REVERTER

Deep REnovation roadmaps to decrease households VulnERability to Energy poveRty

Project No. 101076277

Deliverable 3.1 - Global methodology

Due date:	**31/07/2023**
Dissemination level:	**PU - Public**
Lead beneficiary:	**NTUA**
Contributing beneficiaries:	**All**

Co-funded by the European Union

About this document

This deliverable provides the global methodology for the pilots and the monitoring and evaluation (M&E) strategy.

Status of deliverable	By	Date
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Approved (Coordinator)	Dimitris Damigos	21/7/2023
Submitted	By Dimitris Damigos	25/7/2023

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Acknowledgement

This document is a deliverable of the REVERTER project. This project has received funding from the European Union's LIFE programme under grant agreement No 101076277.

Executive summary

This deliverable provides the global methodology for the pilots and the monitoring and evaluation (M&E) strategy of the REVERTER project. The overall aim of REVERTER is to improve the quality of life for vulnerable citizens across Europe through providing energy advice which leads to energy efficiency improvements. In this direction, REVERTER will develop 9 roadmaps in four different European areas (Brezovo-Bulgaria, Athens Urban area-Greece, Riga-Latvia and Coimbra-Portugal) to effectively alleviate energy poverty (EP) through deep renovation of houses. The roadmaps will target the worst-performing homes first ("worst first" principle), will cope with split-incentive dilemmas and will address market, information, and behavioural failures through the creation of "one-stop shops'' (OSS) as defaults for the enrolment of vulnerable households in subsidised energy efficiency improvement programmes. REVERTER will work with vulnerable citizens and will engage with local, national and EU stakeholder groups and experts to create long-term sustainable impacts at local, national, and regional level.

This deliverable (D3.2) presents the global methodology of the project (Section 3.1), which is based on five steps, i.e., Data gathering, analysis and mapping; Stakeholder mapping; Development of roadmaps; Training, information sharing and capacity building; and Pilot implementation of roadmaps. Each methodological step includes one or more components (activities), eleven in total, which are common to all REVERTER pilots (Section 3.2). Nevertheless, the methodology is designed to be flexible in order to fit the needs of the varying characteristics of the four pilots (i.e., the characteristics of the building stock, the characteristics of the vulnerable households and the climate conditions). For instance, the number of people involved, data capture approaches used, engagement activities implemented, operational characteristics of the OSSs, etc., can be customised. Providing flexibility is important because the pilot implementation of the roadmaps does not exist in isolation from the local community (i.e., vulnerable citizens, local and national stakeholders). Therefore, failing to involve these actors in the activities of the project may lead to poor policy results and lack of sustainability of the results after the project ends. At the same time, the overall key steps are common because a common methodology: (a) will ensure a consistent and comparable measurement of impacts and (b) will allow for the replication and scaling up of the methodology outside of the REVERTER pilots while allowing unique aspects when required. In this sense, the results of the REVERTER will benefit more member states and areas suffering from EP, while fostering cross-border and cross-sector developments on a lasting basis.

Furthermore, the deliverable discusses three critical issues to be considered when piloting this project or replicating it elsewhere, namely the ethical and data protection considerations (Section 3.3), the stakeholder networking (Section 3.4.), and the sustainability, replication, and exploitation of project results (Section 3.5) and presents the implementation plan in each pilot area. Finally, the deliverable includes a series of annexes with useful supplementary information (e.g., examples of consent forms for different data collection approaches).

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Glossary

Abbreviation / acronym	Description
Vulnerable citizen/consumer	The term is used interchangeably throughout the document for individuals.
NECPs	National Energy and Climate Plans
LTRS	Long-Term Renovation Strategies
EP	Energy Poverty
EED	Energy Efficiency Directive
EPBD	Energy performance of buildings directive
OSS	One-stop shop
LCA	Life Cycle Assessment
EPOV	European Energy Poverty Observatory
EPAH	Energy Poverty Advisory Hub
EU-SILC	European Union Statistics on Income and Living Conditions
GWh	Gigawatt Hours
RES	Renewable energy sources
RAs	REVERTER Ambassadors
NGOs	Non-governmental organisations
GDPR	General Data Protection Regulation
EAB	Ethics Advisory Board
SERTF	Sustainability, Exploitation and Replication Task Force

1 Introduction

Energy poverty (EP) is a crucial social-economic problem of the current society, as it deprives people of a basic standard of living and quality of life. According to the latest available data for EP across Europe, about 7% of the European citizens could not afford to adequately heat their homes, 6.4% reported arrears on utility bills, more than 16% spent a significantly high percentage of their income on energy costs, while, on the other hand, 14.6% presented abnormally low energy expenditure, as a result of their low incomes. Overall, there are several factors associated with EP, such as housing conditions (e.g. dwelling type and type of heating systems used); household characteristics (e.g. size of household); building characteristics (e.g. building size and energy efficiency); and demographic characteristics (e.g. employment status, education, nationality, gender) (Bouzarovski, 2014; Papada et al., 2019; Thomson & Snell, 2013). However, EP is mainly connected with three causes: high energy costs, low household income and energy-inefficient buildings (Atanasiu et al., 2014; International Energy Agency, 2011; Palmer et al., 2008). Due to the recent energy crisis in Europe, the importance of these factors has escalated.

Under the Clean Energy for All Europeans package, MS, through their National Energy and Climate Plans (NECPs) and Long-Term Renovation Strategies (LTRS), must identify dwellings of people at risk of EP and develop effective strategies for renovating these as a matter of priority. Further, the Energy Efficiency Directive (2012/27/EU) (EED), as amended by Directive 2018/2002/EU, requires MS to take into account the need to reduce EP, and the revised Energy performance of buildings directive (2018/844/EU) (EPBD) requires MS to address split-incentive dilemmas and market failures as part of the national LTRS, and to target the least efficient building stock first ("worst first" principle). In this direction, the EPBD recast (COM(2021) 802 final) seeks to boost the renovation of the 15% worst performing buildings, which prioritises the most cost-effective renovations and helps fight EP.

Bearing in mind the above remarks, REVERTER will develop 9 roadmaps to alleviate EP by addressing the poor energy efficiency of dwellings. The roadmaps will be tailor-made to the characteristics of the building stock, the characteristics of the vulnerable households and the climate conditions, to cover a sufficiently cohesive group of cases that will allow for a larger-scale rollout and replication of the proposed actions for the effective analysis and tackling of the problem. The roadmaps will target the worst-performing homes first ("worst first" principle), will cope with split-incentive dilemmas and will address market, information and behavioural failures through the creation of "one-stop shops'' (OSS) as defaults for the enrolment of vulnerable households in subsidised energy efficiency improvement programmes. The project will test the roadmaps by setting up a network of pilots in four European countries (Brezovo-Bulgaria, Athens Urban area-Greece, Riga-Latvia and Coimbra-Portugal) that cover four different climate regions (Southern Dry: Portugal; Mediterranean: Greece; Southern Continental: Bulgaria; Northern Continental: Latvia) and different socioeconomic conditions regarding age and size of buildings, owner-occupancy rates, percentage of Multi-Family Houses and Single Family Houses, income, values and beliefs of the inhabitants etc. Furthermore, engagement with local, national and EU stakeholder groups

and experts will embed the roadmaps to be developed in defining future policies for the reduction of EP.

2 The REVERTER concept

REVERTER was submitted under the Call LIFE Clean Energy Transition (LIFE-2021-CET) and, more specifically, the topic LIFE-2021-CET-ENERPOV "Addressing building-related interventions for vulnerable districts", aiming to effectively alleviate EP through deep renovation of houses according to the "worst first" principle. Within this overall context, REVERTER has eight specific objectives:

- **Specific Obj. 1.** Create 9 roadmaps.
- **Specific Obj. 2.** Facilitate the renovation of more 800 houses (SFH, MFH, apartments) during the implementation of the project and within 5 years after its end.
- **Specific Obj. 3.** Create a positive impact on more than 3,000 vulnerable people.
- **Specific Obj. 4.** Demonstrate the effectiveness and replicability of the proposed solutions among 20,000 energy vulnerable households.
- **Specific Obj. 5.** Trigger investments of about 8 million EUR in sustainable energy and primary energy savings/renewable energy generation of 12.3 GWh/year during the implementation of the project and within 5 years after its end.
- **Specific Obj. 6.** Use 10 existing and new "tailor-cut" complementary indicators for measuring EP.
- **Specific Obj. 7.** Create a knowledge database and analyse deep renovation measures employing economic, environmental (via Life Cycle Assessments - LCA), technical, and social criteria using cost-benefit and multicriteria approaches.
- **Specific Obj. 8.** Identify viable financial schemes, support best practices and shape future policies towards alleviating EP through energy retrofits by creating/adapting 15 pieces of legislation, policies or strategies during the implementation of the project and within 5 years after its end.

Building on the achievements of previous and ongoing projects and initiatives and towards maximising the effectiveness of the roadmaps, REVERTER is based on five distinct but interdependent and mutually supportive pillars (Figure 1).

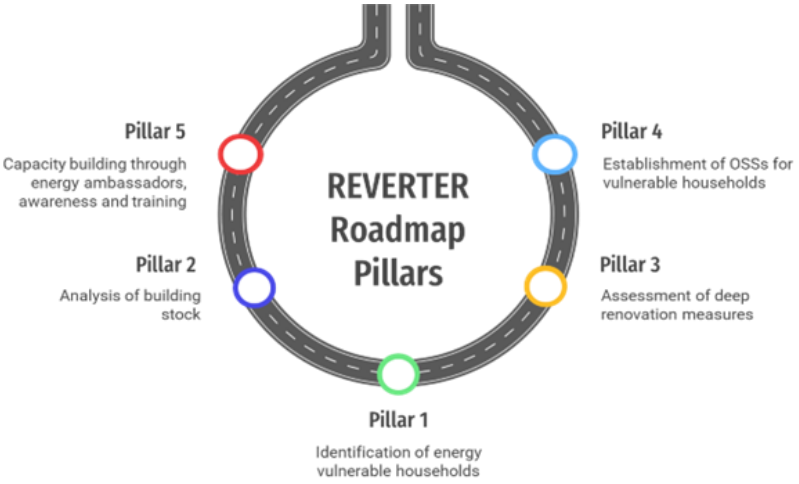

Figure 1. The five pillars of the project

P1. Identification of energy vulnerable households

The identification of energy vulnerable households is a crucial issue for policymakers to design effective policies for EP. In EU Directives for the electricity and natural gas market, 'energy poor' is equal 'vulnerable consumers'. Member states set national criteria to identify households as 'vulnerable' and, thus, cross-country comparisons lead to different outcomes depending on which EP indicator is used. Moreover, in many cases, the definition also heavily influences the socio-demographic composition of the energy poor within the borders of a country.

As a multidimensional social issue, EP cannot be approached by a single indicator. For instance, the EU Energy Poverty Observatory (EPOV), which was recently succeeded by the Energy Poverty Advisory Hub (EPAH), recommends the combination of subjective and objective indicators (e.g. the 2M indicator "high share of energy expenditure in income", and the M/2 indicator "low absolute energy expenditure" indicators, the "inability to keep home adequately warm", the "arrears on utility bills", etc.). Thus, a detailed analysis of the characteristics of EP in the four pilot cases will take place. EP monitoring depends usually on data at national and pan-European scales and relevant indicators, which are treated as comparable across most European countries. In the context of the project, 'subject-oriented strategies' will be used as a complement to existing databases through social questionnaire-based surveys, municipality housing services and other pre-existing city-wide networks, so as to bridge gaps left by national and sub-national level indicators. In this direction, innovative forms of representation such as additional relevant variables, measurement techniques, and advanced quantitative and qualitative indicators will be used to capture the 'depth' of EP contrary to the existing 'binary logic' that a household is either energy poor or not.

P2. Analysis of building stock

The EU building stock comprises about 240 million dwellings, which collectively have a useful floor area of 22,022 km^2 and an average dwelling floor area between 70 m^2 and 130 m^2 depending on the country. The European building stock presents a considerable diversity in terms of size, age, energy performance, tenure size, heating & cooling needs and choice of energy carriers, related among others to the different climate regions. Thus, the second pillar will support the process of de-contextualisation of the EP problem from an object-oriented strategy targeting the housing stock so as to facilitate the implementation of the "worst first" principle. The existing building stock in the pilot areas will be analysed based on data retrieved by existing databases or in situ surveys to determine the energy efficiency of residential buildings. Appropriate methods (e.g. Simplified Engineering, statistical or other) will be used to benchmark the capacity and opportunity for energy renovation. This capacity will be correlated with socio-economic parameters (multifamily or single-family building, private or rented, social housing, income, etc.), as well as with climatic data. The aim is to identify energy-poor and inefficient hotspots.

P3. Assessment of deep renovation measures

According to the EU's Energy Efficiency Directive 2012/27/EU, deep renovations "...*lead to a refurbishment that reduces both the delivered and the final energy consumption of a building by a significant percentage compared with the pre-renovation levels leading to a very high energy performance*...". Deep renovation assumes the use and combination of multiple

simultaneous renovation measures that may evolve with, the state-of-the-art, three technologies for retrofitting: (i) energy efficiency (e.g. fabric measures, windows, heating, lighting and appliances), (ii) renewable energy sources – RES (such as solar hot water, photovoltaics, heat pumps, etc.) and (iii) connecting to district heating systems and other more sustainable energy supply systems (e.g. cogeneration and district heating systems). REVERTER focuses on energy efficiency and RES (in the Bulgarian pilot mainly). The third pillar focuses on the assessment and prioritisation of alternative deep renovation measures in terms of financial (e.g. payback period), technical (e.g. delivery time and minimisation of disturbance for building occupants.), social (e.g. improved thermal comfort) and environmental criteria (e.g. minimisation of carbon emissions estimated via Life Cycle Assessments). The final prioritisation will be based on social cost-benefit analysis and/or multi-criteria analysis as a complement or if monetisation of all non-market benefits is not feasible.

P4. Establishment of "one-stop shops"

Barriers to energy efficiency are defined as circumstances or obstacles that prevent individuals or organisations from implementing higher energy efficiency technologies, even though their implementation would make sense from an economic point of view. The barriers according to the "Energy Efficiency for Low-Income Households" report for the ITRE are economic, behavioural, informational and administrative (Ugarte et al., 2016). One of the most prominent approaches to promote energy renovation decisions beyond financial models seems to be the model of 'one-stop shops' (OSSs), although there are only a few studies specifically investigating its performance. Thus, one of the pillars of the project is the design and pilot operation of physical and digital OSSs for vulnerable households, following the 'Facilitation' business model, to overcome the barriers that will be identified in the pilot areas.

P5. Capacity building using energy ambassadors, awareness and training campaigns

In energy efficiency, capacity building is seen as a systematic and integrated approach to develop and continuously improve organisational and individual competencies and capabilities necessary for becoming more energy-efficient. In the same direction, information campaigns and information centres can raise awareness about energy savings and energy cost reductions. To facilitate capacity building and energy awareness, the fifth pillar of REVERTER aims to recruit frontline staff of energy suppliers, university students, personnel of municipalities, social workers, staff from organisations assisting vulnerable households, dedicated staff of building management companies, elders of multi-family buildings, etc. to become REVERTER Ambassadors (RAs). The RAs will help vulnerable groups to improve their energy use behaviour and will provide advice on both low-cost measures that can be quickly applied and energy renovation works that can reduce households' energy consumption significantly.

