in square brackets*]: choose the applicable option. Options not chosen should be deleted.**
- **For fields in [grey in square brackets]: enter the appropriate data**

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Terms of Reference for an Independent Report of Factual Findings on costs declared under a Grant Agreement financed under the Horizon 2020 Research and Innovation Framework Programme

This document sets out the '**Terms of Reference (ToR)**' under which

[OPTION 1: [insert name of the beneficiary] ('the Beneficiary')] [OPTION 2: [insert name of the linked third party] ('the Linked Third Party'), third party linked to the Beneficiary [insert name of the beneficiary] ('the Beneficiary')]

agrees to engage

[**insert legal name of the auditor**] ('the Auditor')

to produce an independent report of factual findings ('the Report') concerning the Financial Statement(s)[1] drawn up by the *[Beneficiary] [Linked Third Party]* for the Horizon 2020 grant agreement [insert number of the grant agreement, title of the action, acronym and duration from/to] ('the Agreement'), and

to issue a Certificate on the Financial Statements' ('CFS') referred to in Article 20.4 of the Agreement based on the compulsory reporting template stipulated by the Commission.

The Agreement has been concluded under the Horizon 2020 Research and Innovation Framework Programme (H2020) between the Beneficiary and *[OPTION 1: the European Union, represented by the European Commission ('the Commission')][OPTION 2: the European Atomic Energy Community (Euratom,) represented by the European Commission ('the Commission')][OPTION 3: the [Research Executive Agency (REA)] [European Research Council Executive Agency (ERCEA)] [Innovation and Networks Executive Agency (INEA)] [Executive Agency for Small and Medium-sized Enterprises (EASME)] ('the Agency'), under the powers delegated by the European Commission ('the Commission').]*

The *[Commission] [Agency]* is mentioned as a signatory of the Agreement with the Beneficiary only. The *[European Union][Euratom][Agency]* is not a party to this engagement.

1.1 Subject of the engagement

The coordinator must submit to the *[Commission][Agency]* the final report within 60 days following the end of the last reporting period which should include, amongst other documents, a CFS for each beneficiary and for each linked third party that requests a total contribution of EUR 325 000 or more, as reimbursement of actual costs and unit costs calculated on the basis of its usual cost accounting practices (see Article 20.4 of the Agreement). The CFS must cover all reporting periods of the beneficiary or linked third party indicated above.

The Beneficiary must submit to the coordinator the CFS for itself and for its linked third party(ies), if the CFS must be included in the final report according to Article 20.4 of the Agreement.

The CFS is composed of two separate documents:

- The Terms of Reference ('the ToR') to be signed by the *[Beneficiary] [Linked Third Party]* and the Auditor;

[1] By which costs under the Agreement are declared (see template 'Model Financial Statements' in Annex 4 to the Grant Agreement).

- The Auditor's Independent Report of Factual Findings ('the Report') to be issued on the Auditor's letterhead, dated, stamped and signed by the Auditor (or the competent public officer) which includes the agreed-upon procedures ('the Procedures') to be performed by the Auditor, and the standard factual findings ('the Findings') to be confirmed by the Auditor.

If the CFS must be included in the final report according to Article 20.4 of the Agreement, the request for payment of the balance relating to the Agreement cannot be made without the CFS. However, the payment for reimbursement of costs covered by the CFS does not preclude the Commission *[Agency,]* the European Anti-Fraud Office and the European Court of Auditors from carrying out checks, reviews, audits and investigations in accordance with Article 22 of the Agreement.

1.2 Responsibilities

The *[Beneficiary] [Linked Third Party]:*

- must draw up the Financial Statement(s) for the action financed by the Agreement in compliance with the obligations under the Agreement. The Financial Statement(s) must be drawn up according to the *[Beneficiary's] [Linked Third Party's]* accounting and book-keeping system and the underlying accounts and records;
- must send the Financial Statement(s) to the Auditor;
- is responsible and liable for the accuracy of the Financial Statement(s);
- is responsible for the completeness and accuracy of the information provided to enable the Auditor to carry out the Procedures. It must provide the Auditor with a written representation letter supporting these statements. The written representation letter must state the period covered by the statements and must be dated;
- accepts that the Auditor cannot carry out the Procedures unless it is given full access to the *[Beneficiary's] [Linked Third Party's]* staff and accounting as well as any other relevant records and documentation.

The Auditor:

- *[Option 1 by default:* is qualified to carry out statutory audits of accounting documents in accordance with Directive 2006/43/EC of the European Parliament and of the Council of 17 May 2006 on statutory audits of annual accounts and consolidated accounts, amending Council Directives 78/660/EEC and 83/349/EEC and repealing Council Directive 84/253/EEC or similar national regulations*]*.
- *[Option 2 if the Beneficiary or Linked Third Party has an independent Public Officer:* is a competent and independent Public Officer for which the relevant national authorities have established the legal capacity to audit the Beneficiary*]*.
- *[Option 3 if the Beneficiary or Linked Third Party is an international organisation:* is an [internal] [external] auditor in accordance with the internal financial regulations and procedures of the international organisation*]*.

The Auditor:

- must be independent from the Beneficiary *[and the Linked Third Party]*, in particular, it must not have been involved in preparing the *[Beneficiary's] [Linked Third Party's]* Financial Statement(s);
- must plan work so that the Procedures may be carried out and the Findings may be assessed;
- must adhere to the Procedures laid down and the compulsory report format;
- must carry out the engagement in accordance with this ToR;
- must document matters which are important to support the Report;
- must base its Report on the evidence gathered;
- must submit the Report to the *[Beneficiary] [Linked Third Party]*.

The Commission sets out the Procedures to be carried out by the Auditor. The Auditor is not responsible for their suitability or pertinence. As this engagement is not an assurance engagement, the Auditor does not provide an audit opinion or a statement of assurance.

1.3 Applicable Standards

The Auditor must comply with these Terms of Reference and with[2]:

- the International Standard on Related Services ('ISRS') 4400 *Engagements to perform Agreed-upon Procedures regarding Financial Information* as issued by the International Auditing and Assurance Standards Board (IAASB);
- the *Code of Ethics for Professional Accountants* issued by the International Ethics Standards Board for Accountants (IESBA). Although ISRS 4400 states that independence is not a requirement for engagements to carry out agreed-upon procedures, the *[Commission][Agency]* requires that the Auditor also complies with the Code's independence requirements.

The Auditor's Report must state that there is no conflict of interests in establishing this Report between the Auditor and the Beneficiary *[and the Linked Third Party]*, and must specify - if the service is invoiced - the total fee paid to the Auditor for providing the Report.

1.4 Reporting

The Report must be written in the language of the Agreement (see Article 20.7).

Under Article 22 of the Agreement, the Commission*[, the Agency],* the European Anti-Fraud Office and the Court of Auditors have the right to audit any work that is carried out under the action and for which costs are declared from [*the European Union*] [*Euratom*] budget. This includes work related to this engagement. The Auditor must provide access to all working papers (e.g. recalculation of hourly rates, verification of the time declared for the action) related to this assignment if the Commission *[, the Agency]*, the European Anti-Fraud Office or the European Court of Auditors requests them.

1.5 Timing

The Report must be provided by *[*dd Month yyyy*]*.

1.6 Other terms

[*The [Beneficiary] [Linked Third Party] and the Auditor can use this section to agree other specific terms, such as the Auditor's fees, liability, applicable law, etc. Those specific terms must not contradict the terms specified above.*]

[legal name of the Auditor]	[legal name of the *[Beneficiary][Linked Third Party]*]
[name & function of authorised representative]	[name & function of authorised representative]
[dd Month yyyy]	[dd Month yyyy]
Signature of the Auditor	Signature of the *[Beneficiary][Linked Third Party]*

[2] Supreme Audit Institutions applying INTOSAI-standards may carry out the Procedures according to the corresponding International Standards of Supreme Audit Institutions and code of ethics issued by INTOSAI instead of the International Standard on Related Services ('ISRS') 4400 and the Code of Ethics for Professional Accountants issued by the IAASB and the IESBA.

Independent Report of Factual Findings on costs declared under Horizon 2020 Research and Innovation Framework Programme

(To be printed on the Auditor's letterhead)

To
[name of contact person(s)], [Position]
[[*Beneficiary's*] [*Linked Third Party's*] name]
[Address]
[dd Month yyyy]

Dear [Name of contact person(s)],

As agreed under the terms of reference dated [dd Month yyyy]

with *[OPTION 1: [insert name of the beneficiary] ('the Beneficiary')] [OPTION 2: [insert name of the linked third party] ('the Linked Third Party'), third party linked to the Beneficiary [insert name of the beneficiary] ('the Beneficiary')],*

we

[name of the auditor] ('the Auditor'),

established at

[full address/city/state/province/country],

represented by

[name and function of an authorised representative],

have carried out the procedures agreed with you regarding the costs declared in the Financial Statement(s)[3] of the *[Beneficiary] [Linked Third Party]* concerning the grant agreement [insert grant agreement reference: number, title of the action and acronym] ('the Agreement'),

with a total cost declared of
[total amount] EUR,

and a total of actual costs and unit costs calculated in accordance with the [*Beneficiary's*] [*Linked Third Party's*] usual cost accounting practices' declared of

[sum of total actual costs and total direct personnel costs declared as unit costs calculated in accordance with the *[Beneficiary's] [Linked Third Party's]* usual cost accounting practices] EUR

and **hereby provide our Independent Report of Factual Findings ('the Report')** using the compulsory report format agreed with you.

The Report

Our engagement was carried out in accordance with the terms of reference ('the ToR') appended to this Report. The Report includes the agreed-upon procedures ('the Procedures') carried out and the standard factual findings ('the Findings') examined.

[3] By which the Beneficiary declares costs under the Agreement (see template 'Model Financial Statement' in Annex 4 to the Agreement).

The Procedures were carried out solely to assist the *[Commission] [Agency]* in evaluating whether the *[Beneficiary's] [Linked Third Party's]* costs in the accompanying Financial Statement(s) were declared in accordance with the Agreement. The *[Commission] [Agency]* draws its own conclusions from the Report and any additional information it may require.

The scope of the Procedures was defined by the Commission. Therefore, the Auditor is not responsible for their suitability or pertinence. Since the Procedures carried out constitute neither an audit nor a review made in accordance with International Standards on Auditing or International Standards on Review Engagements, the Auditor does not give a statement of assurance on the Financial Statements.