3 Global methodology

3.1 Methodological approach

To create and implement the roadmaps in the four pilots, the five pillars of REVERTER are implemented through a five-step methodology, as follows.

Step 1. Data gathering, analysis and mapping

In this step, an innovative approach will be developed by analysing existing data (e.g. from EU-SILC, EPAH, etc.) and information collected from primary surveys with state-of-the-art qualitative and quantitative approaches (e.g. multiple correspondence and multivariate estimated analyses and learning algorithms) to identify energy vulnerable households using a suite of EP indicators. EP indicators and building stock data will be combined with spatial analysis tools to identify "worst first" EP hotspots. An important aspect of Step 1 will be also the development of a detailed database to map all proven deep renovation measures. The database will include technical and financial data as well as information regarding the environmental performance and the anticipated social costs and benefits of each measure.

Step 2. Stakeholder mapping

A stakeholder analysis and mapping will be carried out and the key stakeholders to get attached to project activities will be identified and reached out to set up a fruitful collaboration during the project and beyond through the Regional Stakeholder Networks. Local, regional and national public authorities, housing associations and social and societal actors will be of particular importance. As a starting point, the following stakeholders could be distinguished: Private Clients: e.g. building owners; Business & Industrial Clients: e.g. housing associations & cooperatives, public housing companies, private housing companies, etc.; Tenants & Residents; 'Supply' stakeholders: e.g. contractors, energy inspectors, consultants, construction companies, installers, material and equipment suppliers of energy-related products & services etc.; Policy & Authorities: e.g. policy makers, energy regulatory authorities, planning authorities, Municipality or civil servants, etc.; Society & General public: direct and surrounding neighbours.

Step 3. Development of roadmaps

Roadmaps of energy efficiency measures will be prepared based on best practices in residential building energy efficiency policies and programmes to recommend suitable instruments for vulnerable households. A review of the literature on projects and programmes will be conducted for the residential sector to explore the strengths and weaknesses of the main types of instruments and to identify the barriers that hinder the implementation of energy efficiency measures in residential buildings, as well as the prominence of each barrier. Holistic deep renovation solutions (e.g. building envelope insulation, window replacement, etc.), as well as low-cost measures (e.g. draught-proofing) alternatives will be assessed using economic, environmental, technical and other criteria. The analysis will provide an overview of the most suitable instruments and policy packages and will formulate a roadmap to overcome barriers to energy efficiency in residential buildings occupied by vulnerable households.

Step 4. Training, information sharing and capacity building

REVERTER will create an effective training program for the RAs and the OSSs' personnel. The aim is to combine traditional approaches with the REVERTER app and advice material (online and offline) that will foster knowledge building, sharing and awareness. The information will be published online and communicated in the four pilot regions. To get the strongest impact and outreach, REVERTR will also implement community engagement campaigns to adapt residents' post-intervention energy use behaviour and to promote energy efficiency renovation actions and programmes.

Step 5. Pilot implementation of roadmaps

Building on previous initiatives and projects, like the EuroPACE and the INNOVATE projects, four pilot OSSs for vulnerable households will be set up. The pilot areas, where the OSSs will be installed during REVERTER's lifetime, cover several complementary and diverse countries and regions.

3.2 Methodological components in each pilot

Each methodological step includes one or more components (activities), which are common to all REVERTER pilots. The following section provides general guidelines on how to implement these activities. The aim is to form a common but still flexible methodology, easy to adapt to the particular conditions of the four pilots. In order to help REVERTER partners in the development and implementation of the roadmaps, as well as the complementary activities (e.g. training and information and engagement campaigns, ethical considerations, etc.), a 'Methodological helpdesk' will be established as a go-to point for any queries or doubts about the on-site activities in the pilot areas. NTUA, as the Coordinator of the project, will be primarily responsible for operating the 'Methodological helpdesk' in cooperation with the other partners.

3.2.1 State-of-the-art assessment in EP, energy retrofits and roadmapping

The first activity in all pilots is to conduct a state-of-the-art assessment of EP, energy retrofits and existing roadmaps. This will include an in-depth literature review covering all MS about existing EP definitions and indicators, alternative deep renovation measures per building category, deep renovation co-benefits and barriers, existing EP and building renovation roadmaps and existing and foreseen policies, initiatives, strategies, measures, etc., including best practices, both at EU level and within the participating countries for the alleviation of EP and the promotion of deep renovation. The results of this activity will provide input to crucial components of the project (e.g. the development of the roadmaps, the design of the OSSs, the policy recommendations, etc.). Moreover, a template will be created to summarise the collected information, which will form the basis for the "European EP Atlas" database.

3.2.2 Identification of EP hotspots

In all pilots, a baseline assessment of EP conditions and characteristics will be conducted. In this direction, data collected from existing databases (e.g. home and population censuses

from national statistical authorities or municipalities, national cadastres and databases of energy performance certificates, EU-SILC surveys, etc.) will be integrated and analysed with state-of-the-art qualitative and quantitative approaches, namely statistical techniques and machine learning algorithms. The data should cover a sufficient time period to allow understanding the structural characteristics of EP and the impacts of COVID-19 pandemic. The aim is to develop a simple, yet comprehensive methodology to better identify energy-poor and inefficient hotspots and to elaborate appropriate renovation roadmaps in the context of the "worst first" principle. The methodology will be tested and verified using data that will be gathered by the four pilots through four questionnaire-based social surveys (see Section 3.2.3).

3.2.3 Assessment of vulnerable consumers' capacity needs

To gain direct insight into real field situations in the selected pilot areas, four questionnaire surveys will be implemented involving at least 300 households in each pilot. The questionnaires will focus mainly on energy issues, house and heating system characteristics and market, administrative, behavioural and informational barriers. A common set of questions will be developed for the local surveys. Yet, they can be revised as the situation in each pilot might be different. Prior to finalising the questionnaire, a pilot study must take place.

The questionnaires can be self-administered (delivered online or in paper-and-pen formats, in person or through mail) or researcher-administered (i.e. face-to-face interviews that take place by phone, in-person, or online). Regardless the survey administration method, particular attention must be given to ethical and data protection considerations (see also Section 3.3). Appropriate information sheets and consent forms will be prepared for that purpose and the ethical guidelines must be strictly followed. Further, the population size and the survey method to be followed (i.e. probability or non-probability and type of method) must be defined.

The results of the questionnaire surveys will be used to:

- test the EP identification methodology (Section 3.2.2)
- develop a set of tailor-made materials for community capacity building programmes that will be used by the RAs and the OSS staff (Section 3.2.6).
- recruit households willing to participate in REVERTER's field activities, e.g. home visits (Section 3.2.7)
- facilitate the development of roadmaps (Section 3.2.4)
- identify best practices in delivering energy advising during the local engaging initiatives/campaigns for low-income households (Section 3.2.8)
- recognise key incentives to EE retrofitting for each property tenure type category, which is necessary for the design of the physical and digital OSSs (Sections 3.2.9 and 3.2.10).

3.2.4 Preparation of the renovation roadmaps

REVERTER will create 9 renovation roadmaps that will provide effective strategies to alleviate EP. The roadmaps will take into consideration the results of the state-of-the-art assessment (Section 3.2.1) and the vulnerable consumers' capacity needs (Section 3.2.3). To facilitate the preparation of the roadmaps, a PESTEL analysis will be carried out in each pilot to identify the most important political, economic, social, technological, environmental and legal challenges and issues (e.g. characteristics of the building stock, types of vulnerable households, existing and foreseen policies, etc.). The roadmaps will emphasise the defined renovation targets, the planned policies and measures, the time plan and milestones for the realisation of the foreseen investments, the financial instruments etc. For this purpose, a template will be prepared together with a guidance note describing all the required actions. Moreover, the pilot partners will participate in regular meetings organised to support the preparation of roadmaps and in dedicated consultation activities dedicated to discussing the progress of the activity.

A guidance note on the preparation of the roadmaps is provided in Annex I.

3.2.5 Recruitment of RAs and OSS personnel

The facilitation of a bi-directional communication channel using RAs as an intermediate link between the EP households and the OSSs, will help to couple local needs and beliefs with renovation opportunities. Moreover, the knowledge to be gained from the two-way communication and information activities and the shelf-training material that will be disseminated in a large number of households and will create a stronger outreach program.

REVERTER pilots will recruit from the local community at least 65 "Ambassadors" (RAs) (Bulgaria: 15; Greece: 30; Latvia: 10; Portugal: 10). The RAs will be building managers, social workers for the municipalities, community members, frontline staff of energy suppliers, university students, staff from organisations assisting vulnerable households, elders of multi-family buildings, etc.

Recruitment of RAs can be made via different channels, as follows:

- Stakeholders: Stakeholder groups such as Municipalities, energy suppliers, NGOs, etc. can be beneficial in recruiting people from their staff to act as RAs.
- Direct contact: Partners can meet directly with citizens interested in becoming RAs (e.g. research/educational partners can meet with university students, consumer associations can meet with their members, municipalities can meet with their citizens or staff from departments assisting vulnerable households, etc.).
- Social media: Social media can be used (e.g. Twitter, Facebook, project partners websites) to advertise the project and provide contact details for those who would be interested in acting as RAs.
- Leaflets: Leaflets can be used alongside social media to attract interested citizens. Leaflets can be made available at public events, stakeholders' premises, etc.
- Questionnaire surveys: At the end of the questionnaire that will be used in the four social surveys, a question can be included asking the participants if they would like to

get involved in the activities of the project. Those who will contact the project partners can be asked if they are willing to act as RAs for the sake of the community.

The OSSs personnel will consist of staff members of the partners of the project, especially those who are responsible for the pilot implementation of the roadmaps. At least 25 OSSs providers will be trained on how to operate the OSS according to the programme described in Section 3.2.6, to serve the activities of the OSSs (Section 3.2.9). The OSSs providers can be permanent or fixed-term members of the staff. In case one or more stakeholders are interested in operating their own OSSs, local partners will train the stakeholders' staff and provide all the information material.

Partners should ensure that the selection of the OSS personnel is also based on the principle of equality and non-discrimination.

3.2.6 Training of RAs and OSS personnel

Training and advisory programmes of recruited RAs will focus on issues such as social inclusion, no- or low-cost measures to cope with EP, simple technical issues of energy saving in households, retrofitting practices, benefits of retrofitting, energy financing mechanisms and innovative tools, etc. Besides training, RAs will be supported by tools and step by step guidelines by the project partners related to the scope of the visits to be conducted. Particular attention will be given to avoid any issues of stigmatisation and all legal (i.e. GDPR) and ethical requirements will be fulfilled.

As regards the OSS training programme, the personnel will be trained on how to approach energy vulnerable households and to increase renovation demand through marketing and communication measures for specific target groups (e.g. low income, specific city districts, etc.), to raise awareness of the benefits resulting from energy retrofits (financial, environmental, thermal comfort conditions, etc.), to promote existing services offered by local stakeholders (local authorities, suppliers, etc.), to communicate with local actors (e.g. local authorities, real estate agents, banks, etc.), to recommend customised energy-saving measures, technologies and materials adapted to a specific life situation and provide list of existing suppliers, to conduct a preliminary building analysis / energy audit, to provide assistance on existing financing options for which the homeowner is eligible (subsidies, tax credits, energy efficiency certificates, etc.) and help to develop a tailor-made financing plan and to prepare all documents necessary for accessing financial instruments, to develop a certification scheme for 'quality' suppliers, etc.

Besides project staff, municipal staff can also be trained by the project. Based on outcomes from pilot sites, at least 5 interested municipalities in developing OSSs will be trained in each country on how to identify vulnerable groups, how to communicate with them and how to raise their awareness and build their skill for improved behaviour and for available retrofit options. This will stimulate uptake of the practical recommendations resulting from the project as widely as possible, to audiences beyond the target groups and individuals /organisations engaged directly in the project.

3.2.7 RAs home visits

Home visits will be used to spread REVERTER knowledge to the local community on an agreed number of occasions. In total, 1,500 home visits (Bulgaria: 500; Greece: 600; Latvia: 200; Portugal: 200) will be conducted by the RAs and project staff. At each visit, the consent of the household should be obtained, and the relevant form should be completed after detailed information on the aims of the project (via the information sheet). Besides legal requirements (i.e. GDPR), home visits must avoid any issues of stigmatisation from an ethical perspective.

During home visits, the RAs and/or the project staff will both provide tailor made advice and undertake a detailed discussion of aspects including:

- Specificities of the external/internal envelope and heating systems
- Energy saving measures or lack of e.g. insulation, LED bulbs, draft excluders
- Energy consumption patterns and possible changes to existing use
- Energy supply sources and possibly alternative suppliers
- Current energy costs
- Knowledge of available incentive programmes and financial tools
- Household income and other relevant socio-economic factors

The results from the visits will help to identify gaps and opportunities per country and will be also used to validate the identification and targeting mechanisms directed at vulnerable consumers. It should be noted that the home visits should be designed to fit the needs of the households at the given pilot. Therefore, while certain advice may be generic (e.g. specificities of the external/internal envelope and heating systems), there are a number of local issues which must be considered. These include the available schemes, e.g. solar panel installation, local social energy tariffs, etc.

Generally, the assessments will take place using either a paper or an electronic questionnaire. Following the visit, it should be examined whether the household has visited the local OSS and, more generally, whether it has decided to adopt some energy-saving measures or to apply for an energy efficiency subsidy scheme. For this reason, as well as in case of a possible audit by the funding authority, the contact details of the visiting households should be kept, in strict compliance with the procedures for the protection of their personal data.

3.2.8 Awareness campaigns

Communication activities are critical to the success of the project. WIT will support all the partners with visual aids and guidelines and the project partners will translate the material in the language of each pilot. In general, the awareness campaigns will include the creation of the print materials, organisation of events, social media communication, media relations, communication with journalists, creation of videos, regular info update in digital OSS platform and REVERTER Hub (Section 3.2.10) as well as the organisation of other activities that will be identified during the development of the communication strategy or later in the project. Within this context and among other activities, local partners must organise four social engagement events at each pilot (M12, M18, M24, M30), with at least 25 participants each.

The events will provide an informal space where households can ask questions and discuss issues with energy-saving experts and receive on-time advice and will create an informal and convivial atmosphere that allows much more effective bi-directional and interactive communication. The first event will include a focus group with relevant local stakeholders and will be used primarily to assess the incentives to energy efficiency retrofitting for each subgroup within the target population, but also the household and/or building retrofitting needs of their properties for the design of the OSS. In the case of COVID-19 restrictions, some of the capacity building events could be transformed into digital events (webinars) via an online meeting platform. Although a common communication framework is foreseen, the activities will be tailored to each pilot.

Dissemination activities will also take place, targeting mainly stakeholders, representatives of the national government and local authorities, the local business community and generally parties interested in the project's results. The dissemination activities will start as soon as the first project results will be available (after M12). WIT will lead this task and will support each partner in the dissemination activities. WIT will also organise all the central dissemination activities of the project such as central - international webinars aimed at stakeholders etc.

3.2.9 REVERTER OSSs operation

The OSSs operation involves the design, set-up, deployment, and management and monitoring for the four pilot areas, building on the experience of EUROPACE and other relevant projects. The established OSS will be based on the "Facilitation" business model, e.g. raise awareness on energy renovation benefits, provide information on optimal renovation works, conduct a preliminary building analysis/energy audit, analyse existing financing options, provide help to prepare all documents necessary for accessing financial instruments, etc. The operation of the pilot OSSs will be based on the obtained questionnaire survey and the PESTEL analysis results (Sections 3.2.3 and 3.2.4), which will help to identify key incentives to energy efficiency retrofitting for each property tenure type category, the main local target groups and stakeholders (e.g. tenants, homeowners, landlord, housing associations, social and societal actors, citizen energy communities, etc.), the existing and foreseen subsidy schemes, etc. The engagement of the target groups will follow a bi-directional approach, i.e. top-down (approaching institutional stakeholders that own or administer buildings) and bottom-up (approaching energy vulnerable tenants, single property owners and small private building owners).

A guidance note will be prepared by FEP to present the main steps for the constitution and operation of the OSS (e.g. selecting the EE retrofitting interventions to promote, drafting the legal documents that will regulate rights and obligations of all the parties, marketing and outreach guidelines, carrying out an energy audit, etc.) before the physical set-up. The full deployment of the OSSs will follow the consequent operational procedure and protocol.

The provided services will be monitored and evaluated by FEP with the application of a specialised monitoring framework having as the main objective the continuous assessment of their operability and effectiveness. This will be done to gather quantitative data that relates to the internal efficacy and efficiency of the OSS operational process, convert it into relevant KPIs (Section 3.2.11) to subsequently measure and maximise impact. The monitoring

framework will also evaluate various elements of the renovation roadmaps, such as the cost-effectiveness of the implemented policies and measures, the actual leverage of the realised investments, etc. Regular meetings will be organised by FEP to support technically the targeted countries for the smooth and effective establishment and operation of the OSSs. Finally, a survey will be conducted to the four pilots targeting the qualitative evaluation of the OSSs. The survey will involve households that received technical support including proposals for improving the current services. For this reason, as well as in case of a possible audit by the funding authority, the contact details of the visiting households should be kept, in strict compliance with the procedures for the protection of their personal data.

3.2.10 REVERTER Hub and digital OSSs

The REVERTER Hub platform (www.reverterhub.eu) will facilitate knowledge exchange, learning, guidance and other relevant information and will serve as an umbrella platform for the digital OSSs in 4 regions. Specifically, the Hub will compile all the project results (including roadmaps) and articles aimed at stakeholders, will transfer knowledge and experience to stakeholders, policy makers and other relevant target groups in the pilots and provide information to stakeholders and policy makers in other countries. Moreover, it will act as a repository of the additional information (already existing information) aimed at all target audiences.

In order for the Hub to function and contribute to achievement of the project's goals, it has to have certain functionalities and be easy to understand and use. Aspects that will be taken into consideration when planning the Hub are:

- Keyword analysis and findability on Google (SEO optimisation)
- Partners' inputs about the needs, goals and frustrations of specific target audiences
- User experience (good practises)
- Content strategy (good practises)
- Central source of information that relates all the REVERTER OSSs and the developed roadmaps
- User experience and knowledge gained from OSSs to be transmitted to other projects, organisations, stakeholders, policy-makers etc.

Besides general guidelines about energy saving measures, relevant articles, roadmaps, information about upcoming events and conferences, EP initiatives including national and international funded projects, NGO initiatives, etc., the REVERTER Hub will include a tool-hub connecting to all public and private virtual tools to calculate energy efficiency measures and energy consumption, including the REVERTER app and advice material.

To foster the concept of the OSSs and help the local awareness campaigns, four digital OSSs will be established, in addition to the Hub, with the following URLs:

Bulgaria: www.reverter-brezovo.bg

Greece: www.energeiakistegi.gr

Latvia: www.renove.lv

Portugal: www.renovar.coimbra.pt

The main goals of the digital OSS are to:

- Transfer knowledge and experience to vulnerable (and other) households to build community capacity and raise the awareness among the community members
- Inform the target audience in the specific region about various local support mechanisms
- Promote trust with respect to Ambassadors (a list of the RAs in the respective region will be provided)
- Inform about planned events or any other relevant activities organised by the project or other organisations
- Educate about issues related to energy (articles, video interviews, tips, advices, etc.)
- Provide the ability to interested consumers to book a visit at the OSS.

In this direction, the digital OSSs will include educational information about the issues related to energy, tips and advice, infographics, videos containing interviews with experts, support mechanisms and other relevant information. Moreover, there will be sections providing information about the local RAs as well as how to become RA for those interested.

All digital OSS will have a common style - look and feel, but each digital OSS will be in the local language and optimised to specific needs (based on research in each pilot). Therefore, the design of the digital OSS will take into consideration the following aspects:

- Keyword analysis and findability on Google (SEO optimisation)
- Partners' inputs about the needs, goals and frustrations of specific target audiences
- User experience (good practises)
- Content strategy (good practises)
- Sustainability and possibility to replicate in other regions as a part of the exploitation strategy.
- User experience and knowledge gained from OSSs to be transmitted to other projects, organisations, municipalities etc. who would like to create digital OSSs and/or create synergies between digital OSSs and physical OSSs.

The digital OSS will be easily manageable by the designated persons in each region and will be user and *Google* friendly. Google Analytics, as well as other tools, such as heatmaps will ensure the tracking of the behaviour of the users, ensuring valuable information to all partners on what audiences are interested in, etc.

The GDPR aspect will be covered as well as the Privacy Policy in each of the OSSs and Hub.

3.2.11 Impact monitoring

Monitoring and evaluation of impacts is a critical component of REVERTER project. The monitoring and evaluation process has three main purposes, i.e. to strengthen accountability for REVERTER's work; to stimulate learning and improved performance across the partnership; and to facilitate organisational decision-making by the Steering Committee. Impacts monitoring provides tracking of the KPIs that measure progress at each level of the project. The KPIs are based on the prescribed impacts requested by the Call (e.g. number of buildings renovated, number of roadmaps created, investments in sustainable energy

triggered by the project, etc.), additional impacts not requested by the Call, and the horizontal and specific LIFE KPIs (e.g. primary and final energy savings, reductions in GHG emissions, etc.) (Table 1).

Table 1. Impacts that must be monitored in the four pilots

Impacts requested by the Call	**Brezovo pilot**	**Athens pilot**	**Riga pilot**	**Coimbra pilot**
Number of buildings renovated - during the implementation and up to 5 years after its end	During the project: 10 SFH and 30 RES installations (90 kWp); Motivated by the project (enrolled through the OSS): 74	During the project: 0; Motivated by the project (enrolled through the OSS): 270 SFH and apartments	During the project: 3 multi-apartment buildings in framework of national support program; Motivated by the project (enrolled through the OSS): 10 multi-apartment buildings	During the project: 0; Motivated by the project (enrolled through the OSS): 40 SFH or apartments
Demonstration of the effectiveness and replicability of the proposed solutions among energy-poor households – during the implementation	280	15,000	5,400	1,450
Number of roadmaps created – during the implementation	3	3	1	2
Number of energy-poor consumers impacted – during the implementation	2,100	2,100	900	900
Multiple benefits, such as improved mental and physical health, etc. – during the implementation	220	820	1870	165
Primary energy savings/renewable energy generation triggered by the project (in GWh/year - during the implementation and up to 5 years after its end)	5.48	3.54	2.40	0.93
Investments in sustainable energy triggered by the project (cumulative, in million Euro - during the implementation and up to 5 years after its end)	1.33	2.75	3.27	0.82
Indicators for measuring energy poverty – during the implementation	10	10	10	10
Additional impacts not requested by the Call	**Brezovo pilot**	**Athens pilot**	**Riga pilot**	**Coimbra pilot**
Number of people helped to improve their quality of life by the project – during the implementation	1,050	1,050	450	450
Number of people helped to adapt their energy use behaviour – during the implementation	840	840	360	360

Number of households enrolled to retrofit subsidy schemes – during the implementation	74	270	620	40
Number of legislation, policies or strategies created/adapted at any governance levels due to the project - during the implementation and up to 5 years after its end	4	5	3	3
Specific KPIs (Part C) requested by theLIFE programme	**Brezovo pilot**	**Athens pilot**	**Riga pilot**	**Coimbra pilot**
Primary Energy Savings - Please enter the Primary Energy Savings in GWh/year triggered by the project				
Project-End Value:	0.91	0.46	0.32	0.16
5 years beyond Project-End Value:	5.48	3.54	2.40	0.93
Final Energy Savings - Please enter the Primary Energy Savings in GWh/year triggered by the project				
Project-End Value:	0.43	0.29	0.25	0.10
5 years beyond Project-End Value:	2.61	2.21	1.85	0.58
Renewable Energy generation - Please enter the Renewable Energy generation in GWh/year triggered by the project				
Project-End Value:	0.32	0.00	0.00	0.00
5 years beyond Project-End Value:	1.58	0.00	0.00	3.62
GHG emissions - Please enter the reduction of greenhouse gas emissions in tons of CO2 equivalent per year (tCO2eq/year) triggered by the project				
Project-End Value:	390	93	46	21
5 years beyond Project-End Value:	2355	708	348	124
Investments in sustainable energy - Please enter the amount of cumulative investments in sustainable energy triggered by the project				
Project-End Value:	0.24	0	0.75	0
5 years beyond Project-End Value:	1.33	2.75	3.27	0.82

These KPI will be integrated into the continuous reporting system and in the LIFE KPI web tool. The reporting will take place in M9 (for the LIFE KPIs) and in M36 for all indicators of REVERTER and will include for each indicator baseline values and targets/milestones. The baseline values will be estimated by the activities of the social questionnaire surveys (Section 3.2.3), the home visits (Section 3.2.7) and the OSS visits (Section 3.2.9), while the targets/milestones have already been set in the GA and are presented in Table 1. To calculate the expected impacts, a common methodology will be implemented for all four pilots that will capture details about measurement and sources of data and procedures about their data-

collection chains, so as to ensure that all data is auditable and replicable. The methodology is based on the calculations performed for the estimation of the impacts during the preparation of the REVERTER proposal and the GA, as follows:

- Number of buildings renovated: It is estimated by the total number of visits to the OSS * %enrolment to subsidised retrofit programs. The number of visits is equal to the number of vulnerable HH approached through media campaigns (number of energy vulnerable HH * %HH approached through media campaigns) * %visits to the OSS through media campaigns + number of HH approached via home visits * %visits to the OSS through visits + number of HH approached via social engagement events * %visits to the OSS through social engagement events. The number of energy vulnerable HH is estimated by the number of households in the area of interest * percentage of energy vulnerable households.
- Demonstration of the effectiveness and replicability of the proposed solutions among energy-poor households: it is equal to the maximum number of vulnerable HH approached via home visits, social events and media campaigns to avoid double-counting.
- Number of roadmaps created: as defined per pilot.
- Number of energy-poor consumers impacted: it is calculated as (number of HH approached via home visits + number of HH approached via social engagement events) * average members per HH. The HH approached via media campaigns have not been considered for purposes of conservative assessment.
- Multiple benefits, such as improved mental and physical health, etc.: it refers to the number of HH enjoying multiple benefits and is equal to the number of people residing in renovated buildings.
- Primary energy savings/renewable energy generation triggered by the project (in GWh/year): it is calculated by the number of households enrolled to retrofit schemes * the average disaggregated final energy consumption per HH (Eurostat data) * %reduction of final energy consumption of the low-income households as estimated by HBS * %energy savings for deep renovation * conversion factor for estimation primary energy savings from final ones (it depends on the energy mix of each country).
- Investments in sustainable energy triggered by the project (cumulative, in million Euro): number of buildings, apartments, etc. renovated * average cost of renovation + RES installed * average cost per MW installed.
- Indicators for measuring EP: 10 indicators, e.g., ‘10% rule’, 2M, M/2, ‘Arrears in bills’, ‘Leaky roof, damp walls, floors, foundations or rotten windows’, ‘Inability to keep the house sufficiently warm’, and two indicators suggested by the Greek ‘Action Plan to combat energy poverty’, plus two new composite indicators developed by the project.
- Number of people helped to improve their quality of life by the project: it is equal to the ‘Number of energy-poor consumers impacted’ * %HH helped by the project to improve their quality of life.

- Number of people helped to adapt their energy use behaviour: it is equal to the 'Number of energy-poor consumers impacted' * %HH adapting their energy behaviour.
- Number of households enrolled to retrofit subsidy schemes: it is estimated by the 'Number of buildings renovated' taking into account the households residing in these buildings (SFH, MFH).

To estimate the targets of REVERTER, the above-mentioned calculations were based on a number of assumptions (see Annex I:). More specifically, they included:

- data retrieved by the Eurostat and National Statistical Authorities (regarding the average energy consumption per HH, the average of HH members, the 'objective' and 'subjective' EP indicators, the energy mix, etc.)
- results of the STEP-IN project based on the experience of NTUA (especially those observed in the Greek Living Lab) about the percentages of HH approached via media campaigns, helped to improve their quality of life and helped to adapt their energy behaviour.
- estimates by FEP based on their experience from the DOMUS programs as regards the percentages of visits to the OSS through media campaigns, visits the OSS through home visits, visits to the OSS through social engagement events and enrolment to subsidised retrofit programs
- literature resources about the percentages of energy savings and deep renovation, such as:

– European Commission (2019). Comprehensive study of building energy renovation activities and the uptake of nearly zero-energy buildings in the EU. https://ec.europa.eu/energy/sites/ener/files/documents/1.final_report.pdf

– Österbring, M., Camarasa, C., Nägeli, C., Thuvander, L., & Wallbaum, H. (2019). Prioritizing deep renovation for housing portfolios. Energy and Buildings, 202. https://doi.org/10.1016/j.enbuild.2019.109361

– IDEA (2009). Changing Energy Behaviour Guidelines for Behavioural Change Programmes. http://www.cres.gr/behave/pdf/Guidelines_Changing_Energy_Behaviour.pdf

In all cases, more conservative indicators were adopted given that REVERTER deals with vulnerable households. At the implementation phase of the project, all these assumptions must be replaced by real data collected by the REVERTER pilots. For instance, all pilots should collect and keep data about:

- number of households in the area of interest
- number of HH approached via home visits
- number of vulnerable HH approached through media campaigns
- total number of visits to the OSS
- number of households decided to enrol to subsidised retrofit programs

- number of households/people residing in renovated (or potentially renovated) buildings triggered by the project
- number of energy-vulnerable consumers helped by the project to improve their quality of life
- number of buildings, apartments, etc. renovated and the average cost of renovation or RES installed and average cost per MW installed, etc.

In addition to the above-mentioned impacts, communication activities will be monitored, as well by the support of WIT. Specifically, WIT will collect the results of these activities to ensure that they are consistent, analyse them and provide a report with the activities that are more efficient.