Had the Auditor carried out additional procedures or an audit of the *[Beneficiary's] [Linked Third Party's]* Financial Statements in accordance with International Standards on Auditing or International Standards on Review Engagements, other matters might have come to its attention and would have been included in the Report.

Not applicable Findings

We examined the Financial Statement(s) stated above and considered the following Findings not applicable:

Explanation (to be removed from the Report):

*If a Finding was not applicable, it must be marked as '**N.A.**' ('Not applicable') in the corresponding row on the right-hand column of the table and means that the Finding did not have to be corroborated by the Auditor and the related Procedure(s) did not have to be carried out.*

The reasons of the non-application of a certain Finding must be obvious i.e.

i) if no cost was declared under a certain category then the related Finding(s) and Procedure(s) are not applicable;

ii) if the condition set to apply certain Procedure(s) are not met the related Finding(s) and those Procedure(s) are not applicable. For instance, for 'beneficiaries with accounts established in a currency other than euro' the Procedure and Finding related to 'beneficiaries with accounts established in euro' are not applicable. Similarly, if no additional remuneration is paid, the related Finding(s) and Procedure(s) for additional remuneration are not applicable.

List here all Findings considered not applicable for the present engagement and explain the reasons of the non-applicability.

….

Exceptions

Apart from the exceptions listed below, the *[Beneficiary] [Linked Third Party]* provided the Auditor all the documentation and accounting information needed by the Auditor to carry out the requested Procedures and evaluate the Findings.

Explanation (to be removed from the Report):

- *If the Auditor was not able to successfully complete a procedure requested, it must be marked as '**E**' ('Exception') in the corresponding row on the right-hand column of the table. The reason such as the inability to reconcile key information or the unavailability of data that prevents the Auditor from carrying out the Procedure must be indicated below.*
- *If the Auditor cannot corroborate a standard finding after having carried out the corresponding procedure, it must also be marked as '**E**' ('Exception') and, where possible, the reasons why the Finding was not fulfilled and its possible impact must be explained here below.*

List here any exceptions and add any information on the cause and possible consequences of each exception, if known. If the exception is quantifiable, include the corresponding amount.

….

Example (to be removed from the Report):

1. *The Beneficiary was unable to substantiate the Finding number 1 on … because ….*
2. *Finding number 30 was not fulfilled because the methodology used by the Beneficiary to calculate unit costs was different from the one approved by the Commission. The differences were as follows: …*
3. *After carrying out the agreed procedures to confirm the Finding number 31, the Auditor found a difference of _____ EUR. The difference can be explained by …*

Further Remarks

In addition to reporting on the results of the specific procedures carried out, the Auditor would like to make the following general remarks:

Example (to be removed from the Report):

1. *Regarding Finding number 8 the conditions for additional remuneration were considered as fulfilled because …*
2. *In order to be able to confirm the Finding number 15 we carried out the following additional procedures: ….*

Use of this Report

This Report may be used only for the purpose described in the above objective. It was prepared solely for the confidential use of the *[Beneficiary] [Linked Third Party]* and the [*Commission*] [*Agency*], and only to be submitted to the *[Commission] [Agency]* in connection with the requirements set out in Article 20.4 of the Agreement. The Report may not be used by the *[Beneficiary] [Linked Third Party]* or by the *[Commission] [Agency]* for any other purpose, nor may it be distributed to any other parties. The *[Commission] [Agency]* may only disclose the Report to authorised parties, in particular to the European Anti-Fraud Office (OLAF) and the European Court of Auditors.

This Report relates only to the Financial Statement(s) submitted to the *[Commission] [Agency]* by the *[Beneficiary] [Linked Third Party]* for the Agreement. Therefore, it does not extend to any other of the *[Beneficiary's] [Linked Third Party's]* Financial Statement(s).

There was no conflict of interest[4] between the Auditor and the Beneficiary *[and Linked Third Party]* in establishing this Report. The total fee paid to the Auditor for providing the Report was EUR _____ (including EUR_____ of deductible VAT).

We look forward to discussing our Report with you and would be pleased to provide any further information or assistance.

[legal name of the Auditor]
[name and function of an authorised representative]
[dd Month yyyy]
Signature of the Auditor

[4] A conflict of interest arises when the Auditor's objectivity to establish the certificate is compromised in fact or in appearance when the Auditor for instance:
- was involved in the preparation of the Financial Statements;
- stands to benefit directly should the certificate be accepted;
- has a close relationship with any person representing the beneficiary;
- is a director, trustee or partner of the beneficiary; or
- is in any other situation that compromises his or her independence or ability to establish the certificate impartially.

Agreed-upon procedures to be performed and standard factual findings to be confirmed by the Auditor

The European Commission reserves the right to i) provide the auditor with additional guidance regarding the procedures to be followed or the facts to be ascertained and the way in which to present them (this may include sample coverage and findings) or to ii) change the procedures, by notifying the Beneficiary in writing. The procedures carried out by the auditor to confirm the standard factual finding are listed in the table below.

If this certificate relates to a Linked Third Party, any reference here below to 'the Beneficiary' is to be considered as a reference to 'the Linked Third Party'.

The 'result' column has three different options: 'C', 'E' and 'N.A.':

- 'C' stands for 'confirmed' and means that the auditor can confirm the 'standard factual finding' and, therefore, there is no exception to be reported.
- 'E' stands for 'exception' and means that the Auditor carried out the procedures but cannot confirm the 'standard factual finding', or that the Auditor was not able to carry out a specific procedure (e.g. because it was impossible to reconcile key information or data were unavailable),
- 'N.A.' stands for 'not applicable' and means that the Finding did not have to be examined by the Auditor and the related Procedure(s) did not have to be carried out. The reasons of the non-application of a certain Finding must be obvious i.e. i) if no cost was declared under a certain category then the related Finding(s) and Procedure(s) are not applicable; ii) if the condition set to apply certain Procedure(s) are not met then the related Finding(s) and Procedure(s) are not applicable. For instance, for 'beneficiaries with accounts established in a currency other than the euro' the Procedure related to 'beneficiaries with accounts established in euro' is not applicable. Similarly, if no additional remuneration is paid, the related Finding(s) and Procedure(s) for additional remuneration are not applicable.

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
A	**ACTUAL PERSONNEL COSTS AND UNIT COSTS CALCULATED BY THE BENEFICIARY IN ACCORDANCE WITH ITS USUAL COST ACCOUNTING PRACTICE**		
	The Auditor draws a sample of persons whose costs were declared in the Financial Statement(s) to carry out the procedures indicated in the consecutive points of this section A. (*The sample should be selected randomly so that it is representative. Full coverage is required if there are fewer than 10 people (including employees, natural persons working under a direct contract and personnel seconded by a third party), otherwise the sample should have a minimum of 10 people, or 10% of the total, whichever number is the highest)* The Auditor sampled _____ people out of the total of _____ people.		

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
A.1	**PERSONNEL COSTS** For the persons included in the sample and working under an employment contract or equivalent act (general procedures for individual actual personnel costs and personnel costs declared as unit costs) To confirm standard factual findings 1-5 listed in the next column, the Auditor reviewed following information/documents provided by the Beneficiary: o a list of the persons included in the sample indicating the period(s) during which they worked for the action, their position (classification or category) and type of contract; o the payslips of the employees included in the sample; o reconciliation of the personnel costs declared in the Financial Statement(s) with the accounting system (project accounting and general ledger) and payroll system; o information concerning the employment status and employment conditions of personnel included in the sample, in particular their employment contracts or equivalent; o the Beneficiary's usual policy regarding payroll matters (e.g. salary policy, overtime policy, variable pay); o applicable national law on taxes, labour and social security and o any other document that supports the personnel costs declared. The Auditor also verified the eligibility of all components of the retribution (see Article 6 GA) and recalculated the personnel costs for employees included in the sample.	1) The employees were i) directly hired by the Beneficiary in accordance with its national legislation, ii) under the Beneficiary's sole technical supervision and responsibility and iii) remunerated in accordance with the Beneficiary's usual practices.	
		2) Personnel costs were recorded in the Beneficiary's accounts/payroll system.	
		3) Costs were adequately supported and reconciled with the accounts and payroll records.	
		4) Personnel costs did not contain any ineligible elements.	
		5) There were no discrepancies between the personnel costs charged to the action and the costs recalculated by the Auditor.	
	Further procedures if 'additional remuneration' is paid To confirm standard factual findings 6-9 listed in the next column, the Auditor: o reviewed relevant documents provided by the Beneficiary (legal form, legal/statutory	6) The Beneficiary paying "additional remuneration" was a non-profit legal entity.	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
	obligations, the Beneficiary's usual policy on additional remuneration, criteria used for its calculation, the Beneficiary's usual remuneration practice for projects funded under national funding schemes…); o recalculated the amount of additional remuneration eligible for the action based on the supporting documents received (full-time or part-time work, exclusive or non-exclusive dedication to the action, usual remuneration paid for projects funded by national schemes) to arrive at the applicable FTE/year and pro-rata rate (see data collected in the course of carrying out the procedures under A.2 'Productive hours' and A.4 'Time recording system'). *'ADDITIONAL REMUNERATION' MEANS ANY PART OF THE REMUNERATION WHICH EXCEEDS WHAT THE PERSON WOULD BE PAID FOR TIME WORKED IN PROJECTS FUNDED BY NATIONAL SCHEMES.* *IF ANY PART OF THE REMUNERATION PAID TO THE EMPLOYEE QUALIFIES AS "ADDITIONAL REMUNERATION" AND IS ELIGIBLE UNDER THE PROVISIONS OF ARTICLE 6.2.A.1, THIS CAN BE CHARGED AS ELIGIBLE COST TO THE ACTION UP TO THE FOLLOWING AMOUNT:* *(A) IF THE PERSON WORKS FULL TIME AND EXCLUSIVELY ON THE ACTION DURING THE FULL YEAR: UP TO EUR 8 000/YEAR;* *(B) IF THE PERSON WORKS EXCLUSIVELY ON THE ACTION BUT NOT FULL-TIME OR NOT FOR THE FULL YEAR: UP TO THE CORRESPONDING PRO-RATA AMOUNT OF EUR 8 000, OR* *(C) IF THE PERSON DOES NOT WORK EXCLUSIVELY ON THE ACTION: UP TO A PRO-RATA AMOUNT CALCULATED IN ACCORDANCE TO ARTICLE 6.2.A.1.*	7) The amount of additional remuneration paid corresponded to the Beneficiary's usual remuneration practices and was consistently paid whenever the same kind of work or expertise was required.	
		8) The criteria used to calculate the additional remuneration were objective and generally applied by the Beneficiary regardless of the source of funding used.	
		9) The amount of additional remuneration included in the personnel costs charged to the action was capped at EUR 8,000 per FTE/year (up to the equivalent pro-rata amount if the person did not work on the action full-time during the year or did not work exclusively on the action).	
	Additional procedures in case "unit costs calculated by the Beneficiary in accordance with its usual cost accounting practices" is applied: Apart from carrying out the procedures indicated above to confirm standard factual findings 1-5 and, if applicable, also 6-9, the Auditor carried out following procedures to confirm standard	10) The personnel costs included in the Financial Statement were calculated in accordance with the Beneficiary's usual cost accounting practice. This methodology was consistently	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
	factual findings 10-13 listed in the next column: o obtained a description of the Beneficiary's usual cost accounting practice to calculate unit costs;. o reviewed whether the Beneficiary's usual cost accounting practice was applied for the Financial Statements subject of the present CFS; o verified the employees included in the sample were charged under the correct category (in accordance with the criteria used by the Beneficiary to establish personnel categories) by reviewing the contract/HR-record or analytical accounting records; o verified that there is no difference between the total amount of personnel costs used in calculating the cost per unit and the total amount of personnel costs recorded in the statutory accounts; o verified whether actual personnel costs were adjusted on the basis of budgeted or estimated elements and, if so, verified whether those elements used are actually relevant for the calculation, objective and supported by documents.	used in all H2020 actions.	
		11) The employees were charged under the correct category.	
		12) Total personnel costs used in calculating the unit costs were consistent with the expenses recorded in the statutory accounts.	
		13) Any estimated or budgeted element used by the Beneficiary in its unit-cost calculation were relevant for calculating personnel costs and corresponded to objective and verifiable information.	
	<u>For natural persons included in the sample and working with the Beneficiary under a direct contract other than an employment contract, such as consultants (no subcontractors).</u> To confirm standard factual findings 14-17 listed in the next column the Auditor reviewed following information/documents provided by the Beneficiary: o the contracts, especially the cost, contract duration, work description, place of work, ownership of the results and reporting obligations to the Beneficiary; o the employment conditions of staff in the same category to compare costs and; o any other document that supports the costs declared and its registration (e.g. invoices, accounting records, etc.).	14) The natural persons worked under conditions similar to those of an employee, in particular regarding the way the work is organised, the tasks that are performed and the premises where they are performed.	
		15) The results of work carried out belong to the Beneficiary, or, if not, the Beneficiary has obtained all necessary rights to fulfil its obligations as if those	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
		results were generated by itself.	
		16) Their costs were not significantly different from those for staff who performed similar tasks under an employment contract with the Beneficiary.	
		17) The costs were supported by audit evidence and registered in the accounts.	
	<u>For personnel seconded by a third party and included in the sample (not subcontractors)</u> To confirm standard factual findings 18-21 listed in the next column, the Auditor reviewed following information/documents provided by the Beneficiary: o their secondment contract(s) notably regarding costs, duration, work description, place of work and ownership of the results; o if there is reimbursement by the Beneficiary to the third party for the resource made available (in-kind contribution against payment): any documentation that supports the costs declared (e.g. contract, invoice, bank payment, and proof of registration in its accounting/payroll, etc.) and reconciliation of the Financial Statement(s) with the accounting system (project accounting and general ledger) as well as any proof that the amount invoiced by the third party did not include any profit; o if there is no reimbursement by the Beneficiary to the third party for the resource made available (in-kind contribution free of charge): a proof of the actual cost borne by the Third Party for the resource made available free of charge to the Beneficiary such as a statement of costs incurred by the Third Party and proof of the registration in the Third Party's accounting/payroll;	18) Seconded personnel reported to the Beneficiary and worked on the Beneficiary's premises (unless otherwise agreed with the Beneficiary).	
		19) The results of work carried out belong to the Beneficiary, or, if not, the Beneficiary has obtained all necessary rights to fulfil its obligations as if those results were generated by itself..	
		If personnel is seconded against payment: 20) The costs declared were supported with documentation and recorded in the	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
	○ any other document that supports the costs declared (e.g. invoices, etc.).	Beneficiary's accounts. The third party did not include any profit.	
		If personnel is seconded free of charge: 21) The costs declared did not exceed the third party's cost as recorded in the accounts of the third party and were supported with documentation.	
A.2	**PRODUCTIVE HOURS** To confirm standard factual findings 22-27 listed in the next column, the Auditor reviewed relevant documents, especially national legislation, labour agreements and contracts and time records of the persons included in the sample, to verify that: ○ the annual productive hours applied were calculated in accordance with one of the methods described below, ○ the full-time equivalent (FTEs) ratios for employees not working full-time were correctly calculated. If the Beneficiary applied method B, the auditor verified that the correctness in which the total number of hours worked was calculated and that the contracts specified the annual workable hours. If the Beneficiary applied method C, the auditor verified that the 'annual productive hours' applied when calculating the hourly rate were equivalent to at least 90 % of the 'standard annual workable hours'. The Auditor can only do this if the calculation of the standard annual workable	22) The Beneficiary applied method [*choose one option and delete the others*] [**A**: 1720 hours] [**B**: the 'total number of hours worked'] [**C**: 'standard annual productive hours' used correspond to usual accounting practices]	
		23) Productive hours were calculated annually.	
		24) For employees not working full-time the full-time equivalent (FTE) ratio was correctly applied.	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
	hours can be supported by records, such as national legislation, labour agreements, and contracts. *BENEFICIARY'S PRODUCTIVE HOURS' FOR PERSONS WORKING FULL TIME SHALL BE ONE OF THE FOLLOWING METHODS:* ***A**. 1720 ANNUAL PRODUCTIVE HOURS (PRO-RATA FOR PERSONS NOT WORKING FULL-TIME)* ***B**. THE TOTAL NUMBER OF HOURS WORKED BY THE PERSON FOR THE BENEFICIARY IN THE YEAR (THIS METHOD IS ALSO REFERRED TO AS 'TOTAL NUMBER OF HOURS WORKED' IN THE NEXT COLUMN). THE CALCULATION OF THE TOTAL NUMBER OF HOURS WORKED WAS DONE AS FOLLOWS: ANNUAL WORKABLE HOURS OF THE PERSON ACCORDING TO THE EMPLOYMENT CONTRACT, APPLICABLE LABOUR AGREEMENT OR NATIONAL LAW PLUS OVERTIME WORKED MINUS ABSENCES (SUCH AS SICK LEAVE OR SPECIAL LEAVE).* ***C**. THE STANDARD NUMBER OF ANNUAL HOURS GENERALLY APPLIED BY THE BENEFICIARY FOR ITS PERSONNEL IN ACCORDANCE WITH ITS USUAL COST ACCOUNTING PRACTICES (THIS METHOD IS ALSO REFERRED TO AS 'STANDARD ANNUAL PRODUCTIVE HOURS' IN THE NEXT COLUMN). THIS NUMBER MUST BE AT LEAST 90% OF THE STANDARD ANNUAL WORKABLE HOURS.* *'ANNUAL WORKABLE HOURS' MEANS THE PERIOD DURING WHICH THE PERSONNEL MUST BE WORKING, AT THE EMPLOYER'S DISPOSAL AND CARRYING OUT HIS/HER ACTIVITY OR DUTIES UNDER THE EMPLOYMENT CONTRACT, APPLICABLE COLLECTIVE LABOUR AGREEMENT OR NATIONAL WORKING TIME LEGISLATION.*	*If the Beneficiary applied method B.* 25) The calculation of the number of 'annual workable hours', overtime and absences was verifiable based on the documents provided by the Beneficiary. 25.1) The Beneficiary calculates the hourly rates per full financial year following procedure A.3 (method B is not allowed for beneficiaries calculating hourly rates per month).	
		If the Beneficiary applied method C. 26) The calculation of the number of 'standard annual workable hours' was verifiable based on the documents provided by the Beneficiary.	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
		27) The 'annual productive hours' used for calculating the hourly rate were consistent with the usual cost accounting practices of the Beneficiary and were equivalent to at least 90 % of the 'annual workable hours'.	
A.3	**HOURLY PERSONNEL RATES** I) For unit costs calculated in accordance to the Beneficiary's usual cost accounting practice (unit costs): If the Beneficiary has a "Certificate on Methodology to calculate unit costs " (CoMUC) approved by the Commission, the Beneficiary provides the Auditor with a description of the approved methodology and the Commission's letter of acceptance. The Auditor verified that the Beneficiary has indeed used the methodology approved. If so, no further verification is necessary. If the Beneficiary does not have a "Certificate on Methodology" (CoMUC) approved by the Commission, or if the methodology approved was not applied, then the Auditor: o reviewed the documentation provided by the Beneficiary, including manuals and internal guidelines that explain how to calculate hourly rates; o recalculated the unit costs (hourly rates) of staff included in the sample following the results of the procedures carried out in A.1 and A.2. II) For individual hourly rates: The Auditor: o reviewed the documentation provided by the Beneficiary, including manuals and internal guidelines that explain how to calculate hourly rates;	28) The Beneficiary applied [*choose one option and delete the other*]: [Option I: "Unit costs (hourly rates) were calculated in accordance with the Beneficiary's usual cost accounting practices"] [Option II: Individual hourly rates were applied] *For option I concerning unit costs and if the Beneficiary applies the methodology approved by the Commission (CoMUC):* 29) The Beneficiary used the Commission-approved methodology to calculate hourly rates. It corresponded to the organisation's usual cost accounting practices and was applied consistently for all	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
	○ recalculated the hourly rates of staff included in the sample (recalculation of all hourly rates if the Beneficiary uses annual rates, recalculation of three months selected randomly for every year and person if the Beneficiary uses monthly rates) following the results of the procedures carried out in A.1 and A.2; ○ (only in case of monthly rates) confirmed that the time spent on parental leave is not deducted, and that, if parts of the basic remuneration are generated over a period longer than a month, the Beneficiary has included only the share which is generated in the month. *"UNIT COSTS CALCULATED BY THE BENEFICIARY IN ACCORDANCE WITH ITS USUAL COST ACCOUNTING PRACTICES":* *IT IS CALCULATED BY DIVIDING THE TOTAL AMOUNT OF PERSONNEL COSTS OF THE CATEGORY TO WHICH THE EMPLOYEE BELONGS VERIFIED IN LINE WITH PROCEDURE A.1 BY THE NUMBER OF FTE AND THE ANNUAL TOTAL PRODUCTIVE HOURS OF THE SAME CATEGORY CALCULATED BY THE BENEFICIARY IN ACCORDANCE WITH PROCEDURE A.2.* *HOURLY RATE FOR INDIVIDUAL ACTUAL PERSONAL COSTS:* *IT IS CALCULATED FOLLOWING ONE OF THE TWO OPTIONS BELOW:* *A) [OPTION BY DEFAULT] BY DIVIDING THE ACTUAL ANNUAL AMOUNT OF PERSONNEL COSTS OF AN EMPLOYEE VERIFIED IN LINE WITH PROCEDURE A.1 BY THE NUMBER OF ANNUAL PRODUCTIVE HOURS VERIFIED IN LINE WITH PROCEDURE A.2 (FULL FINANCIAL YEAR HOURLY RATE);* *B) BY DIVIDING THE ACTUAL MONTHLY AMOUNT OF PERSONNEL COSTS OF AN EMPLOYEE VERIFIED IN LINE WITH PROCEDURE A.1 BY 1/12 OF THE NUMBER OF ANNUAL PRODUCTIVE HOURS VERIFIED IN LINE WITH PROCEDURE A.2.(MONTHLY HOURLY RATE).*	activities irrespective of the source of funding.	
		For option I concerning unit costs and if the Beneficiary applies a methodology not approved by the Commission: 30) The unit costs re-calculated by the Auditor were the same as the rates applied by the Beneficiary.	
		For option II concerning individual hourly rates: 31) The individual rates re-calculated by the Auditor were the same as the rates applied by the Beneficiary. 31.1) The Beneficiary used only one option (per full financial year or per month) throughout each financial year examined. 31.2) The hourly rates do not include additional remuneration.	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
A.4	**TIME RECORDING SYSTEM** To verify that the time recording system ensures the fulfilment of all minimum requirements and that the hours declared for the action were correct, accurate and properly authorised and supported by documentation, the Auditor made the following checks for the persons included in the sample that declare time as worked for the action on the basis of time records: o description of the time recording system provided by the Beneficiary (registration, authorisation, processing in the HR-system); o its actual implementation; o time records were signed at least monthly by the employees (on paper or electronically) and authorised by the project manager or another manager; o the hours declared were worked within the project period; o there were no hours declared as worked for the action if HR-records showed absence due to holidays or sickness (further cross-checks with travels are carried out in B.1 below) ; o the hours charged to the action matched those in the time recording system. *ONLY THE HOURS WORKED ON THE ACTION CAN BE CHARGED. ALL WORKING TIME TO BE CHARGED SHOULD BE RECORDED THROUGHOUT THE DURATION OF THE PROJECT, ADEQUATELY SUPPORTED BY EVIDENCE OF THEIR REALITY AND RELIABILITY (SEE SPECIFIC PROVISIONS BELOW FOR PERSONS WORKING EXCLUSIVELY FOR THE ACTION WITHOUT TIME RECORDS).*	32) All persons recorded their time dedicated to the action on a **daily/ weekly/ monthly** basis using a **paper/computer-based** system. (*delete the answers that are not applicable)*	
		33) Their time-records were authorised at least monthly by the project manager or other superior.	
		34) Hours declared were worked within the project period and were consistent with the presences/absences recorded in HR-records.	
		35) There were no discrepancies between the number of hours charged to the action and the number of hours recorded.	
	<u>If the persons are working exclusively for the action and without time records</u> For the persons selected that worked exclusively for the action without time records, the Auditor verified evidence available demonstrating that they were in reality exclusively dedicated to the action and that the Beneficiary signed a declaration confirming that they have worked exclusively for the action.	36) The exclusive dedication is supported by a declaration signed by the Beneficiary and by any other evidence gathered.	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
B	**COSTS OF SUBCONTRACTING**		
B.1	**The Auditor obtained the detail/breakdown of subcontracting costs and sampled _____ cost items selected randomly** (*full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest*). To confirm standard factual findings 37-41 listed in the next column, the Auditor reviewed the following for the items included in the sample: o the use of subcontractors was foreseen in Annex 1; o subcontracting costs were declared in the subcontracting category of the Financial Statement; o supporting documents on the selection and award procedure were followed; o the Beneficiary ensured best value for money (key elements to appreciate the respect of this principle are the award of the subcontract to the bid offering best price-quality ratio, under conditions of transparency and equal treatment. In case an existing framework contract was used the Beneficiary ensured it was established on the basis of the principle of best value for money under conditions of transparency and equal treatment). In particular, i. if the Beneficiary acted as a contracting authority within the meaning of Directive 2004/18/EC (or 2014/24/EU) or of Directive 2004/17/EC (or 2014/25/EU), the Auditor verified that the applicable national law on public procurement was followed and that the subcontracting complied with the Terms and Conditions of the Agreement. ii. if the Beneficiary did not fall under the above-mentioned category the Auditor verified that the Beneficiary followed their usual procurement rules and respected the Terms and Conditions of the Agreement..	37) The use of claimed subcontracting costs was foreseen in Annex 1 and costs were declared in the Financial Statements under the subcontracting category.	
		38) There were documents of requests to different providers, different offers and assessment of the offers before selection of the provider in line with internal procedures and procurement rules. Subcontracts were awarded in accordance with the principle of best value for money. *(When different offers were not collected the Auditor explains the reasons provided by the Beneficiary under the caption "Exceptions" of the Report. The Commission will analyse this information to evaluate whether these costs might be accepted as eligible)*	
		39) The subcontracts were not awarded to other Beneficiaries	