The findings from the impact monitoring will be evaluated and used to provide objective findings and recommendations about the progress of the project (e.g. it will probe the strengths and weaknesses of its operational model, and provide detailed information about the effectiveness of its activities). The evaluation process will explore why, how and how well REVERTER outputs and activities contribute to its objectives and the achievement of results and will be undertaken periodically (every 6 months) during the implementation phase of REVERTER (especially between M12-M36). A final (overall) evaluation will be conducted at the end of the project, as described in Task 4.5.

3.3 Ethical and Data Protection Considerations

3.3.1 Need for ethical considerations

REVERTER is funded under the Call LIFE-2021-CET and, specifically, under the topic LIFE-2021-CET-ENERPOV. The project by its nature will collaborate with vulnerable households and, at some point and to a certain extent, will collect personal and (minimum) sensitive data with the aim to influence policy makers and to encourage the development of new more efficient and effective policies to fight EP through deep renovation. For this reason, and even though a description of the ethical approach was not applicable for the Call, REVERTER devoted a specific task in project management (i.e. Task 1.5) to the ethics review and compliance processes, in line with EU and national legislations.

Drawing lessons from the experience of previous research projects, and more specifically the STEP-IN[1] project that established Living Labs (LLs) with energy poor citizens and the TRUST[2] project that examined ethical issues related to working with low-income groups, the following key ethical issues are taken into consideration (for details see (McCall et al., 2019):

- Fairness: Local relevance should be considered, feedback mechanisms must be established and sharing of benefits should be ensured.
- Respect: Local cultural sensitivities should be understood and respected, and consent should be obtained from the community.

[1] https://www.step-in-project.eu/
[2] http://trust-project.eu/

- Care: Stigmatisation should be avoided and tailor procedures (including consent) should fit to local needs.
- Honesty: The highest ethical standards should be adopted, even if local norms are at a lower level, ensure that he role of all those involved is made clear. Educational levels should not be a barrier to providing clear explanations and no corruption or bribery should take place. Finally, conflicts of interest should be avoided.
- Balance of benefits and risks: The field activities (e.g. home visits, operation of OSSs, social engagement events, etc.) must primarily benefit the citizens involved. All activities must avoid issues such as erosion of privacy or stigmatisation or any other negative side effects. Stigmatisation can apply in a number of ways, e.g. use of certain language in documentation through the recruitment processes or accidentally stigmatising an individual or group of people through the publication of information. Partners and stakeholders involved in field activities must pay particular attention to this topic.
- Consent and voluntary participation: All citizens taking part in REVERTER's activities must be able to understand and voluntary participate, be competent enough to take that decision, and aware that can withdraw consent at any time.
- Fidelity, transparency and dignity: Those working in the project should be able to benefit from its results, for example the REVERTER Ambassadors. However, they should not benefit personally from taking part. All those working for REVERTER must behave in an open, transparent and honest way.
- Respect for rights and dignity: Care should be taken to avoid bias or other problems related to aspects such as race, gender or age.

3.3.2 REVERTER response to ethical considerations

A. Establishment of an Ethics Advisory Board

As a first step towards responding to ethical requirements related to REVERTER, an Ethics Advisory Board (EAB) will be established. The Ethics Advisory Board will consist of the Coordinator and one representative from each partner in the pilot areas. The EAB will be responsible for:

- Ensuring that partners adhere to the ethical clearance obtained
- Securing compliance to ethical norms and compliance with data protection standards
- Reviewing any documents or other materials which are used within the field activities (e.g. social surveys, home visits, etc.) or may have ethical impacts
- Suggesting actions to take if/when ethical issues arise
- Developing ethical materials (e.g. information sheets and consent forms)
- Investigating any ethical complaints
- Preparing and submitting for approval to the NTUA's Ethics Committee of Research a full ethics review at the start of the project

- Cooperating with the NTUA's Ethics Committee of Research when needed

Thε EAB will meet at regular intervals, or whenever needed.

B. Approval of research by the NTUA's Ethics Committee of Research

As mentioned, the EAB will prepare an ethics review at the start of the project. The review will then be submitted for a formal approval by the NTUA's Ethics Committee of Research filling in its application form. The review will take into account, inter alia, the assurance of informed consent among research participants, the incorporation of integrity and safety issues when dealing with vulnerable participants, as well as questions of confidentiality, data storage and retrieval. This process will be repeated during the project, if necessary to ensure compliance.

C. Basic principles to be followed in REVERTER's pilots

C1. Ethical procedures for all partners and involved stakeholders in the pilot areas

From the perspective of the citizens taking part in the field activities of REVERTER's pilots (surveys, home visits, etc.), it is important that the following aspects are followed:

1. They are provided with sufficient information in their native language that allows them to make an informed decision as to whether or not to take part.
2. They are informed of their rights and responsibility, including the right to withdraw participation and their data.
3. They are provided with a consent form, which they then sign along with the representative from the REVERTER pilot.

C2. Ethical and Data Protection Procedures

REVERTER's field activities will receive the approval of the NTUA's Ethics Committee of Research. However, it is recommended that each REVERTER pilot seeks full ethical authorisation from the competent authorities, which can range from national ethics boards to those based within partner organisations (e.g. universities or Municipalities). This may not be needed in all cases, but it is important to clarify at the outset if it is required. As part of this process, it is important to draw up a clear plan for each pilot that adheres to the ethical concepts outlined earlier.

Further, all partners involved in collection and processing of personal (even more sensitive) data should ensure compliance with the EU General Data Protection Regulation that has come into effect (Regulation 2016/679, 2016). A key aspect is that if there is a data breach, then significant fines can be imposed. Hence, it is advisable to seek legal advice regarding data protection issues as they must be complied with during the operation of REVERTER pilots. Particular attention needs to be paid to the repository where any private data may be stored (US-based cloud services are generally not suitable). The exchange of data between REVERTER partners needs to be taken into account and managed. Identifiable data can only

be shared between partners when consent has been obtained from the persons contributing the data. Therefore, it is usually preferable to avoid sharing any identifiable data. Where appropriate aggregated and/or pseudo-anonymised data can be shared. In general, data should be stored for the minimum amount of time that is reasonably required to undertake any work.

3.4 Stakeholder networking

Stakeholders are either part of the REVERTER consortium (e.g. BM, EKPIZO, REA, CMC) or external supporters of the project who have provided letters of support. REVERTER partners will create Regional Stakeholder Networks (RSNs) through a multi-stakeholder analysis to identify the main local target groups and stakeholders, such as: local, regional and national authorities; EU and national policy makers; companies and other organisations offering services for city planning, designing, etc.; SMEs and professionals working in energy retrofit, public business supporting agencies, etc.; and home-owners associations, tenants associations, social housing associations, consumer associations, NGOs, vulnerable citizens and citizen communities, tenants, landlords, etc.

The RSNs aim to:

- form the ground of knowledge representing the expertise, interests, motives, and strategies of all relevant actors in the region of the REVERTER pilot
- facilitate the market uptake of cost-effective renovation approaches and scale up state of the art technology developments to support innovation diffusion
- ensure a broader spectrum of transformations required for alleviating EP while improving the housing park through energy renovations
- lower the cost of renovation through the application of more sustainable and circular refurbishments.

The RSNs will operate throughout the project lifetime while holding regular meetings to share ideas, skills and experience in all processes of the project activities. To strengthen the role and the effectiveness of the RSNs, a dedicated communication and dissemination strategy will be created towards policy makers, stakeholders, other initiatives etc. Further, the first social event that will take place in the pilots will include a focus group with relevant local stakeholders and will be used primarily to assess the incentives to energy retrofitting for each particular subgroup within the target population and facilitate the design of the OSSs. Finally, as mentioned in Section 3.2.8, central - international webinars aimed at stakeholders will be organised.

3.5 Sustainability, replication, and exploitation of project results

Ensuring the sustainability, replication, and exploitation of the results is of utmost importance for the REVERTER project. The objective is to ensure that the results of the REVERTER will benefit more member states and areas suffering from EP, while fostering further cross-border, cross-sector developments on a lasting basis. More specifically:

Sustainability: REVERTER must develop long-lasting renovations roadmaps, analysing market barriers and solutions and providing effective strategies to encourage market uptake with the aim to alleviate EP in the four pilot regions. One of the main outcomes of the project will be the creation of OSS, which will continue to operate after project end by providing access to data, organising training programmes and supporting various awareness-raising activities or by aggregating local renovation opportunities, contributing further to municipalities' local heating and cooling planning, energy efficiency, RES plans and decarbonisation efforts.

Replication/upscaling: The aim of replication is to make it easier for other vulnerable households, districts, clusters of buildings, or groups of buildings managed through common building management or housing/home-owners associations to implement similar integrated building renovations successfully in other contexts. The aim of upscaling is to increase the number of vulnerable households using the results of REVERTER, i.e. the results are replicated on a larger scale and different social and institutional contexts. Implementation of the replication and exploitation strategy facilitates the horizontal upscaling of the findings to other/new topics and the cross-country upscaling of the findings to other identified member states through a free and open methodology, implementation services and a shared and open development platform. The replication/upscaling process is probably one of the most challenging parts of the exploitation and capitalisation exercise and will require making strategic choices as to how it will be replicated in new areas or new countries, how it is to be organised, how resources will be used and how it will be monitored and evaluated.

Exploitation: The exploitation of the REVERTER 'Key Exploitable Results' (KERs) will bring value generated to both market (from a business perspective), and society (from an educational, scientific, political and societal perspective), identifying ways to maximise the impact of the project across key stakeholder groups. The expected KERs of the project are: Energy retrofit roadmaps; OSS set-up and deployment methodology and results; Training programme for RAs; Training programme for OSS staff; REVERTER Hub/Atlas/Knowledge database; EP hotspots assessment and measurement methodology; Deep renovation measures multiple criteria assessment methodology; Information and awareness material; Policy briefs and recommendations. REVERTER intends to realise all the potential exploitation pathways, as follows:

- Potential commercial exploitation: KERs will be provided as open access, so as REVERTER to remain a meaningful, scientifically proved and up-to-date source of data and assessment in the field of EP and energy retrofit. They can be commercialised, however, by business stakeholders through further development, customisation and promotion of higher-quality technological solutions.
- Potential Political Exploitation: Project reports, briefs and recommendations on EP assessment and measurement, energy retrofit of residential buildings, etc., can be used by policy stakeholders.
- Potential Scientific and Educational Exploitation: The project's outputs will have a significant impact on raising the European knowledge base. The results from communication activities can be also exploited in further similar projects to facilitate effective communication campaigns, recommendations for digital OSS usability and others,

- Potential societal exploitation: REVERTER aims, above all, to improve the quality of life of vulnerable households by lowering their energy costs, increasing their thermal comfort, improving their health, supporting social inclusion, etc. The experience to be gained will bring valuable insights about the EP contextualisation, the energy paradox, etc.

The first step to this direction will be the creation of a Sustainability, Exploitation and Replication Task Force (SERTF), as a counselling body, which will consist of members of the REVERTER project and of local, regional and EU stakeholders. The SERTF will examine different exploitation possibilities and business options for the project results, integrating measures for maximising impacts and its members will meet every 4-5 months to fine-tune the exploitation activities. The SERTF, collaborating with the different Pilot sites, will build the Exploitation Table (ET) to facilitate exploitation for each pilot.

Further, REVERTER will devote three deliverables in these activities:

- The Exploitation Plan, including recommendation for communication) will be based on a two-level approach: exploitation by the partners (focused on the exploitation of the project results by the partners) and exploitation through the external stakeholders (to ensure that the stakeholders outside the project will know and use the results).
- The Sustainability Plan, describing the different aspects in which the REVERTER results will survive in the long term, will address issues like community sustainability (e.g. how the community could continue with the OSSs once there is no more financial support from the LIFE programme, etc.), financial sustainability (i.e. the ability of REVERTER to survive financially by identifying the funding sources for the future so as the project can sustain its financial needs, that is external or internal sources), and organisational sustainability (in terms of the ability of the OSSs to survive which can be achieved through external sources like grants). The Sustainability Plan will focus on critical factors, like: establishing a coherent mission/theory of change for the organisation, searching for multiple sources of funding, achieving organisational stability, integrating the plan into existing systems and political support, ensuring community support, etc.
- The Transfer Roadmap and Policy Recommendations to alleviate EP. REVERTER will develop (i) an evidence-based 'Transfer roadmap' synthesising findings, offering clear steps for policy-makers, and (ii) concrete policy recommendations to cut EP by making the best use of OSSs and deep renovation schemes.

4 REVERTER Pilot implementation plan

The following sections summarise the main characteristics of and the activities in the four REVERTER pilots.

4.1 Pilot 1 - Brezovo (Bulgaria)

The Pilot area at a glance: Energy efficiency and RES are essential components for the Municipality of Brezovo. The Municipality has elaborated its Energy Efficiency and RES plans, where it has set an ambitious goal to achieve a complete renovation of at least 30% of the used dwellings by 2025. To do so, it has to influence the renovation of approx. 810 dwellings. Thus, the Brezovo pilot will be focused on developing a roadmap dedicated to addressing single and multifamily buildings with poor energy efficiency. Emphasis is in the private housing and on refurbishment approaches and new community-based RES, as tools for tackling EP. The Municipality has a total area of 465.41 km². The population is 7,000 inhabitants, occupying 2,900 dwellings. Most dwellings are private single houses with low levels of efficiency (>95%). In 2019, the final energy consumption of the Municipality was estimated at 44.85 GWh. The housing sector is responsible for 26.64 GWh of the total energy consumption, taking the largest share or 59.4%. The use of raw wood for domestic heating is dominant (47%), followed by electricity (39%) and coal (12%). This is a prerequisite for high PM pollution during the heating season. The housing sector is responsible for 10,247 tons of greenhouse emissions. The technical potential of the possible recovery of the waste streams from the agricultural sector and animal waste is calculated for the production of 5,900 MWth. The Municipality is also rich in forestry. Residual biomass from logging is equal to 7,460 tons of wood, whose energy equivalent is equal to 38,250 MWh of heat.

Main target group(s): The particular focus is on the most vulnerable households, those living in single or multi-family homes with no insulation and no energy efficiency measures implemented, also those relying on low-quality heating fuels. Special attention is also paid to households receiving social heating aid or similar.

The Pilot process: Green Synergy Cluster is the leader and technical partner in the process. It will work in close collaboration with the Municipality of Brezovo to train staff and set up a local OSS. The Municipality will perform a communication campaign on engaging and empowering households, seeking improved efficiency. Minimum 15 RAs will be recruited to go through community capacity building activities in responding to EP challenges. Four workshops will be conducted with minimum 25 participants each. During targeted sessions, the RAs will perform minimum 500 home visits and further raise the literacy of vulnerable consumers from their respectful community. The energy enhancement path of the buildings will initially be based on the architectural retrofitting design that best integrates the innovations available in the regional stakeholder group. These networks will consist of construction and energy-related companies, ESCOs, clusters active in building services, entities from the financial sector, and design engineers. The final objective is to develop three roadmaps for: (i) social public buildings; (ii) owner-occupied dwellings in multi-family homes; and (iii) owner-occupied dwellings in single-family homes. The roadmaps aim to help the

communities find strategies at the local level with emphasis on refurbishment and RES, through forming energy cooperatives and utilising new financial models. They will be based on the full-spectrum analyses of the building stock per each Municipal district (housing age, envelope conditions, heating system, RES penetration, possible savings, impact, etc.). The largest share of private buildings will also allow the experimentation of energy communities, applying the model outlined in the EU directive 2018/001 (RED II), where users coordinate their efforts for the creation of intelligent and efficient energy supply systems. Community-based approaches for the establishment of a Municipal biogas plant to provide renewable heating for the vulnerable districts will be one of the elements of the roadmap, as well as PV generation on a community basis.

Benefits for target group(s): The Brezovo Pilot will drive heating system transformation based on a waste to energy approach, accelerating the transition to climate-neutral cities by 2030. It will emphasise sustainable and more cost and energy-efficient local materials and renewable energy generation. The Pilot activities will bring additional benefits for the target groups, namely: increased energy literacy, increased awareness on new forms of cooperation (energy communities, community purchases) and new financial models (ESCOs, PPAs) while raising awareness on how to make the right choices, regarding energy use and sustainability. Renovation measures, change of heating systems, solar thermal and PV system installation, public awareness campaigns on the benefits of energy-saving as well as information on available technologies will help to reduce the final energy consumption of homes (about 39% of energy consumption) and encourage the construction of PV installations for own consumption (about 39% of energy consumption).

Engagement with other stakeholders: The Brezovo Pilot will engage with other local authorities, e.g. Municipality of Rakovski, Energy Agency of Plovdiv and Sofia Energy Agency, EcoEnergy – Municipal Energy Efficiency Network, Caritas and Red Cross Bulgaria, Housing Associations, and NGOs working with vulnerable consumers. It will also engage with the Regional Stakeholder Network aiming for a co-creation process and identification of innovative paths towards new solutions.

Sustainability opportunities: One of the main outcomes of the project at the Municipal level is the creation of an OSS, which will continue to operate after the project end by providing access to data, organising training programmes and supporting various awareness-raising activities or by aggregating local renovation opportunities, contributing further to municipalities' local heating and cooling plans. The OSS will play an important role in alleviating EP in the future, by empowering tenants in single and multi-family buildings to make the case for a renovation or by helping the energy-poor get access to various funding opportunities. The interest of local stakeholders (clusters, energy and construction companies) will be also raised by their direct involvement in the co-design and creation process, thus new important links between companies, the public body and final consumers are created and continued. The digital version of the OSS will be set and adapted as the primary tool, ensuring the long-lasting sustainability of project results.

Replication and upscaling opportunities: One of the key exploitation routes will be the commercial use of the project knowledge and technology developments from the Regional Stakeholder Group for the creation of new refurbishment mechanisms. The OSS will also exploit all project findings and capitalise efforts from the roadmap, continuing the process of

engaging citizens in the energy transition. As the countries' levels of EP are high and there is a high demand to protect them, there will be a great interest of other municipalities in developing effective strategies for renovation. Thus, project outcomes and lessons learnt will be pivotal. Interested municipalities in developing the OSS concept will be engaged in the process and trained on how to identify vulnerable groups, how to communicate with them and how to raise their awareness and build their skill for improved behaviour and for available retrofit options. This will stimulate uptake of the practical recommendations resulting from the project as widely as possible. Success is ensured by a robust post-project exploitation strategy, by direct changes in policy and enabling new retrofit mechanisms, adjusted to the specific political and economic surroundings. The impact on the EU level includes bringing specific inputs to EU policies from countries with high levels of EP. To facilitate and complement the commercial exploitation of the results, the project will also make selected non-confidential public knowledge generated in the project available to all the stakeholders from the different sectors.

4.2 Pilot 2 - Athens Urban area (Greece)

The Pilot area at a glance: The Athens Urban area (Greater Athens and Piraeus), where the pilot implementation activities will take place, has a population of more than 3,000,000 (about 1,000,000 households) over an area of 412 km^2. Based on the Hellenic Statistical Authority (ELSTAT), in 2019, 9.7% of the Pilot Area households were energy-poor according to the '10% rule' and 4.2% and 21.5% according to the 2M and the M/2 indexes, respectively. Moreover, based on the subjective indicators of the EU SILC survey, 21.9% reported "Leaky roof, damp walls, floors, foundations or rotten windows", 21.6% reported "Inability to keep the house sufficiently warm" and 24.6% declared "Arrears in bills". The pilot area includes more than 1.6 million residences (app. 390,500 buildings), almost 80% of which are multi-story residential buildings and 62% have been built before thermal requirements and energy-related building codes (before 1980). Programs dedicated to building renovations are scarce and actions to tackle EP have not been initiated extensively mainly due to the limited public funds and other priorities. Moreover, a large share of inhabitants is elderly who cannot afford to carry out energy-efficient improvements and construction works or do not have the knowledge on how to start the renovation journey. Therefore, a holistic approach is required to promote energy efficiency maximising the delivered impacts and effectively combating the EP on a long-term basis.

Main target group(s): The Athens Pilot will focus on energy-poor households within the Athens Urban area (Greater Athens and Piraeus) according to the provisions of the "Action Plan for the Alleviation of Energy Poverty", which was adopted in September 2021 through a Ministerial Decision. The targeted population of the energy-poor households is estimated at 648,000 considering the reported indicator "Inability to keep the house sufficiently warm" and the total population of the targeted area.

The Pilot process: The Athens Pilot will focus on the development of three different roadmaps, namely for (i) tenants, (ii) owner-occupied dwellings in multi-family homes and (iii) owner-occupied dwellings in single-family homes. EKPIZO is appointed as the leader of the Pilot implementation in close collaboration with CRES and NTUA. EKPIZO will establish

contacts with its members to provide a well-balanced mixture of services through the established OSS. Moreover, a campaign will be carried out in cooperation with municipalities of the Athens Urban area, which have provided LoS for informing their citizens about the possibility to receive the provided services by the OSS. The objective is to implement, test, and evaluate the developed roadmaps so as to facilitate the participation of the energy-poor households into the implemented policies and measures. Further, pilot activities will help to understand all the dimensions of EP, to foster the most effective utilisation of the existing resources, to enhance their skills towards improving their comfort in buildings with the lowest cost and to realise the multi-benefits triggered by the promotion of energy efficiency interventions. These objectives will be achieved through (a) provision of information about the EP phenomenon; (b) establishment and operation of an OSS at the premises of EKPIZO focusing on energy-poor households; (c) provision of technical and legal support for the implementation of the most cost-effective energy efficiency interventions and the potential deployment of RES, (d) provision of information about the available financial instruments including instructions for the participation of the energy-poor households into them, (e) training of 10 persons for the operation of the OSS; (e) recruitment and training of minimum 30 RAs (e.g. frontline staff of energy suppliers, social workers, people from organisations assisting vulnerable households personnel of municipalities, etc.); (f) organisation of 600 visits by the RAs and the members of the OSS to energy-poor households for promoting the OSS, providing targeted advice on energy behaviour and facilitating the promotion of energy efficiency and the further penetration of RES; (g) organisation of 4 capacity building events with minimum 25 participants each (e.g., energy cafés, hands-on workshops, etc.) and awareness-raising activities (through interviews to local newspapers, radio stations, websites, etc.) to boost proper energy usage behaviours, promote energy literacy, and help individuals to make informed sustainable energy decisions.

Benefits for target group(s): The Athens Pilot will contribute to the alleviation of EP leading also to the achievement of the energy and environmental targets at the national level due to the promotion of energy efficiency and potential RES. Moreover, the energy-poor households will manage to improve the indoor environment and to increase the thermal comfort avoiding mental and physical health problems, to manage more effectively their budget and to increase it due to the cost savings, to enhance their existing level of knowledge about EP, to confront effectively the resurgences of COVID-19 and other pandemics minimising the public health expenditures and to receive sustainable energy decisions based on the rationale use of energy.

Engagement with other stakeholders: In the Athens Pilot, various local and regional authorities will be engaged (such as KEDE and the municipalities that collaborate with EKPIZO) along with other associations (such as POMIDA), as well as NGOs acting as facilitators for the provision of targeted services to energy-poor through the OSS. The obligated parties within the framework of the EEOs will also be involved in the OSS facilitating the implementation of energy efficiency projects in energy-poor households and the achievement of their mandatory target. Finally, renovation companies and energy communities (such as ELECTRA energy community) of the region, will be invited to join a working group to identify and co-design the path forward through a co-creation process towards the best solutions and develop dedicated renovation roadmaps based on impartial advice.

Sustainability opportunities: The potential continuation of the OSS by the involved organisations will be assessed through the preparation of the Sustainability Plan. Generally, the continuation of the OSS can be undertaken by the involved organisations. Specifically, EKPIZO currently provides similar services to its members such as the provision of information and legal advice. Moreover, CRES supports initiatives for the promotion of energy efficiency and RES as the technical advisor of the Ministry of Environment and Energy according to the respective legislation, while NTUA has as a mission the promotion of educational activities as one of the most famous universities in Greece. In any case, the successful operation of the OSS for the alleviation of EP will lead the responsible authority (Ministry of Environment and Energy) to integrate it into the National Action Plan for the Alleviation of Energy Poverty mobilising the foreseen measures within it. Moreover, the OSS can be utilised probably as a supporting instrument in the measure for the energy upgrade of the energy-poor households' building including the installation of RES systems facilitating the participation and financing of the energy-poor households without neglecting its contribution to the planned awareness-raising and information activities that will be occurred.

Replication and upscaling opportunities: An ambitious target for the alleviation of EP has been specified in Greece within the framework of the NECP. Specifically, the EP level should be reduced by 50% in 2025 and by 75% in 2030 compared to 2016. Consequently, the alleviation of EP constitutes a priority at the national level taking into consideration the national conditions, such as the high level of inequalities, the inefficient building stock, and the high energy prices. The incorporation of the OSS as an effective instrument to combat EP into the 'National Action Plan for tackling Energy Poverty' will facilitate the achievement of these ambitious targets. Moreover, the implementation of the measures within the development dimension will be fostered leading to a significant increase in the renovation rate. Finally, the most useful outcomes of the OSS will be utilised for the design and implementation of more effective policies and measures contributing to the fulfilment of the ambitious targets for the alleviation of EP in Greece.

4.3 Pilot 3 – Riga (Latvia)

The pilot area at a glance: Riga is one of the key economic and financial centres of the Baltic States. In Riga city, almost 85% of inhabitants live in multi-apartment buildings out of which 94% own their apartment. Around 6,000 multi-apartment buildings, which cover almost 75% of the total floorspace, were built during the post-war period with poor insulation. Households use 36% of the energy in Riga, being the biggest energy consumer in the city. Most buildings in Latvia are energy inefficient and need to be renovated. According to the information provided by Riga Energy Agency (REA), the average specific heat consumption in the period from 2017-2020 for apartment buildings connected to the DH was 147 kWh/m^2. Riga itself as a municipality is responsible for roughly 10,000 municipal buildings and provides housing management services to a great majority of Riga residential buildings. Riga city municipality has established its own building management company, which ensures new housing development, construction, and management. At the moment, Riga city serves about 167,000 customers and manages more than 4,200 apartment buildings with a total managed area of over 8 million m^2. Most buildings need to be renovated/rebuilt. According to Latvian legislation and bank financing rules, to obtain credit for renovation of multi-

apartment buildings, at least 51% of owners should accept the collective decision regarding the renovations. As a significant part of multifamily buildings owners are low-income households and elderly people, it sets up a barrier to persuade them to renovate their estate. In addition, Riga has declared the goal to become the first climate-neutral city in the Baltic states. Currently, the Riga City Council is working on the new Riga sustainable energy and climate plan for 2030 with foreseen that 2000 multi-apartment buildings should be renovated and climate neutrality achieved in municipally-owned infrastructure by 2030. Thus, Riga's pilot will be focused on developing a roadmap dedicated to addressing vulnerable households living in multifamily buildings with poor energy efficiency.

Main target group(s): The particular focus is on vulnerable households living among other households, in poor condition multifamily buildings with no energy efficiency measures implemented, but willing to undergo the building's deep renovation.

The Pilot process: REA, which operates under the City of Riga municipality and is already actively working on promoting the renovation of buildings and educating homeowners in energy efficiency necessity, in 2022 will establish The Housing Competence Center (HCC). The aim of HCC is to build and implement a thoughtful and equal condition-based housing program in Riga. Together with Ekodoma Ltd. (EKO), as a technical partner, HCC will work and focus on ensuring the availability of housing to different population groups, as well as promote a deep renovation of housing stock and facilitate improvement of indoor comfort. During the project, a roadmap dedicated to owner-occupied dwellings in multi-family buildings will be prepared and an OSS will be developed as one of the departments working especially with vulnerable households, to deal with all the challenges related to decision-making within this group of households regarding building renovation issues. To raise citizens' awareness and motivation to renovate their homes, the municipality will facilitate application for grant schemes and support for energy efficiency measures implementation and will set up the OSS, providing all necessary information on renovation programs co-financed by the city and other actors. The OSS will reach its clients through different communication and marketing tools such as social media, leaflets or events. Targeted communication and marketing tools will be key to reaching out to the right groups at the right moment (e.g. young families, elderly people, low-income households, etc.) with the right message. This will include the following activities: (a) assessment of EP status using existing and tailor-made indicators; (b) analysis of the existing building stock; (c) establishment and operation of an OSS for vulnerable households; (d) training of 2 persons for the operation of the OSS; (e) recruitment and training of 10 local people as RAs; (f) organisation of 200 visits by the RAs to social houses to promote the OSS, provide advice on energy behaviour and install low-cost measures in certain circumstances to provide immediate relief; (g) participation in general meetings of homeowners, answering questions and sharing the positive experience of already renovated buildings; (h) organisation of 4 capacity building events on-site (with minimum 25 participants) and media campaigns (through interviews to local newspapers, radio stations, etc.) to help individuals and communities to make informed sustainable energy decisions. REA already has a wide range of campaigns, webinars, events, such as the webinar "How to renovate apartment buildings in Riga?", Climate festival about Riga's climate and goals, information campaigns such as "Energy efficiency in apartment buildings-improve living conditions, energy and cost savings". These activities will be combined with Riga's city pilot activities, strengthening the impact of the project.

Benefits for target group(s): The OSS will recommend implementing certain energy efficiency measures and will provide recommendations on quality standards and pricing for construction works. Besides benefits such as improved welfare and indoor comfort an lower utility bills for homeowners, OSS can address several market gaps, including offering a smooth renovation journey for the homeowners, forming a trustworthy process for the homeowners to find reliable and accredited experts, reliable renovation advice and result guarantees, and address coordination gaps in the construction value chain. In addition, the OSS can contribute to making deep renovations more attractive for the homeowners by packaging technical and financial solutions and by demonstrating the long-term value of deep renovations. According to 2021 data, there are at least 3,000 persons in Riga municipality, asking for financial support regarding housing issues. Pensioners and low-income households are particularly in need of co-finance, grant schemes for energy efficiency implementation. The OSS will advise flat owners on the project financing, using their resources, available subsidies and other financing means. It will also assist in the preparation of the application to the municipal subsidy scheme. In the best-case scenario (deep renovation), the homeowner can reach up to 50% energy savings, thereby decreasing his overall utility bill by 40%.