Ref	Procedures	Standard factual finding	Result (C / E / N.A.)
	For the items included in the sample the Auditor also verified that: o the subcontracts were not awarded to other Beneficiaries in the consortium; o there were signed agreements between the Beneficiary and the subcontractor; o there was evidence that the services were provided by subcontractor;	of the consortium.	
		40) All subcontracts were supported by signed agreements between the Beneficiary and the subcontractor.	
		41) There was evidence that the services were provided by the subcontractors.	
C	**COSTS OF PROVIDING FINANCIAL SUPPORT TO THIRD PARTIES**		
C.1	**The Auditor obtained the detail/breakdown of the costs of providing financial support to third parties and sampled _____ cost items selected randomly** (*full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest*). The Auditor verified that the following minimum conditions were met: a) the maximum amount of financial support for each third party did not exceed EUR 60 000, unless explicitly mentioned in Annex 1; b) the financial support to third parties was agreed in Annex 1 of the Agreement and the other provisions on financial support to third parties included in Annex 1 were respected.	42) All minimum conditions were met	

D	OTHER ACTUAL DIRECT COSTS		
D.1	**COSTS OF TRAVEL AND RELATED SUBSISTENCE ALLOWANCES** **The Auditor sampled _____ cost items selected randomly** (*full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is the highest*). The Auditor inspected the sample and verified that: o travel and subsistence costs were consistent with the Beneficiary's usual policy for travel. In this context, the Beneficiary provided evidence of its normal policy for travel costs (e.g. use of first class tickets, reimbursement by the Beneficiary on the basis of actual costs, a lump sum or per diem) to enable the Auditor to compare the travel costs charged with this policy; o travel costs are correctly identified and allocated to the action (e.g. trips are directly linked to the action) by reviewing relevant supporting documents such as minutes of meetings, workshops or conferences, their registration in the correct project account, their consistency with time records or with the dates/duration of the workshop/conference; o no ineligible costs or excessive or reckless expenditure was declared (see Article 6.5 MGA).	43) Costs were incurred, approved and reimbursed in line with the Beneficiary's usual policy for travels.	
		44) There was a link between the trip and the action.	
		45) The supporting documents were consistent with each other regarding subject of the trip, dates, duration and reconciled with time records and accounting.	
		46) No ineligible costs or excessive or reckless expenditure was declared.	
D.2	**DEPRECIATION COSTS FOR EQUIPMENT, INFRASTRUCTURE OR OTHER ASSETS** **The Auditor sampled _____ cost items selected randomly** (*full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is the highest*). For "equipment, infrastructure or other assets" [from now on called "asset(s)"] selected in the sample the Auditor verified that: o the assets were acquired in conformity with the Beneficiary's internal guidelines and procedures;	47) Procurement rules, principles and guides were followed.	
		48) There was a link between the grant agreement and the asset charged to the action.	
		49) The asset charged to the action was traceable to the accounting records and the underlying documents.	

	○ they were correctly allocated to the action (with supporting documents such as delivery note invoice or any other proof demonstrating the link to the action) ○ they were entered in the accounting system; ○ the extent to which the assets were used for the action (as a percentage) was supported by reliable documentation (e.g. usage overview table); The Auditor recalculated the depreciation costs and verified that they were in line with the applicable rules in the Beneficiary's country and with the Beneficiary's usual accounting policy (e.g. depreciation calculated on the acquisition value). The Auditor verified that no ineligible costs such as deductible VAT, exchange rate losses, excessive or reckless expenditure were declared (see Article 6.5 GA).	50) The depreciation method used to charge the asset to the action was in line with the applicable rules of the Beneficiary's country and the Beneficiary's usual accounting policy. 51) The amount charged corresponded to the actual usage for the action. 52) No ineligible costs or excessive or reckless expenditure were declared.	
D.3	**COSTS OF OTHER GOODS AND SERVICES** **The Auditor sampled _____ cost items selected randomly** (*full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest*). For the purchase of goods, works or services included in the sample the Auditor verified that: ○ the contracts did not cover tasks described in Annex 1; ○ they were correctly identified, allocated to the proper action, entered in the accounting system (traceable to underlying documents such as purchase orders, invoices and accounting); ○ the goods were not placed in the inventory of durable equipment; ○ the costs charged to the action were accounted in line with the Beneficiary's usual accounting practices; ○ no ineligible costs or excessive or reckless expenditure were declared (see Article 6 GA). In addition, the Auditor verified that these goods and services were acquired in conformity with	53) Contracts for works or services did not cover tasks described in Annex 1. 54) Costs were allocated to the correct action and the goods were not placed in the inventory of durable equipment. 55) The costs were charged in line with the Beneficiary's accounting policy and were adequately supported. 56) No ineligible costs or excessive or reckless expenditure were declared. For internal invoices/charges only the cost element was charged, without any mark-ups.	

	the Beneficiary's internal guidelines and procedures, in particular: o if Beneficiary acted as a contracting authority within the meaning of Directive 2004/18/EC (or 2014/24/EU) or of Directive 2004/17/EC (or 2014/25/EU), the Auditor verified that the applicable national law on public procurement was followed and that the procurement contract complied with the Terms and Conditions of the Agreement. o if the Beneficiary did not fall into the category above, the Auditor verified that the Beneficiary followed their usual procurement rules and respected the Terms and Conditions of the Agreement. For the items included in the sample the Auditor also verified that: o the Beneficiary ensured best value for money (key elements to appreciate the respect of this principle are the award of the contract to the bid offering best price-quality ratio, under conditions of transparency and equal treatment. In case an existing framework contract was used the Auditor also verified that the Beneficiary ensured it was established on the basis of the principle of best value for money under conditions of transparency and equal treatment); *SUCH GOODS AND SERVICES INCLUDE, FOR INSTANCE, CONSUMABLES AND SUPPLIES, DISSEMINATION (INCLUDING OPEN ACCESS), PROTECTION OF RESULTS, SPECIFIC EVALUATION OF THE ACTION IF IT IS REQUIRED BY THE AGREEMENT, CERTIFICATES ON THE FINANCIAL STATEMENTS IF THEY ARE REQUIRED BY THE AGREEMENT AND CERTIFICATES ON THE METHODOLOGY, TRANSLATIONS, REPRODUCTION.*	57) Procurement rules, principles and guides were followed. There were documents of requests to different providers, different offers and assessment of the offers before selection of the provider in line with internal procedures and procurement rules. The purchases were made in accordance with the principle of best value for money. *(When different offers were not collected the Auditor explains the reasons provided by the Beneficiary under the caption "Exceptions" of the Report. The Commission will analyse this information to evaluate whether these costs might be accepted as eligible)*	
D.4	**AGGREGATED CAPITALISED AND OPERATING COSTS OF RESEARCH INFRASTRUCTURE** The Auditor ensured the existence of a positive ex-ante assessment (issued by the EC Services) of the cost accounting methodology of the Beneficiary allowing it to apply the guidelines on direct costing for large research infrastructures in Horizon 2020.	58) The costs declared as direct costs for Large Research Infrastructures (in the appropriate line of the Financial Statement) comply with the methodology described in the positive ex-ante assessment report.	

	In the cases that a positive ex-ante assessment has been issued *(see the standard factual findings 58-59 on the next column)***,** The Auditor ensured that the beneficiary has applied consistently the methodology that is explained and approved in the positive ex ante assessment; ***In the cases that a positive ex-ante assessment has NOT been issued*** *(see the standard factual findings 60 on the next column),* The Auditor verified that no costs of Large Research Infrastructure have been charged as direct costs in any costs category; ***In the cases that a draft ex-ante assessment report has been issued with recommendation for further changes*** *(see the standard factual findings 60 on the next column),* • The Auditor followed the same procedure as above (when a positive ex-ante assessment has NOT yet been issued) and paid particular attention (testing reinforced) to the cost items for which the draft ex-ante assessment either rejected the inclusion as direct costs for Large Research Infrastructures or issued recommendations.	59) Any difference between the methodology applied and the one positively assessed was extensively described and adjusted accordingly. 60) The direct costs declared were free from any indirect costs items related to the Large Research Infrastructure.	
D.5	**Costs of internally invoiced goods and services** **The Auditor sampled cost items selected randomly** (*full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest*). To confirm standard factual findings 61-65 listed in the next column, the Auditor: ○ obtained a description of the Beneficiary's usual cost accounting practice to calculate costs of internally invoiced goods and services (unit costs); ○ reviewed whether the Beneficiary's usual cost accounting practice was applied for the Financial Statements subject of the present CFS; ○ ensured that the methodology to calculate unit costs is being used in a consistent manner, based on objective criteria, regardless of the source of funding; ○ verified that any ineligible items or any costs claimed under other budget categories, in particular indirect costs, have not been taken into account when calculating the costs of	61) The costs of internally invoiced goods and services included in the Financial Statement were calculated in accordance with the Beneficiary's usual cost accounting practice. 62) The cost accounting practices used to calculate the costs of internally invoiced goods and services were applied by the Beneficiary in a consistent manner based on objective criteria regardless of the source of funding. 63) The unit cost is calculated using the actual costs for the good or service recorded in the Beneficiary's accounts, excluding any ineligible cost or costs included in other	

	internally invoiced goods and services (see Article 6 GA); ○ verified whether actual costs of internally invoiced goods and services were adjusted on the basis of budgeted or estimated elements and, if so, verified whether those elements used are actually relevant for the calculation, and correspond to objective and verifiable information. ○ verified that any costs of items which are not directly linked to the production of the invoiced goods or service (e.g. supporting services like cleaning, general accountancy, administrative support, etc. not directly used for production of the good or service) have not been taken into account when calculating the costs of internally invoiced goods and services. ○ verified that any costs of items used for calculating the costs internally invoiced goods and services are supported by audit evidence and registered in the accounts.	budget categories. 64) The unit cost excludes any costs of items which are not directly linked to the production of the invoiced goods or service. 65) The costs items used for calculating the actual costs of internally invoiced goods and services were relevant, reasonable and correspond to objective and verifiable information.	
E	**USE OF EXCHANGE RATES**		
E.1	a) For Beneficiaries with accounts established in a currency other than euros **The Auditor sampled _____ cost items selected randomly and verified that the exchange rates used for converting other currencies into euros were in accordance with the following rules established in the Agreement** (*full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest)*: *COSTS RECORDED IN THE ACCOUNTS IN A CURRENCY OTHER THAN EURO SHALL BE CONVERTED INTO EURO AT THE AVERAGE OF THE DAILY EXCHANGE RATES PUBLISHED IN THE C SERIES OF OFFICIAL JOURNAL OF THE EUROPEAN UNION (https://www.ecb.int/stats/exchange/eurofxref/html/index.en.html), DETERMINED OVER THE CORRESPONDING REPORTING PERIOD.* *IF NO DAILY EURO EXCHANGE RATE IS PUBLISHED IN THE OFFICIAL JOURNAL OF THE EUROPEAN UNION FOR THE CURRENCY IN QUESTION, CONVERSION SHALL BE MADE AT THE AVERAGE OF THE MONTHLY ACCOUNTING RATES ESTABLISHED BY THE COMMISSION AND PUBLISHED ON ITS WEBSITE (http://ec.europa.eu/budget/contracts_grants/info_contracts/inforeuro/inforeuro_en.cfm),*	66) The exchange rates used to convert other currencies into Euros were in accordance with the rules established of the Grant Agreement and there was no difference in the final figures.	

	DETERMINED OVER THE CORRESPONDING REPORTING PERIOD.		
	b) For Beneficiaries with accounts established in euros **The Auditor sampled _____ cost items selected randomly and verified that the exchange rates used for converting other currencies into euros were in accordance with the following rules established in the Agreement** (*full coverage is required if there are fewer than 10 items, otherwise the sample should have a minimum of 10 item, or 10% of the total, whichever number is highest)*: *COSTS INCURRED IN ANOTHER CURRENCY SHALL BE CONVERTED INTO EURO BY APPLYING THE BENEFICIARY'S USUAL ACCOUNTING PRACTICES.*	67) The Beneficiary applied its usual accounting practices.	

[legal name of the audit firm]
[name and function of an authorised representative]
[dd Month yyyy]
<Signature of the Auditor>

ANNEX 6

MODEL FOR THE CERTIFICATE ON THE METHODOLOGY

- **For options [*in italics in square brackets*]: choose the applicable option. Options not chosen should be deleted.**
- **For fields in [grey in square brackets]: enter the appropriate data.**

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Terms of reference for an audit engagement for a methodology certificate in connection with one or more grant agreements financed under the Horizon 2020 Research and Innovation Framework Programme

This document sets out the '**Terms of Reference (ToR)**' under which

[OPTION 1: [insert name of the beneficiary] ('the Beneficiary')] [OPTION 2: [insert name of the linked third party] ('the Linked Third Party'), third party linked to the Beneficiary [insert name of the beneficiary] ('the Beneficiary')]

agrees to engage

[**insert legal name of the auditor**] ('the Auditor')

to produce an independent report of factual findings ('the Report') concerning the *[Beneficiary's] [Linked Third Party's]* usual accounting practices for calculating and claiming direct personnel costs declared as unit costs ('the Methodology') in connection with grant agreements financed under the Horizon 2020 Research and Innovation Framework Programme.

The procedures to be carried out for the assessment of the methodology will be based on the grant agreement(s) detailed below:

[title and number of the grant agreement(s)] ('the Agreement(s)')

The Agreement(s) has(have) been concluded between the Beneficiary and *[OPTION 1: the European Union, represented by the European Commission ('the Commission')][OPTION 2: the European Atomic Energy Community (Euratom,) represented by the European Commission ('the Commission')][OPTION 3: the [Research Executive Agency (REA)] [European Research Council Executive Agency (ERCEA)] [Innovation and Networks Executive Agency (INEA)] [Executive Agency for Small and Medium-sized Enterprises (EASME)] ('the Agency'), under the powers delegated by the European Commission ('the Commission').]*.

The *[Commission] [Agency]* is mentioned as a signatory of the Agreement with the Beneficiary only. The *[European Union] [Euratom] [Agency]* is not a party to this engagement.

1.1 Subject of the engagement

According to Article 18.1.2 of the Agreement, beneficiaries *[and linked third parties]* that declare direct personnel costs as unit costs calculated in accordance with their usual cost accounting practices may submit to the *[Commission] [Agency]*, for approval, a certificate on the methodology ('CoMUC') stating that there are adequate records and documentation to prove that their cost accounting practices used comply with the conditions set out in Point A of Article 6.2.