Engagement with other stakeholders: The Riga Pilot will engage with various departments responsible for managing the housing stock in Riga municipality, Housing Associations, NGOs working with vulnerable consumers, ESCOs, as well as the "Live Warmer" information campaign, implemented by the Ministry of Economics. In addition, renovation companies of the region will be invited to join a working group to identify and co-design the path forward through a co-creation process towards the best solutions and develop dedicated renovation roadmaps based on impartial advice.

Sustainability opportunities: The established OSS will continue to operate after the lifetime of the project as an integral part of the Riga City Competence Centre for building renovation and energy efficiency (a more holistic OSS supporting municipal housing policy). The competence centre for building renovation and energy efficiency is already being developed with an allocated budget for 2022 to support 3 Riga Energy Agency staff members working with energy issues and communication with residents. However, currently, there is very little knowledge and expertise in EP as well as associated social issues among key staff members. Through the REVERTER project, the staff members will acquire additional knowledge, experience, expertise for the Competence Centre to be able to work with EP issues linked and intertwined with building renovation and energy efficiency. To this end, the continuation of established OSS can be considered as organic next steps for Riga Energy Agency to perform its main organisational functions and carry out the goals set in the cities SECAP 2030.

Replication and upscaling opportunities: There is a significant replication potential of the project results during and after the lifetime of the project since the situation with energy efficiency measures implemented in other Latvian municipalities is very similar to Riga's case. Smaller municipalities are willing to replicate the experience of the capital city. Example of Riga could be used by other cities in Latvia with high energy efficiency potential in residential sector (Daugavpils, Rezekne, etc.) and neighbouring countries.

4.4 Pilot 4 – Coimbra (Portugal)

The Pilot area at a glance: The Coimbra Municipality has around 141,000 inhabitants (2021), located in the Centre Portugal Region. Its population is considerably aged, with an ageing index of 203.9 against the Portuguese average of 157.4 and the EU27 average of 132.3. Although with limitations regarding indicators and hard data, it is well known that the region has an at-risk-of-poverty rate of 17.3%. At-risk or EP vulnerable households have been signalled by the Municipality services working in the field. However, due to the shortage of public budgets and other priorities (e.g., investing in public infrastructures, services, security, etc., which are more visible for citizens), programs dedicated to building renovations are scarce and actions to tackle EP have been limited. The Coimbra Pilot will be focused on the most vulnerable households of the Municipality of Coimbra, who live in social houses under the management of the Municipality. The Coimbra Municipal Housing Park - MHP (social housing) consists of a total of 854 dwellings, with different typologies, integrating building apartments and houses dispersed over the city. The buildings have been built before the first building code entered in force in 1990, and therefore those buildings do not have any thermal insulation. Part of the MHP in the city centre has recently undergone some retrofits, but the actions taken were mainly on painting the façades. Hence, the existing potential for energy renovations is high. Moreover, a large share of inhabitants is elderly and low educated, who cannot afford to carry out improvements and construction works or do not have the knowledge on how to start the renovation journey, and therefore a holistic approach is required to have a high impact. Sound impartial advice on what is best for improving the overall environment and actions geared towards behavioural changes and capacity building can lead to significant improvements in households' well-being.

Main target group(s): The Coimbra Pilot is focused on the most vulnerable households of the Municipality of Coimbra and includes a population of about 150 citizens, who live in social houses under the management of the Municipality, in the poorest neighbourhood of the city. They are inhabitants facing the higher risk of poverty, mainly single parents, especially woman, unemployed and families with more than 3 children.

The Pilot process: The Coimbra Pilot will focus on developing two roadmaps (for buildings and houses) targeted to consumers who are particularly vulnerable concerning thermal comfort levels in their homes. Solutions will not focus only on the building envelope and energy-efficient appliances but also on the urgent need to switch fossil fuel-based heating and cooking systems using gas to electricity by promoting solar thermal and photovoltaics, as well as its integration in Renewable Energy Communities (RECs). ISR is the leader of the Pilot implementation in close collaboration with the Municipality of Coimbra (MCM), in particular, the Social Housing Department which will act as a capacity building facilitator. The MCM will establish contacts with the households, will collaborate in the engagement strategy, empowerment, and commitment of the target group seeking healthier contexts. The objective is to implement, test, and evaluate the roadmap(s) that will be developed to help the communities to find strategies at the local level, customised for the region and the specified target groups. This will include the following activities: (a) assessment of EP status by means of existing and tailor-made indicators and collected data; (b) analysis of the pilot building stock; (c) establishment and operation of an OSS for vulnerable households; (d) training of 6 persons for the operation of the OSS; (e) recruitment and training of 10

volunteers, from the students' community, from organisations assisting vulnerable households, personnel of municipalities, etc., acting as RAs; (f) organisation of 200 home visits by the RAs to social houses to promote the OSS, provide advice on energy behaviour and install low-cost measures in certain circumstances to provide immediate relief in 4 houses; (g) organisation of 10 capacity building events on-site (e.g., energy cafés, DIY renovations workshops, etc.) to boost proper energy usage behaviours, promote energy literacy, and help individuals and communities to make informed sustainable energy decisions.

Benefits for target group(s): Besides contributing to decarbonisation of the city and the renovation of social housing park, the Pilot brings additional benefits for the target group, namely: a better environment to live in and better life experience; improved thermal comfort and, to some extent, indoor air quality and health; better management of their budgets; increase energy literacy but also digital literacy by helping them with existing tools/simulators and platforms; improved preparedness to resurgences of Coronavirus and other pandemics; increased awareness and willingness to make good choices, regarding energy use and sustainability, etc. Another important benefit regards the consciousness of the right to live with a certain minimum condition, which will give the citizens the strength to ask for advice and information without feelings of shame or embarrassment, towards a just transition.

Sustainability opportunities: The participation of the Municipality of Coimbra in the project, in collaboration with ISR which is a non-profit organisation belonging to a public University, ensures the capacity operation of the OSS during and after the project ends, as there is no such service being provided in the centre region. The capacity building training organised for the RAs will empower these volunteers on energy and indoor air quality performance evaluation. A certification will be provided to prove their achievements. The involvement of Cleanwatts and RdA with LoS, as well as local authorities indicating the interest to actively participate in the project activities, is an additional guarantee of the replication of the pilot results in other regions and geographies of the country ensuring the continuity of the project activities beyond project duration. The Pilot results will be disseminated by ISR-UC over the country, based on existing partnerships with other projects and entities. Moreover, ISR team has a strong connection with the National Directorate General of Energy (policy-maker) and also with the professional guilds (Ordem dos Arquitetos, Ordem dos Engenheiros, Ordem dos Engenheiros Técnicos) providing scientific and technical support and advice, and has privileged access to the technicians of the entire country through Centro de Estudos e Formação Autárquica (CEFA), a public institution that is dedicated to training technicians all over Portugal, ensuring the project will impact future actions at National level

Engagement with other stakeholders: The Coimbra Pilot will engage with local and regional authorities, such as the Central Regional Energy Agency (AREAC); Neighbourhood and Housing Associations; NGOs working with vulnerable consumers (Rotary Coimbra); solidarity associations, such as the Santa Casa da Misericórdia and the Cáritas Diocesanas (these organisations have a decades-long track record of working with socially disadvantaged people, in particular the elderly, and could also work as facilitators identifying beneficiaries in need and establishing communication channels); energy service companies and energy suppliers/energy cooperatives, who are doing interesting projects with vulnerable districts in Portugal (RdA, Cleanwatts). In addition, renovation companies of the region will be invited to

join RSN and/or the SERTF groups to identify and co-design the path forward through a co-creation process towards the best solutions and develop the dedicated renovation roadmaps based on impartial advice. Last, but not least, being a country with a high number of sun hours, and grounded in the RECs legal framework available, these groups will also leverage the existing concept of smart neighbourhoods based on the engagement of vulnerable citizens to create energy communities that will have an impact on energy tariffs, reducing the energy bill, aggregating buildings to be equipped with local PV generation financed by third parties (e.g., Energy Cooperatives, retailers, aggregators, ESCOs, etc.).

Replication and upscaling opportunities: Due to the Portuguese situation (high levels of inequalities, weak welfare system, poor performance of the building stock, high energy prices, lack of access to modern/energy-efficient services/equipment) EP vulnerability during winter and summer is high. Therefore, actions to tackle weatherization of houses are a priority. Besides capacity building actions, and after having the baseline situation duly characterised, the design of an Action Plan will look at the overall social building park in the Municipality (854 dwellings in total) as a whole and will provide a customised unbiased plan over a long-term horizon to reduce EP in the Municipality. Besides Coimbra Municipality, the replication potential is high in other Municipalities both targeting social housing and other vulnerable households, in urban and in rural areas, living in apartments and houses. In Portugal around 90% of people have no thermal comfort at home, about 29% of the Portuguese residential buildings need intervention work (around 600,000 dwellings) and families living in undignified and inadequate housing conditions amount to around 5% (26,000 dwellings) [based on a survey carried out by the Housing and Urban Rehabilitation Institute (IHRU) and by local authorities]. The involvement of companies like Cleanwatts, RdA, CARITAS Coimbra and other Municipalities (LoS) will ensure the replicability of the lessons and upscale of the results during and beyond the project lifetime, and apart from social housing. These companies and institutions will be closely following the project activities, being invited to participate in the national discussion workshops, demonstrating the project added value and best practices, engaging them to replicate the actions on other locations. The national discussion workshops will be organised in collaboration with engaged local entities, in different locations of the Portuguese territory where EP is most severe (e.g., Trás os Montes, Alentejo and Algarve), to increase the replication area. The strategic involvement of other national and local activities or projects in the EP landscape will be brought also to these national discussion workshops, to further increase the knowledge exchange. Also, during this project activity, ISR will try to engage the adequate entities (e.g., IPSS, Social Innovation Associations) to integrate on their annual programs the measures developed on the national roadmaps.

5 Conclusions

REVERTER aims to develop 9 roadmaps in four different European areas (Brezovo-Bulgaria, Athens Urban area-Greece, Riga-Latvia and Coimbra-Portugal) in order to effectively alleviate EP through deep renovation of houses. The roadmaps will target the worst-performing homes first ("worst first" principle), will cope with split-incentive dilemmas and will address market, information and behavioural failures through the creation of "one-stop shops'' (OSS) as defaults for the enrolment of vulnerable households in subsidised energy efficiency improvement programmes. The overall aim is to improve the quality of life for vulnerable citizens across Europe through providing energy advice which leads to energy efficiency improvements. In this direction, the four REVERTER pilots will engage with vulnerable citizens and local, national and EU stakeholder groups and experts to create long-term sustainable impacts at local, national and regional level.

To this end, REVERTER has set up a global methodology, which is based on five steps, i.e. Data gathering, analysis and mapping; Stakeholder mapping; Development of roadmaps; Training, information sharing and capacity building; and Pilot implementation of roadmaps. Each methodological step includes one or more components (activities), which are common to all REVERTER pilots. Nevertheless, the methodology is designed to be flexible in order to fit the needs of the varying characteristics of the four pilots (i.e. the characteristics of the building stock, the characteristics of the vulnerable households and the climate conditions). For instance, the number of people involved, data capture approaches used, engagement activities implemented, operational characteristics of the OSSs, etc., can be customised. This is important because the pilot implementation of the roadmaps does not exist in isolation from the local community (vulnerable citizens, local and national stakeholders). Failing to involve these actors in the activities of the project may lead to poor policy results and lack of sustainability of the results after the project ends. At the same time, the overall key steps should remain in place. This is important for two reasons. First, a common methodology can ensure not only the achievement of project objectives but also a consistent and comparable measurement of impacts. Second, implementing a common methodology while allowing unique aspects when required, would mean that similar approaches can be adopted outside of the REVERTER pilots. In this sense, the results of the REVERTER will benefit more member states and areas suffering from EP, while fostering cross-border and cross-sector developments on a lasting basis.

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7 Annexes

Annex I: Guidance note on the preparation of the building renovation roadmaps

REVERTER

Deep REnovation roadmaps to decrease households VulnERability to Energy poveRty

Project No. 101076277

Guidance note on the preparation of the building renovation roadmaps

Due date:	**14/03/2023**
Dissemination level:	**Confidential**
Lead beneficiary:	**CRES**
Contributing beneficiaries:	

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About this document

The preparation of building renovation roadmaps in four targeted countries is foreseen within the framework of Task 3.5. More specifically, the renovation roadmaps will be developed taking into consideration both the derived conclusions and policy recommendations resulting from the analysis of the best practices within Task 2.1 and the different characteristics and conditions of the targeted countries. A political, economic, social, technological, environmental and legal (PESTEL) analysis will be carried out for each country separately to identify the most relevant challenges and issues, which must be considered during the preparation of the renovation roadmaps. Indicatively, the characteristics of the building stock, the different types of vulnerable households and the climate conditions will be taken into account allowing the larger-scale rollout and replication of the proposed actions within the roadmaps.

A template will be prepared to facilitate the development of homogeneous renovation roadmaps to be adapted to the four targeted countries. Emphasis will be given on the defined renovation target, the existing and planned policies and measures, the time plan, and milestones for the completion of the foreseen investments, the financial instruments etc. A guidance note will be compiled describing all the required actions for the preparation of the renovation roadmaps, while regular meetings will be organised to technically support during the development of the roadmaps. Finally, dedicated consultation activities will be designed in the targeted countries for discussing the preparation. The guidance note aims to facilitate the preparation of the building renovation roadmaps both through the provision of a template and instructions about the conduction of the PESTEL analysis. Moreover, information is provided also for the activities, which are foreseen for the preparation of the building renovation roadmaps including their timeline.

Status of deliverable	By	Date
Delivered	CRES	06/03/23
Submitted	n.a.	n.a.

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Disclaimer

Acknowledgement

This document is a deliverable of the REVERTER project. This project has received funding from the European Union's Horizon Europe research and innovation programme under grant agreement No 101082685.

1 Operational framework for the preparation of the building renovation roadmaps

Nine different building renovation roadmaps will be developed within the framework of the four targeted pilot cases.

Information about the building renovation roadmaps is presented in Table 1 including the involved partners.

The task has to be completed in February 2024 with the submission of D3.4, which is a public report in English presenting the methodological framework and the nine prepared building renovation roadmaps.

Figure 1 displays the foreseen steps for the accomplishment of Task 3.5 with the specified timeline.

The template which will be used for the preparation of the building renovation roadmaps is presented in Chapter 3. Moreover, guidance is provided about the technical elements, which have to be explored.

The fundamental pillar of the building renovation roadmaps is the PESTEL analysis, which has to be conducted to identify and assess the impact of the various factors that affect the effectiveness of the building renovation roadmaps.

Guidance about the conduction of the PESTEL analysis is provided in Annex I.

The analytical description of the pilot cases, which entails critical information about the building renovation roadmaps is presented in Annex II. The preparation of the building renovation roadmaps should be based on the main objectives of the four pilot cases as outlined within the framework of REVERTER project.

CRES will support technically all the involved partners during the preparation of the building renovation roadmaps both through the provision of guidance and technical support for addressing potential problems.

Regular meetings will be organised with the participation of all involved partners to monitor the progress of the foreseen steps and to solve potential problems.