The subject of this engagement is the CoMUC which is composed of two separate documents:

- the Terms of Reference ('the ToR') to be signed by the *[Beneficiary] [Linked Third Party]* and the Auditor;

- the Auditor's Independent Report of Factual Findings ('the Report') issued on the Auditor's letterhead, dated, stamped and signed by the Auditor which includes; the standard statements ('the Statements') evaluated and signed by the *[Beneficiary] [Linked Third Party]*, the agreed-upon procedures ('the Procedures') performed by the Auditor and the standard factual findings

('the Findings') assessed by the Auditor. The Statements, Procedures and Findings are summarised in the table that forms part of the Report.

The information provided through the Statements, the Procedures and the Findings will enable the Commission to draw conclusions regarding the existence of the *[Beneficiary's] [Linked Third Party's]* usual cost accounting practice and its suitability to ensure that direct personnel costs claimed on that basis comply with the provisions of the Agreement. The Commission draws its own conclusions from the Report and any additional information it may require.

1.2 Responsibilities

The parties to this agreement are the *[Beneficiary] [Linked Third Party]* and the Auditor.

The *[Beneficiary] [Linked Third Party]:*

- is responsible for preparing financial statements for the Agreement(s) ('the Financial Statements') in compliance with those Agreements;
- is responsible for providing the Financial Statement(s) to the Auditor and enabling the Auditor to reconcile them with the *[Beneficiary's] [Linked Third Party's]* accounting and bookkeeping system and the underlying accounts and records. The Financial Statement(s) will be used as a basis for the procedures which the Auditor will carry out under this ToR;
- is responsible for its Methodology and liable for the accuracy of the Financial Statement(s);
- is responsible for endorsing or refuting the Statements indicated under the heading 'Statements to be made by the Beneficiary/ Linked Third Party' in the first column of the table that forms part of the Report;
- must provide the Auditor with a signed and dated representation letter;
- accepts that the ability of the Auditor to carry out the Procedures effectively depends upon the *[Beneficiary] [Linked Third Party]* providing full and free access to the *[Beneficiary's] [Linked Third Party's]* staff and to its accounting and other relevant records.

The Auditor:

- *[Option 1 by default: is qualified to carry out statutory audits of accounting documents in accordance with Directive 2006/43/EC of the European Parliament and of the Council of 17 May 2006 on statutory audits of annual accounts and consolidated accounts, amending Council Directives 78/660/EEC and 83/349/EEC and repealing Council Directive 84/253/EEC or similar national regulations].*
- *[Option 2 if the Beneficiary or Linked Third Party has an independent Public Officer: is a competent and independent Public Officer for which the relevant national authorities have established the legal capacity to audit the Beneficiary].*
- *[Option 3 if the Beneficiary or Linked Third Party is an international organisation: is an [internal] [external] auditor in accordance with the internal financial regulations and procedures of the international organisation].*

The Auditor:

- must be independent from the Beneficiary *[and the Linked Third Party]*, in particular, it must not have been involved in preparing the Beneficiary's *[and Linked Third Party's]* Financial Statement(s);
- must plan work so that the Procedures may be carried out and the Findings may be assessed;
- must adhere to the Procedures laid down and the compulsory report format;
- must carry out the engagement in accordance with these ToR;
- must document matters which are important to support the Report;
- must base its Report on the evidence gathered;
- must submit the Report to the *[Beneficiary] [Linked Third Party]*.

The Commission sets out the Procedures to be carried out and the Findings to be endorsed by the Auditor. The Auditor is not responsible for their suitability or pertinence. As this engagement is not an assurance engagement the Auditor does not provide an audit opinion or a statement of assurance.

1.3 Applicable Standards

The Auditor must comply with these Terms of Reference and with[1]:

- the International Standard on Related Services ('ISRS') 4400 *Engagements to perform Agreed-upon Procedures regarding Financial Information* as issued by the International Auditing and Assurance Standards Board (IAASB);
- the *Code of Ethics for Professional Accountants* issued by the International Ethics Standards Board for Accountants (IESBA). Although ISRS 4400 states that independence is not a requirement for engagements to carry out agreed-upon procedures, the Commission requires that the Auditor also complies with the Code's independence requirements.

The Auditor's Report must state that there was no conflict of interests in establishing this Report between the Auditor and the Beneficiary *[and the Linked Third Party]* that could have a bearing on the Report, and must specify – if the service is invoiced - the total fee paid to the Auditor for providing the Report.

1.4 Reporting

The Report must be written in the language of the Agreement (see Article 20.7 of the Agreement).

Under Article 22 of the Agreement, the Commission, *[the Agency]*, the European Anti-Fraud Office and the Court of Auditors have the right to audit any work that is carried out under the action and for which costs are declared from *[the European Union] [Euratom]* budget. This includes work related to this engagement. The Auditor must provide access to all working papers related to this assignment if the Commission*[, the Agency]*, the European Anti-Fraud Office or the European Court of Auditors requests them.

1.5 Timing

The Report must be provided by [dd Month yyyy].

1.6 Other Terms

[The [Beneficiary] [Linked Third Party] and the Auditor can use this section to agree other specific terms, such as the Auditor's fees, liability, applicable law, etc. Those specific terms must not contradict the terms specified above.]

[legal name of the Auditor]	[legal name of the [Beneficiary] [Linked Third Party]]
[name & title of authorised representative]	[name & title of authorised representative]
[dd Month yyyy]	[dd Month yyyy]
Signature of the Auditor	Signature of the *[Beneficiary] [Linked Third Party]*

[1] Supreme Audit Institutions applying INTOSAI-standards may carry out the Procedures according to the corresponding International Standards of Supreme Audit Institutions and code of ethics issued by INTOSAI instead of the International Standard on Related Services ('ISRS') 4400 and the Code of Ethics for Professional Accountants issued by the IAASB and the IESBA.

Independent report of factual findings on the methodology concerning grant agreements financed under the Horizon 2020 Research and Innovation Framework Programme

(To be printed on letterhead paper of the auditor)

To
[name of contact person(s)], [Position]
[[Beneficiary's] [Linked Third Party's] name]
[Address]
[dd Month yyyy]

Dear [Name of contact person(s)],

As agreed under the terms of reference dated [dd Month yyyy]

with *[OPTION 1: [insert name of the beneficiary] ('the Beneficiary')] [OPTION 2: [insert name of the linked third party] ('the Linked Third Party'), third party linked to the Beneficiary [insert name of the beneficiary] ('the Beneficiary')]*,

we

[name of the auditor] ('the Auditor'),

established at

[full address/city/state/province/country],

represented by

[name and function of an authorised representative],

have carried out the agreed-upon procedures ('the Procedures') and provide hereby our Independent Report of Factual Findings ('the Report'), concerning the *[Beneficiary's] [Linked Third Party's]* usual accounting practices for calculating and declaring direct personnel costs declared as unit costs ('the Methodology').

You requested certain procedures to be carried out in connection with the grant(s)

[title and number of the grant agreement(s)] ('the Agreement(s)').

The Report

Our engagement was carried out in accordance with the terms of reference ('the ToR') appended to this Report. The Report includes: the standard statements ('the Statements') made by the *[Beneficiary] [Linked Third Party]*, the agreed-upon procedures ('the Procedures') carried out and the standard factual findings ('the Findings') confirmed by us.

The engagement involved carrying out the Procedures and assessing the Findings and the documentation requested appended to this Report, the results of which the Commission uses to draw conclusions regarding the acceptability of the Methodology applied by the *[Beneficiary] [Linked Third Party]*.

The Report covers the methodology used from [dd Month yyyy]. In the event that the *[Beneficiary] [Linked Third Party]* changes this methodology, the Report will not be applicable to any Financial Statement[1] submitted thereafter.

The scope of the Procedures and the definition of the standard statements and findings were determined solely by the Commission. Therefore, the Auditor is not responsible for their suitability or pertinence.

Since the Procedures carried out constitute neither an audit nor a review made in accordance with International Standards on Auditing or International Standards on Review Engagements, we do not give a statement of assurance on the costs declared on the basis of the *[Beneficiary's] [Linked Third Party's]* Methodology. Had we carried out additional procedures or had we performed an audit or review in accordance with these standards, other matters might have come to its attention and would have been included in the Report.

Exceptions

Apart from the exceptions listed below, the *[Beneficiary] [Linked Third Party]* agreed with the standard Statements and provided the Auditor all the documentation and accounting information needed by the Auditor to carry out the requested Procedures and corroborate the standard Findings.

List here any exception and add any information on the cause and possible consequences of each exception, if known. If the exception is quantifiable, also indicate the corresponding amount.

…..

Explanation of possible exceptions in the form of examples (to be removed from the Report):

i. the [Beneficiary] [Linked Third Party] did not agree with the standard Statement number … because…;

ii. the Auditor could not carry out the procedure … established because …. (e.g. due to the inability to reconcile key information or the unavailability or inconsistency of data);

iii. the Auditor could not confirm or corroborate the standard Finding number … because ….

Remarks

We would like to add the following remarks relevant for the proper understanding of the Methodology applied by the [Beneficiary] [Linked Third Party] or the results reported:

Example (to be removed from the Report):

Regarding the methodology applied to calculate hourly rates …

Regarding standard Finding 15 it has to be noted that …

The [Beneficiary] [Linked Third Party] explained the deviation from the benchmark statement XXIV concerning time recording for personnel with no exclusive dedication to the action in the following manner: …

Annexes

Please provide the following documents to the auditor and annex them to the report when submitting this CoMUC to the Commission:

[1] Financial Statement in this context refers solely to Annex 4 of the Agreement by which the Beneficiary declares costs under the Agreement.

1. Brief description of the methodology for calculating personnel costs, productive hours and hourly rates;
2. Brief description of the time recording system in place;
3. An example of the time records used by the [*Beneficiary] [Linked Third Party*];
4. Description of any budgeted or estimated elements applied, together with an explanation as to why they are relevant for calculating the personnel costs and how they are based on objective and verifiable information;
5. A summary sheet with the hourly rate for direct personnel declared by the [*Beneficiary*] [*Linked Third Party*] and recalculated by the Auditor for each staff member included in the sample (the names do not need to be reported);
6. A comparative table summarising for each person selected in the sample a) the time claimed by the [*Beneficiary*] [*Linked Third Party*] in the Financial Statement(s) and b) the time according to the time record verified by the Auditor;
7. A copy of the letter of representation provided to the Auditor.

Use of this Report

This Report has been drawn up solely for the purpose given under Point 1.1 Reasons for the engagement.

The Report:

- is confidential and is intended to be submitted to the Commission by the [*Beneficiary*] [*Linked Third Party*] in connection with Article 18.1.2 of the Agreement;
- may not be used by the [*Beneficiary*] [*Linked Third Party*] or by the Commission for any other purpose, nor distributed to any other parties;
- may be disclosed by the Commission only to authorised parties, in particular the European Anti-Fraud Office (OLAF) and the European Court of Auditors.
- relates only to the usual cost accounting practices specified above and does not constitute a report on the Financial Statements of the [*Beneficiary*] [*Linked Third Party*].

No conflict of interest[2] exists between the Auditor and the Beneficiary *[and the Linked Third Party*] that could have a bearing on the Report. The total fee paid to the Auditor for producing the Report was EUR _____ (including EUR _____ of deductible VAT).

We look forward to discussing our Report with you and would be pleased to provide any further information or assistance which may be required.

Yours sincerely

[legal name of the Auditor]
[name and title of the authorised representative]
[dd Month yyyy]
Signature of the Auditor

[2] A conflict of interest arises when the Auditor's objectivity to establish the certificate is compromised in fact or in appearance when the Auditor for instance:
- was involved in the preparation of the Financial Statements;
- stands to benefit directly should the certificate be accepted;
- has a close relationship with any person representing the beneficiary;
- is a director, trustee or partner of the beneficiary; or
- is in any other situation that compromises his or her independence or ability to establish the certificate impartially.

Statements to be made by the Beneficiary/Linked Third Party ('the Statements') and Procedures to be carried out by the Auditor ('the Procedures') and standard factual findings ('the Findings') to be confirmed by the Auditor

The Commission reserves the right to provide the auditor with guidance regarding the Statements to be made, the Procedures to be carried out or the Findings to be ascertained and the way in which to present them. The Commission reserves the right to vary the Statements, Procedures or Findings by written notification to the Beneficiary/Linked Third Party to adapt the procedures to changes in the grant agreement(s) or to any other circumstances.

If this methodology certificate relates to the Linked Third Party's usual accounting practices for calculating and claiming direct personnel costs declared as unit costs any reference here below to 'the Beneficiary' is to be considered as a reference to 'the Linked Third Party'.

Please explain any discrepancies in the body of the Report.	
Statements to be made by Beneficiary	**Procedures to be carried out and Findings to be confirmed by the Auditor**
A. Use of the Methodology I. The cost accounting practice described below has been in use since *[*dd Month yyyy*]*. II. The next planned alteration to the methodology used by the Beneficiary will be from [dd Month yyyy*]*.	**Procedure:** ✓ The Auditor checked these dates against the documentation the Beneficiary has provided. **Factual finding:** 1. The dates provided by the Beneficiary were consistent with the documentation.
B. Description of the Methodology III. The methodology to calculate unit costs is being used in a consistent manner and is reflected in the relevant procedures. *[Please describe the methodology your entity uses to calculate personnel costs, productive hours and hourly rates, present your description to the Auditor and annex it to this certificate]* *[If the statement of section "B. Description of the methodology" cannot be endorsed by the Beneficiary or there is no written methodology to calculate unit costs it should be listed here below and reported as exception by the Auditor in the main Report of Factual Findings:* - *…]*	**Procedure:** ✓ The Auditor reviewed the description, the relevant manuals and/or internal guidance documents describing the methodology. **Factual finding:** 2. The brief description was consistent with the relevant manuals, internal guidance and/or other documentary evidence the Auditor has reviewed. 3. The methodology was generally applied by the Beneficiary as part of its usual costs accounting practices.

Please explain any discrepancies in the body of the Report.	
Statements to be made by Beneficiary	**Procedures to be carried out and Findings to be confirmed by the Auditor**
C. **Personnel costs** General IV. The unit costs (hourly rates) are limited to salaries including during parental leave, social security contributions, taxes and other costs included in the remuneration required under national law and the employment contract or equivalent appointing act; V. Employees are hired directly by the Beneficiary in accordance with national law, and work under its sole supervision and responsibility; VI. The Beneficiary remunerates its employees in accordance with its usual practices. This means that personnel costs are charged in line with the Beneficiary's usual payroll policy (e.g. salary policy, overtime policy, variable pay) and no special conditions exist for employees assigned to tasks relating to the European Union or Euratom, unless explicitly provided for in the grant agreement(s); VII. The Beneficiary allocates its employees to the relevant group/category/cost centre for the purpose of the unit cost calculation in line with the usual cost accounting practice; VIII. Personnel costs are based on the payroll system and accounting system. IX. Any exceptional adjustments of actual personnel costs resulted from relevant budgeted or estimated elements and were based on objective and verifiable information. *[Please describe the 'budgeted or estimated elements' and their relevance to personnel costs, and explain how they were reasonable and based on objective and verifiable information, present your explanation to the Auditor and annex it to this certificate].* X. Personnel costs claimed do not contain any of the following ineligible costs: costs related to return on capital; debt and debt service charges; provisions for future losses or debts; interest owed; doubtful debts; currency exchange losses; bank costs charged by the Beneficiary's bank for transfers from the Commission/Agency; excessive or reckless expenditure; deductible VAT or costs incurred during suspension of the implementation of the action. XI. Personnel costs were not declared under another EU or Euratom grant	**Procedure:** *The Auditor draws a sample of employees to carry out the procedures indicated in this section C and the following sections D to F.* *[The Auditor has drawn a random sample of 10 employees assigned to Horizon 2020 action(s). If fewer than 10 employees are assigned to the Horizon 2020 action(s), the Auditor has selected all employees assigned to the Horizon 2020 action(s) complemented by other employees irrespective of their assignments until he has reached 10 employees.].* For this sample: ✓ the Auditor reviewed all documents relating to personnel costs such as employment contracts, payslips, payroll policy (e.g. salary policy, overtime policy, variable pay policy), accounting and payroll records, applicable national tax , labour and social security law and any other documents corroborating the personnel costs claimed; ✓ in particular, the Auditor reviewed the employment contracts of the employees in the sample to verify that: i. they were employed directly by the Beneficiary in accordance with applicable national legislation; ii. they were working under the sole technical supervision and responsibility of the latter; iii. they were remunerated in accordance with the Beneficiary's usual practices; iv. they were allocated to the correct group/category/cost centre for the purposes of calculating the unit cost in line with the Beneficiary's usual cost accounting practices; ✓ the Auditor verified that any ineligible items or any costs claimed under other costs categories or costs covered by other types of grant or by other grants financed from the European Union budget have not been taken into account when calculating the personnel costs; ✓ the Auditor numerically reconciled the total amount of personnel costs used to calculate the unit cost with the total amount of personnel costs recorded in the statutory accounts and the payroll system.

Please explain any discrepancies in the body of the Report.	
Statements to be made by Beneficiary	**Procedures to be carried out and Findings to be confirmed by the Auditor**
(including grants awarded by a Member State and financed by the EU budget and grants awarded by bodies other than the Commission/Agency for the purpose of implementing the EU or Euratom budget in the same period, unless the Beneficiary can demonstrate that the operating grant does not cover any costs of the action). <u>If additional remuneration as referred to in the grant agreement(s) is paid</u> XII. The Beneficiary is a non-profit legal entity; XIII. The additional remuneration is part of the beneficiary's usual remuneration practices and paid consistently whenever the relevant work or expertise is required; XIV. The criteria used to calculate the additional remuneration are objective and generally applied regardless of the source of funding; XV. The additional remuneration included in the personnel costs used to calculate the hourly rates for the grant agreement(s) is capped at EUR 8 000 per full-time equivalent (reduced proportionately if the employee is not assigned exclusively to the action). *[If certain statement(s) of section "C. Personnel costs" cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the Auditor in the main Report of Factual Findings:* *- …]*	✓ to the extent that actual personnel costs were adjusted on the basis of budgeted or estimated elements, the Auditor carefully examined those elements and checked the information source to confirm that they correspond to objective and verifiable information; ✓ if additional remuneration has been claimed, the Auditor verified that the Beneficiary was a non-profit legal entity, that the amount was capped at EUR 8 000 per full-time equivalent and that it was reduced proportionately for employees not assigned exclusively to the action(s). ✓ the Auditor recalculated the personnel costs for the employees in the sample. **Factual finding:** 4. All the components of the remuneration that have been claimed as personnel costs are supported by underlying documentation. 5. The employees in the sample were employed directly by the Beneficiary in accordance with applicable national law and were working under its sole supervision and responsibility. 6. Their employment contracts were in line with the Beneficiary's usual policy; 7. Personnel costs were duly documented and consisted solely of salaries, social security contributions (pension contributions, health insurance, unemployment fund contributions, etc.), taxes and other statutory costs included in the remuneration (holiday pay, thirteenth month's pay, etc.); 8. The totals used to calculate the personnel unit costs are consistent with those registered in the payroll and accounting records; 9. To the extent that actual personnel costs were adjusted on the basis of budgeted or estimated elements, those elements were relevant for calculating the personnel costs and correspond to objective and verifiable information. The budgeted or estimated elements used are: — (indicate the elements and their values). 10. Personnel costs contained no ineligible elements; 11. Specific conditions for eligibility were fulfilled when additional