Nevertheless, the partners have the opportunity for bilateral communications with CRES to accelerate the procedure for the preparation of the building renovation roadmaps.

Table 1. Overview of the main information about the building renovation roadmaps

Pilot area	Climate region	Population (people/HH) and percentage of energy-poor	Number and topic of roadmaps to be developed	Number of buildings in the area of interest	Percentage of poor performing buildings	Involved partners
Brezovo, Bulgaria	Southern Continental	7,000 people - Based on Eurostat indicators: 30%; Below the poverty line 39.5%; Based on 'subjective' indicators: >48%	i) social public buildings ii) owner-occupied dwellings in multi-family home iii) owner-occupied dwellings in single-family homes	2,900	>90%	GSC, MB
Athens Urban area, Greece	Mediterranean	3,000,000 people -Based on 'objective' indicators: 5-10%; Based on 'subjective' indicators: 21.5%-24.5%	i) tenants ii) owner-occupied dwellings in multi-family homes iii) owner-occupied dwellings in single-family homes	390,500	62%	CRES, NTUA, EKPOIZO
Riga, Latvia	Northern Continental	614,618 people – Based on 'objective' indicators: 0.5%; Based on 'subjective' indicators: 26.2%	i) owner-occupied dwellings in multi-family buildings	10,648	56.3%	EKODOMA, REA
Coimbra, Portugal	Mediterranean	141,000 people – Based on 'objective' indicators: 4.7%; Based on 'subjective' indicators: 17.3%	i) Social houses managed by the Municipality, in the poorest neighbourhood of the city ii) inhabitants facing the highest risk of poverty, mainly single parents, especially women, unemployed and families with more than 3 children	40,701	70%	ISR-UC, CMC

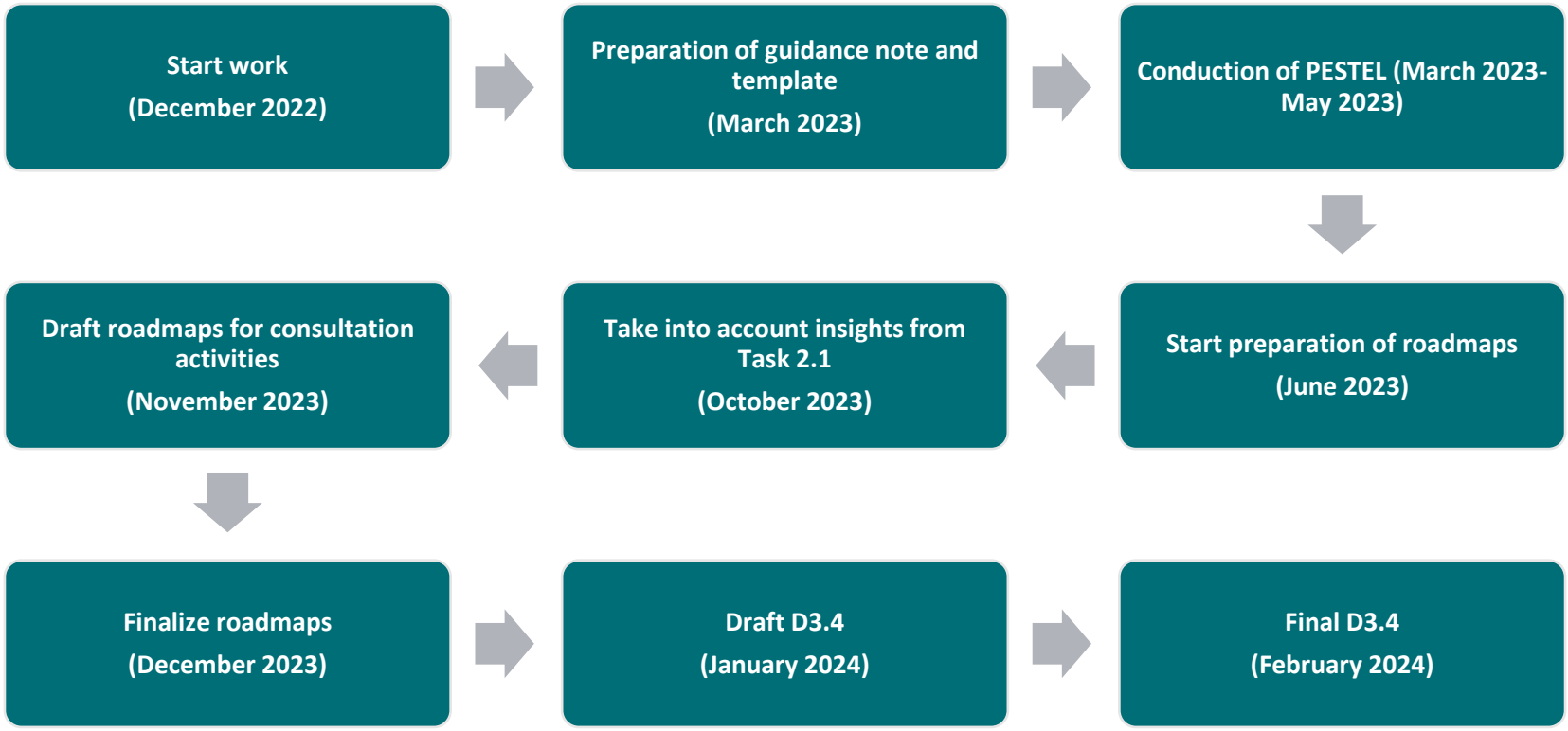

Figure 1. Timeline for the preparation of the building renovation roadmaps

2 Template for the building renovation roadmap

The building renovation roadmaps should be prepared in English.

2.1 Introduction

Analysis of the main objectives of the renovation roadmap.

Presentation of the main energy, environmental and climate change legislative and policy framework at national level, which has been taken into consideration for the preparation of the renovation roadmap (e.g., legislation, energy and climate targets, minimum requirements etc.).

Analysis of the current levels of energy poverty in the pilot area and comparison with the respective figures at national level (if applicable). Provision of indicators related to the energy poverty phenomenon:

- % of people affected by energy poverty
- the proportion of disposable household income spent on energy
- population living in inadequate dwelling conditions (e.g., leaking roof) or with inadequate thermal comfort conditions

Identification of the key stakeholders including the procedures for their engagement.

Overview of the conducted activities for the preparation of the renovation roadmaps.

Analysis of the consultation activities for the preparation of the renovation roadmaps (detailed analysis in separate annex).

1. Overview of the building stock

Analysis of the conditions in the pilot area

Overview of the building stock for the targeted building types within the pilot area including information about the construction periods and the climatic zone.

Information about the energy demand and the utilized fuels per building type.

Analysis of the energy poverty levels per building type.

Presentation of data from the energy performance certificates per building type.

Identification and analysis of existing policies, strategies or investments planned for the pilot area so as to renovate the building stock.

Proposed indicators

1. Number of buildings and total floor area (m^2):

- per building type (including social housing)
- per energy performance class
- NZEB
- worst-performing (including a definition)

2. Number of buildings and total floor area (m^2):

- per building age
- per building size
- per climatic zone

3. Annual renovation rates: number and total floor area (m^2):

- per building type
- to nearly zero-energy building levels
- per renovation depth (weighted average renovation)

4. Primary and final annual energy consumption (ktoe):

- per building type
- per end use

5. Average primary energy use in kWh/(m^2*y) for residential buildings

6. Share of renewable energy in buildings (MW generated) for each RES technology separately:

- on-site
- off-site

7. Production of renewable energy in buildings (MWh generated) for each RES technology separately:

- on-site
- off-site

8. Share of renewable energy in the building sector (MW generated)

9. Reduction in energy costs (EUR) per household (average)

10. Annual greenhouse gas emission reduction (kgCO2eq/(m^2*y)

It should be noted that additional indicators can be utilized.

Moreover, priority should be given on the collection of actual/metered data. In the case that actual data are not available, estimated data can be used alternatively with the appropriate assumptions.

2.2 PESTEL analysis

Conduction of PESTEL analysis so as to identify the most important parameters and the main market barriers and market failures (administrative, financial, technical, awareness and other) in the pilot area.

The PESTEL analysis consists of the following steps:

- Step 1: Speculate the PESTEL factors
- Step 2: Identify and map all the relevant PESTEL factors
- Step 3: Assess the level of impact of PESTEL factors
- Step 4: Identify opportunities and threats
- Step 5: Select the most effective policies and measures

The application of the PESTEL analysis should be conducted according to the guidelines, which are presented in Annex 1.

Insertion of the Table 2 for identifying and assessing the factors, which affect the building renovation roadmap.

2.3 Roadmap

Analysis of different scenarios (pathways), which can be selected for the preparation of the building renovation roadmap in the pilot area.

Analysis of the roadmap for the pilot area with the established targets for 2030, 2040 and 2050 including at least information about the annual energy renovation rate, the primary and final energy consumption of the building stock, the penetration of RES and the reduction of the GHG emission.

Overview of the main energy efficiency interventions and RES technologies that will be promoted by the roadmap.

Presentation of the trajectory for the renovation of the targeted buildings

Presentation of specific timelines for buildings to achieve higher energy performance classes or new or renovated zero-emission building thresholds.

Analysis of the wider multiple benefits delivered by the building renovation.

The establishment of the targets should be performed taking into consideration the outcomes of the PESTEL analysis.

Proposed targets

1. Targets for annual renovation rates: number and total floor area (m^2):

- per building type
- worst-performing

2. Target for expected primary and final annual energy consumption (ktoe):

- per building type
- per end use

3. Targets for expected greenhouse gas emission reduction (%)

4. Expected wider benefits

- number of energy-poor households impacted
- % reduction of energy poverty levels
- quantified targets for various types of multiple benefits, such as number of households with improved mental and physical health, number of households with improved indoor conditions, number of households with improved quality of life, number of households helped to adapt their energy use behaviour etc.

5. Targets for expected share (%) of renovated buildings:

- per building type
- per renovation depth

6. Share of energy from renewable sources in buildings (MW generated)

7. Production of energy from renewable sources in buildings (MWh generated)

8. Increase of GDP (share and billion Euros)

- Creation of new jobs

It should be noted that additional targets can be specified.

Additional scenarios was be assessed in order to identify the scenario, which will be utilised for the development of the building renovation roadmaps.

2.4 Policies and measures

Overview of the implemented and planned policies and measures in order to support the implementation of the roadmap in the pilot area.

For each policy and measure the following information should be provided:

- Name of policy or measure
- Short description (precise scope, objective and modalities of operation)
- Quantified objective
- Type of policy or measure (such as legislative, economic, fiscal, training, awareness)
- Planned budget and funding sources
- Entities responsible for implementing the policy
- Number of affected households
- Expected impact in relation to the specified targets
- Status of implementation
- Date of entry into force
- Implementation period

The identification and design of the policies and measures should be performed taking into consideration the outcomes of the PESTEL analysis and the objectives of the roadmap.

2.5 Investment needs

Presentation of the investment needs for 2030, 2040, 2050 (million EUR), which are required for the implementation of the building renovation roadmap in the pilot area including their distinction between public investments (million EUR) and private investments (million EUR).

Analysis of the financing sources and measures.

Description of the administrative resources in regards their availability and adequacy, the requirement for additional external expertise.

The identification and of the investment needs should be performed taking into consideration the objectives of the roadmap and the identified policies and measures.

2.6 Monitoring and evaluation framework

Description of the procedures in order to monitor, report and evaluate progress for pursuing the objectives of the building renovation roadmap.

Specification of the timeline for the conduction of the monitoring, reporting and evaluation procedures.

Information must be presented regarding the authority, which will be assigned as responsible for the coordination of the monitoring and evaluation mechanism, the indicators that will be monitored and assessed, the trajectory of these indicators until the end of the plan.

Preparation of a template for the collection of the required data including the establishment of the appropriate data collection procedures.

Specification of the rules for initiating the adjustment of the plan in the case of potential deviations.

Analysis of the foreseen activities for the communication of the roadmap.

Annex A: PESTEL Analysis

1. What is a PESTEL Analysis?

PESTEL analysis is a strategic business-planning tool used in order to identify, analyse, and control major external macro-environmental factors, which affect an examined issue, such as the building renovation policies and measures. These factors can be defined as the general legislative context, the global business conditions, the role of various entities, the events, and other factors.

The PESTEL analysis consists of the Political, Economic, Social, Technological, Environmental and Legal factors, which act as an analysis basis in order to examine how these factors affect building renovation interventions.

The PESTEL analysis covers and examines indicatively the following external factors:

- **Political factors:** How and to what degree a government intervenes in the economy. This includes government policy, political stability or instability, foreign trade policy, tax policy, labour law, environmental law, trade restrictions, etc. It is obvious that the political factors often have an impact on building renovation interventions.
- **Economic factors:** These factors include economic growth, interest rates, exchange rates, inflation, disposable income of consumers and companies, etc. These factors can be further broken down into macro-economic and micro-economic factors. Macro-economic factors deal with the management of demand in any given economy. Governments use interest rate control, taxation policy and government expenditure as their main mechanisms. Micro-economic factors focus on the disposable income, which is spent by the households.
- **Social factors:** These factors include population growth, age distribution, health consciousness, career attitudes, etc. These factors are of particular interest as they have a direct effect on how people perceive them and what drives them.
- **Technological factors:** Technological aspects, such as research and development (R&D) activity, automation, technology incentives and lifecycle, the rate of technological change and the role of the Internet, among others, need to be considered.
- **Environmental factors:** These factors include the ecological and environmental aspects that may affect building renovation interventions. Environment factors include geographical location, weather, climate change, pollution, and waste management. Also, attitudes towards “green” or ecological products, renewable energy sources and energy efficient appliances.
- **Legal factors:** These factors include all the regulations and laws that can affect operations and profitability. Legal factors include discrimination law, anti-trust law, intellectual property law, consumer protection law, health and safety law, tax regulations, employment law, advertising standards, product labelling regulations, health-care laws and retirement laws.

2. Why use a PESTEL Analysis?

A PESTEL analysis provides the following advantages:

- Provides a cost-effective approach and simple structure to conduct a systematic and detailed evaluation of the external macro environment.
- Encourages and promotes a strategic approach. It facilitates the evaluation of how a strategy can fit into a broader external environment and plan accordingly.
- Creates better awareness of vital external factors that affect building renovation interventions and helps understand the impact of an external macro environment.
- Provides insight for important business opportunities and prepares someone for addressing potential threats.
- Facilitates the efficient evaluation of the triggered impact of building renovation interventions before their implementation.

3. A step-by-step guide for preparing a PESTEL analysis

Step 1: Speculate the PESTEL factors: Collect and analyse information on the relevant political, economic, social, technological, environmental, and legal factors in terms of building renovation interventions.

Step 2: Identify and map all the relevant PESTEL factors: Map the PESTEL factors, identify and evaluate those that affect the building renovation interventions, by either representing a potential threat or opportunity. Consider the current situation and potential future changes by using both in separate headings.

Step 3: Assess the level of impact of PESTEL factors: Assess individually the level of impact of each PESTEL factor. Highlight any significant differences in the ratings, which will help better understand the opportunities and challenges the building renovation interventions are facing.