Please explain any discrepancies in the body of the Report.	
Statements to be made by Beneficiary	**Procedures to be carried out and Findings to be confirmed by the Auditor**
	remuneration was paid: a) the Beneficiary is registered in the grant agreements as a non-profit legal entity; b) it was paid according to objective criteria generally applied regardless of the source of funding used and c) remuneration was capped at EUR 8 000 per full-time equivalent (or up to up to the equivalent pro-rata amount if the person did not work on the action full-time during the year or did not work exclusively on the action).
D. Productive hours XVI. The number of productive hours per full-time employee applied is *[delete as appropriate]*: A. 1720 productive hours per year for a person working full-time (corresponding pro-rata for persons not working full time). B. the total number of hours worked in the year by a person for the Beneficiary C. the standard number of annual hours generally applied by the beneficiary for its personnel in accordance with its usual cost accounting practices. This number must be at least 90% of the standard annual workable hours. <u>If method B is applied</u> XVII. The calculation of the total number of hours worked was done as follows: annual workable hours of the person according to the employment contract, applicable labour agreement or national law plus overtime worked minus absences (such as sick leave and special leave). XVIII. 'Annual workable hours' are hours during which the personnel must be working, at the employer's disposal and carrying out his/her activity or duties under the employment contract, applicable collective labour agreement or national working time legislation. XIX. The contract (applicable collective labour agreement or national working time legislation) do specify the working time enabling to calculate the annual workable hours.	**Procedure (same sample basis as for Section C: Personnel costs):** ✓ The Auditor verified that the number of productive hours applied is in accordance with method A, B or C. ✓ The Auditor checked that the number of productive hours per full-time employee is correct. ✓ If method B is applied the Auditor verified i) the manner in which the total number of hours worked was done and ii) that the contract specified the annual workable hours by inspecting all the relevant documents, national legislation, labour agreements and contracts. ✓ If method C is applied the Auditor reviewed the manner in which the standard number of working hours per year has been calculated by inspecting all the relevant documents, national legislation, labour agreements and contracts and verified that the number of productive hours per year used for these calculations was at least 90 % of the standard number of working hours per year. **Factual finding:** <u>General</u> 12. The Beneficiary applied a number of productive hours consistent with method A, B or C detailed in the left-hand column. 13. The number of productive hours per year per full-time employee was accurate. <u>If method B is applied</u> 14. The number of 'annual workable hours', overtime and absences was

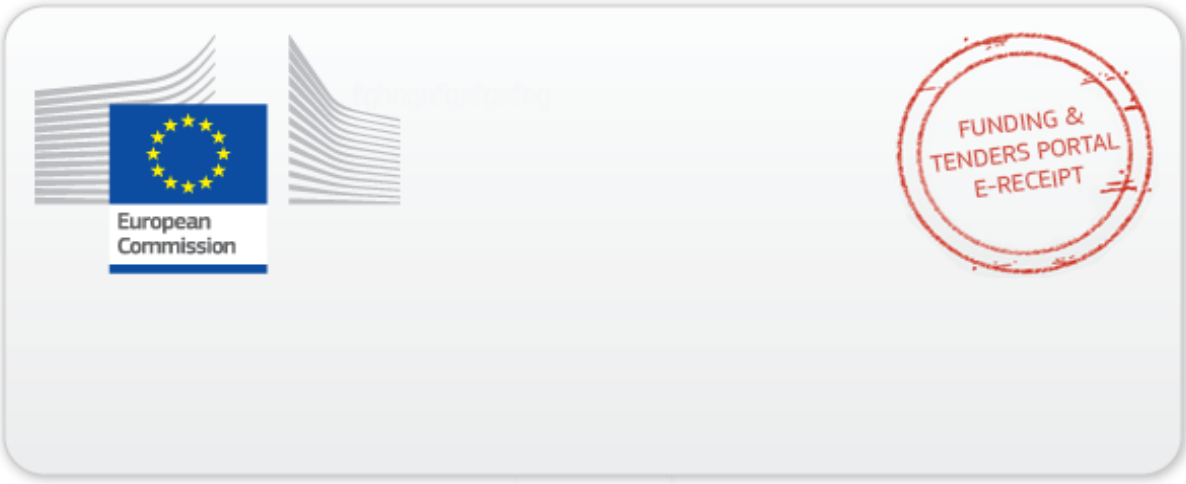
Please explain any discrepancies in the body of the Report.	
Statements to be made by Beneficiary	**Procedures to be carried out and Findings to be confirmed by the Auditor**
<u>If method C is applied</u> XX. The standard number of productive hours per year is that of a full-time equivalent. XXI. The number of productive hours per year on which the hourly rate is based i) corresponds to the Beneficiary's usual accounting practices; ii) is at least 90% of the standard number of workable (working) hours per year. XXII. Standard workable (working) hours are hours during which personnel are at the Beneficiary's disposal preforming the duties described in the relevant employment contract, collective labour agreement or national labour legislation. The number of standard annual workable (working) hours that the Beneficiary claims is supported by labour contracts, national legislation and other documentary evidence. *[If certain statement(s) of section "D. Productive hours" cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the Auditor:* - *…]*	verifiable based on the documents provided by the Beneficiary and the calculation of the total number of hours worked was accurate. 15. The contract specified the working time enabling to calculate the annual workable hours. <u>If method C is applied</u> 16. The calculation of the number of productive hours per year corresponded to the usual costs accounting practice of the Beneficiary. 17. The calculation of the standard number of workable (working) hours per year was corroborated by the documents presented by the Beneficiary. 18. The number of productive hours per year used for the calculation of the hourly rate was at least 90% of the number of workable (working) hours per year.
E. Hourly rates The hourly rates are correct because: XXIII. Hourly rates are correctly calculated since they result from dividing annual personnel costs by the productive hours of a given year and group (e.g. staff category or department or cost centre depending on the methodology applied) and they are in line with the statements made in section C. and D. above. *[If the statement of section 'E. Hourly rates' cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the Auditor:* - *…]*	**Procedure** ✓ The Auditor has obtained a list of all personnel rates calculated by the Beneficiary in accordance with the methodology used. ✓ The Auditor has obtained a list of all the relevant employees, based on which the personnel rate(s) are calculated. For 10 employees selected at random (same sample basis as Section C: Personnel costs): ✓ The Auditor recalculated the hourly rates. ✓ The Auditor verified that the methodology applied corresponds to the usual accounting practices of the organisation and is applied consistently for all activities of the organisation on the basis of objective criteria irrespective of the source of funding. **Factual finding:**

Please explain any discrepancies in the body of the Report.	
Statements to be made by Beneficiary	**Procedures to be carried out and Findings to be confirmed by the Auditor**
	19. No differences arose from the recalculation of the hourly rate for the employees included in the sample.
F. Time recording XXIV. Time recording is in place for all persons with no exclusive dedication to one Horizon 2020 action. At least all hours worked in connection with the grant agreement(s) are registered on a **daily/weekly/monthly** basis *[delete as appropriate]* using a **paper/computer-based system** *[delete as appropriate]*; XXV. For persons exclusively assigned to one Horizon 2020 activity the Beneficiary has either signed a declaration to that effect or has put arrangements in place to record their working time; XXVI. Records of time worked have been signed by the person concerned (on paper or electronically) and approved by the action manager or line manager at least monthly; XXVII. Measures are in place to prevent staff from: i. recording the same hours twice, ii. recording working hours during absence periods (e.g. holidays, sick leave), iii. recording more than the number of productive hours per year used to calculate the hourly rates, and iv. recording hours worked outside the action period. XXVIII. No working time was recorded outside the action period; XXIX. No more hours were claimed than the productive hours used to calculate the hourly personnel rates. *[Please provide a brief description of the time recording system in place together with the measures applied to ensure its reliability to the Auditor and annex it to the*	**Procedure** ✓ The Auditor reviewed the brief description, all relevant manuals and/or internal guidance describing the methodology used to record time. The Auditor reviewed the time records of the random sample of 10 employees referred to under Section C: Personnel costs, and verified in particular: ✓ that time records were available for all persons with not exclusive assignment to the action; ✓ that time records were available for persons working exclusively for a Horizon 2020 action, or, alternatively, that a declaration signed by the Beneficiary was available for them certifying that they were working exclusively for a Horizon 2020 action; ✓ that time records were signed and approved in due time and that all minimum requirements were fulfilled; ✓ that the persons worked for the action in the periods claimed; ✓ that no more hours were claimed than the productive hours used to calculate the hourly personnel rates; ✓ that internal controls were in place to prevent that time is recorded twice, during absences for holidays or sick leave; that more hours are claimed per person per year for Horizon 2020 actions than the number of productive hours per year used to calculate the hourly rates; that working time is recorded outside the action period; ✓ the Auditor cross-checked the information with human-resources records to verify consistency and to ensure that the internal controls have been effective. In addition, the Auditor has verified that no more hours were charged to Horizon 2020 actions per person per year than the number of productive hours per year used to calculate the hourly rates, and verified that

Please explain any discrepancies in the body of the Report.	
Statements to be made by Beneficiary	**Procedures to be carried out and Findings to be confirmed by the Auditor**
present certificate[1]]. *[If certain statement(s) of section "F. Time recording" cannot be endorsed by the Beneficiary they should be listed here below and reported as exception by the Auditor:* - *…]*	no time worked outside the action period was charged to the action. **Factual finding:** 20. The brief description, manuals and/or internal guidance on time recording provided by the Beneficiary were consistent with management reports/records and other documents reviewed and were generally applied by the Beneficiary to produce the financial statements. 21. For the random sample time was recorded or, in the case of employees working exclusively for the action, either a signed declaration or time records were available; 22. For the random sample the time records were signed by the employee and the action manager/line manager, at least monthly. 23. Working time claimed for the action occurred in the periods claimed; 24. No more hours were claimed than the number productive hours used to calculate the hourly personnel rates; 25. There is proof that the Beneficiary has checked that working time has not been claimed twice, that it is consistent with absence records and the number of productive hours per year, and that no working time has been claimed outside the action period. 26. Working time claimed is consistent with that on record at the human-resources department.

[1] The description of the time recording system must state among others information on the content of the time records, its coverage (full or action time-recording, for all personnel or only for personnel involved in H2020 actions), its degree of detail (whether there is a reference to the particular tasks accomplished), its form, periodicity of the time registration and authorisation (paper or a computer-based system; on a daily, weekly or monthly basis; signed and countersigned by whom), controls applied to prevent double-charging of time or ensure consistency with HR-records such as absences and travels as well as it information flow up to its use for the preparation of the Financial Statements.

Please explain any discrepancies in the body of the Report.	
Statements to be made by Beneficiary	**Procedures to be carried out and Findings to be confirmed by the Auditor**
[official name of the *[Beneficiary] [Linked Third Party]**]*** ***[name and title of authorised representative]*** ***[dd Month yyyy]*** ***<Signature of the*** *[Beneficiary] [Linked Third Party]>*	***[official name of the Auditor]*** ***[name and title of authorised representative]*** ***[dd Month yyyy]*** ***<Signature*** *of the Auditor>*



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