Step 4: Identify opportunities and threats: Identify the opportunities and threats that each of the PESTEL factors present to the building renovation interventions.

Step 5: Select the most effective policies and measures: Identify the policies and measures, which are required to implement the results of the PESTEL analysis. In addition, it is of paramount importance to integrate into the building renovation roadmap the selected policies and measures. If there are any significant risks or threats, take appropriate steps to mitigate or eliminate them. Similarly, develop robust interventions to exploit the opportunities.

4. Conduction of the PESTEL analysis

The PESTEL analysis will be carried out through the completion of the Table 2. Firstly, the main factors, which affect the building renovation roadmaps, have to be identified. Indicative external

factors are presented for further consideration and analysis. Finally, the identified factors should be assessed in regards their importance using a qualitative scale (high, medium or low importance).

Table 2. Table for the conduction of PESTEL analysis

	External factors to consider	Factors affect building renovation roadmaps	Importance to the renovation roadmap (High-medium-low)
Political	*EU directives focused on 2050* *Governance structures (e.g., formal or non-formal structures that supports governance* *Incentives/financial Measures* *Pending legislation changes* *Policy goals/specified national targets (e.g., in energy, environment, regional development)* *Political stability and renumeration framework*		
Economic	*Availability of lending funds* *Capacity of construction and energy sector* *Competitiveness* *Cost of living* *Demand for building renovation and energy services* *Economic development patterns (future trend)* *Economic growth/decline (current status)* *Energy expenses* *Energy prices* *Energy services companies* *Energy taxation* *Inflation* *Interest rates* *Labour costs* *Prevailing economic sectors in terms of GVA with competitive advantages* *Skilled energy efficiency professionals* *Split incentives* *Unemployment*		
Social	*Career attitudes* *Demographics* *Energy consumption & production patterns* *Institutional capacity* *Level of awareness on delivered impacts by RES and energy efficiency*		

	External factors to consider	Factors affect building renovation roadmaps	Importance to the renovation roadmap (High-medium-low)
	Lifestyle factors *Participatory culture* *Population* *Rates and characteristics of energy poverty in the population* *Rates and characteristics of general poverty in the population* *Resistance to change* *Role of prosumers* *Social capacity* *Social residence towards RES* *Society's levels of health, education, and social mobility* *Work-life balance*		
Technology	*Artificial Intelligence* *Automation* *Degree of digitalization of the energy sector* *Disruptive technologies* *Innovation* *New energy saving technologies* *Renewables technologies* *Smart city platforms* *Smart meters deployment* *Social networking*		
Environment	*Adaptation policies* *Circular economy* *CSR (Corporate social responsibility)* *Environmental objectives* *Environmental programs/partnerships* *Environmental restrictions imposed by in-country governments* *Ethical sourcing* *Future pandemics* *Procurement* *Sustainable energy resources/potential* *Transportation* *Waste management*		
Legal	*Common law* *Data protection law* *Employment law* *Health and safety regulations* *Legislative and regulatory framework (e.g., for energy, spatial planning, environment, regional development)*		

	External factors to consider	Factors affect building renovation roadmaps	Importance to the renovation roadmap (High-medium-low)
	Level of compliance with the laws *Local labour law* *Laws & regulations on permissions and licenses (e.g., for renewables installations, buildings, production sites etc)*		

Annex B: Presentation of the pilot cases

Pilot 1. Brezovo, Bulgaria
The Pilot area at a glance: Energy efficiency and RES are essential components for the Municipality of Brezovo. The Municipality has elaborated its Energy Efficiency and RES plans, where it has set an ambitious goal to achieve a complete renovation of at least 30% of the used dwellings by 2025. To do so, it has to influence the renovation of approx. 810 dwellings. Thus, the Brezovo pilot will be focused on developing a roadmap dedicated to addressing single and multifamily buildings with poor energy efficiency. Emphasis is in the private housing and on refurbishment approaches and new community-based RES, as tools for tackling EP. The Municipality has a total area of 465.41 km². The population is 7000 inhabitants, occupying 2900 dwellings. The majority of dwellings are private single houses with low levels of efficiency (>95%). In 2019, the final energy consumption of the Municipality was estimated at 44.85 GWh. The housing sector is responsible for 26.64 GWh of the total energy consumption, taking the largest share or 59.4%. The use of raw wood for domestic heating is dominant (47%), followed by electricity (39%) and coal (12%). This is a prerequisite for high PM pollution during the heating season. The housing sector is responsible for 10,247 tons of greenhouse emissions. The technical potential of the possible recovery of the waste streams from the agricultural sector and animal waste is calculated for the production of 5,900 MWth. The Municipality is also rich in forestry. Residual biomass from logging is equal to 7,460 tons of wood, whose energy equivalent is equal to 38,250 MWh of heat. **Main target group(s)**: The particular focus is on the most vulnerable households, those living in single or multi-family homes with no insulation and no energy efficiency measures implemented, also those relying on low-quality heating fuels. Special attention is also paid to households receiving social heating aid or similar. **The Pilot process**: Green Synergy Cluster is the leader and technical partner in the process. It will work in close collaboration with the Municipality to train staff and set up a local OSS. The Municipality will perform a communication campaign on engaging and empowering households, seeking improved efficiency. RAs will be recruited to go through community capacity building activities in responding to EP challenges. Four workshops will be conducted with 25 participants each. During targeted sessions, each RA will perform visits and further raise the literacy of vulnerable consumers from their respectful community. The energy enhancement path of the buildings will initially be based on the architectural retrofitting design that best integrates the innovations available in the regional stakeholder group. These networks will consist of construction and energy-related companies, ESCOs, clusters active in building services, entities from the financial sector, and design engineers. The final objective is to develop a roadmap to help the communities

to find strategies at the local level with emphasis on refurbishment and RES, through forming energy cooperatives and utilising new financial models. It will be based on the full-spectrum analyses of the building stock per each Municipal district (housing age, envelope conditions, heating system, RES penetration, possible savings, impact, etc.). The largest share of private buildings will also allow the experimentation of energy communities, applying the model outlined in the EU directive 2018/001 (RED II), where users coordinate their efforts for the creation of intelligent and efficient energy supply systems. Community-based approaches for the establishment of a Municipal biogas plant to provide renewable heating for the vulnerable districts will be one of the elements of the roadmap, as well as PV generation on a community basis.

Benefits for target group(s): The Brezovo Pilot will drive heating system transformation based on a waste to energy approach, accelerating the transition to climate-neutral cities by 2030. It will emphasise sustainable and more cost and energy-efficient local materials and renewable energy generation. The Pilot activities will bring additional benefits for the target groups, namely: increased energy literacy, increased awareness on new forms of cooperation (energy communities, community purchases) and new financial models (ESCOs, PPAs) while raising awareness on how to make the right choices, regarding energy use and sustainability. Renovation measures, change of heating systems, solar thermal and PV system installation, public awareness campaigns on the benefits of energy-saving as well as information on available technologies will help to reduce the final energy consumption of homes (about 39% of energy consumption) and encourage the construction of PV installations for own consumption (about 39% of energy consumption).

Pilot 2. Athens Urban area, Greece

The Pilot area at a glance: The Athens Pilot will be focused on the development of three different roadmaps. More specifically, the three roadmaps will aim at (i) tenants, (ii) owner-occupied dwellings in multi-family homes and (iii) owner-occupied dwellings in single-family homes taking into consideration various other characteristics, such as the construction year of the buildings, the number of household members, the existence of children and elderly persons etc. The Athens Urban area (Greater Athens and Piraeus), where the pilot implementation activities will take place, has a population of more than 3,000,000 (about 1,000,000 households) over an area of 412 km^2. Almost ¼ of the population is over 60 years old. In 2020, the Gini Coefficient generally in Greece was equal to 32.9%. Based on the latest available data of the Hellenic Statistical Authority (ELSTAT), in 2019, 9.7% of the Pilot Area households were energy-poor according to the '10% rule' and 4.2% and 21.5% according to the 2M and the M/2 indexes, respectively. Moreover, based on the subjective indicators of the EU SILC survey, 21.9% reported "Leaky roof, damp walls, floors, foundations or rotten windows", 21.6% reported "Inability to keep the house

sufficiently warm" and 24.6% declared "Arrears in bills". The pilot area includes more than 1.6 million residences (app. 390,500 buildings), almost 80% of which are multi-story residential buildings and 62% have been built before thermal requirements and energy-related building codes (before 1980). Programs dedicated to building renovations are scarce and actions to tackle EP have not been initiated extensively mainly due to the limited public funds and other priorities. Moreover, a large share of inhabitants is elderly who cannot afford to carry out energy-efficient improvements and construction works or do not have the knowledge on how to start the renovation journey. Therefore, a holistic approach is required to promote energy efficiency maximising the delivered impacts and combating effectively the EP on a long-term basis.

Main target group(s): The Athens Pilot will focus on energy-poor households within the Athens Urban area (Greater Athens and Piraeus) according to the provisions of the "Action Plan for the Alleviation of Energy Poverty", which was adopted in September 2021 through a Ministerial Decision. The targeted population of the energy-poor households is estimated at 648,000 taking into account the reported indicator "Inability to keep the house sufficiently warm and the total population of the targeted area.

The Pilot process: EKPIZO will be appointed as the leader of the Pilot implementation in close collaboration with CRES and NTUA. EKPIZO will establish contacts with its members (approximately 4000) to provide a well-balanced mixture of services through the established OSS. Moreover, a campaign will be carried out in cooperation with the Athens Urban area municipalities, which have provided LoS for informing their citizens about the possibility to receive the provided services by the OSS. The objective is to implement, test, and evaluate the developed roadmaps so as to facilitate the participation of the energy-poor households into the implemented policies and measures, to understand all the dimensions of EP, to foster the most effective utilisation of the existing resources, to enhance their skills towards improving their comfort in buildings with the lowest cost and to realise the multi-benefits triggered by the promotion of energy efficiency interventions. These objectives will be achieved through (a) provision of information about the EP phenomenon focusing on the factors that contribute to its evolution; (b) establishment and operation of an OSS in Athens Urban area focusing on energy-poor households; (c) provision of technical and legal support for the implementation of the most cost-effective energy efficiency interventions and the potential deployment of RES, (d) provision of information about the available financial instruments including instructions for the participation of the energy-poor households into them, (e) training of 10 persons for the operation of the OSS; (e) recruitment and training of min. 30 frontline staff of energy suppliers, social workers, people from organisations assisting vulnerable households personnel of municipalities, etc. as RAs; (f) organisation of 600 visits by the RAs and the members of the OSS to energy-poor households for promoting the OSS, providing targeted advice on energy behaviour and facilitating the promotion of energy efficiency and the

further penetration of RES; (g) organisation of 4 capacity building events (e.g., energy cafés, hands-on workshops, etc.) and awareness-raising activities (through interviews to local newspapers, radio stations, websites, etc.) to boost proper energy usage behaviours, promote energy literacy, and help individuals to make informed sustainable energy decisions.

Benefits for target group(s): The Athens Pilot will contribute to the alleviation of EP leading also to the achievement of the energy and environmental targets at the national level due to the promotion of energy efficiency and potential RES. Moreover, the energy-poor households will manage to improve the indoor environment and to increase the thermal comfort avoiding mental and physical health problems, to manage more effectively their budget and to increase it due to the cost savings, to enhance their existing level of knowledge about EP, to confront effectively the resurgences of COVID-19 and other pandemics minimising the public health expenditures and to receive sustainable energy decisions based on the rationale use of energy.

Pilot 3. Riga, Latvia

The pilot area at a glance: Riga is one of the key economic and financial centres of the Baltic States. In Riga city, almost 85% of inhabitants live in multi-apartment buildings out of which 94% own their apartment. Around 6,000 multi-apartment buildings which cover almost 75% of the total floorspace were built during the post-war period with poor insulation. Households use 36% of the energy in Riga, being the biggest energy consumer in the city. Most buildings in Latvia are energy inefficient and need to be renovated. According to the information provided by Riga Energy Agency (REA), the average specific heat consumption in the period from 2017-2020 for apartment buildings connected to the DH was 147 kWh/m^2 . Riga itself as a municipality is responsible for roughly 10,000 municipal buildings and provides housing management services to a great majority of Riga residential buildings. Riga city municipality has established its own building management company, which ensures new housing development, construction, and management. At the moment, Riga city serves about 167,000 customers and manages more than 4,200 apartment buildings with a total managed area of over 8 million m^2. Most buildings need to be renovated/rebuilt. According to Latvian legislation and bank financing rules, to obtain credit for renovation of multi-apartment buildings, at least 51% of owners should accept the collective decision regarding the renovations. As a significant part of multifamily buildings owners are low-income households and elderly people, it sets up a barrier to persuade them to renovate their estate. In addition, Riga has declared the goal to become the first climate-neutral city in the Baltic states. Currently, the Riga City Council is working on the new Riga sustainable energy and climate plan for 2030 with foreseen that 2000 multi-apartment buildings should be renovated and climate neutrality achieved in

municipally-owned infrastructure by 2030. Thus, Riga's pilot will be focused on developing a roadmap dedicated to addressing vulnerable households living in multifamily buildings with poor energy efficiency.

Main target group(s): The particular focus is on the vulnerable households living among other households, in poor condition multifamily buildings with no energy efficiency measures implemented, but willing to undergo the building's deep renovation.

The Pilot process: REA, which operates under the City of Riga municipality and is already actively working on promoting the renovation of buildings and educating homeowners in energy efficiency necessity, in 2022 will establish The Housing Competence Center (HCC). The aim of HCC is to build and implement a thoughtful and equal condition-based housing program in Riga. Together with Ekodoma Ltd. (EKO), as a technical partner, HCC will work and focus on ensuring the availability of housing to different population groups, as well as promote a deep renovation of housing stock and facilitate improvement of indoor comfort. During the project, an OSS will be developed as one of the departments working especially with vulnerable households, to deal with all the challenges related to decision-making within this group of households regarding building renovation issues. To raise citizens' awareness and motivation to renovate their homes, the municipality will facilitate application for grant schemes and support for energy efficiency measures implementation and will set up the OSS, providing all necessary information on renovation programs co-financed by the city and other actors. The OSS will reach its clients through different communication and marketing tools such as social media, leaflets or events. Targeted communication and marketing tools will be key to reaching out to the right groups at the right moment (e.g. young families, elderly people, low-income households, etc.) with the right message. This will include the following activities: (a) assessment of EP status using existing and tailor-made indicators; (b) analysis of the existing building stock; (c) establishment and operation of an OSS for vulnerable households; (d) training of 2 persons for the operation of the OSS; (e) recruitment and training of 10 local people as RAs; (f) organisation of 200 visits by the RAs to social houses to promote the OSS, provide advice on energy behaviour and install low-cost measures in certain circumstances to provide immediate relief; (g) participation in general meetings of homeowners, answering questions and sharing the positive experience of already renovated buildings; (h) organisation of 4 capacity building events on-site and media campaigns (through interviews to local newspapers, radio stations, etc.) to help individuals and communities to make informed sustainable energy decisions. REA already has a wide range of campaigns, webinars, events, such as the webinar "How to renovate apartment buildings in Riga?", Climate festival about Riga's climate and goals, information campaigns such as "Energy efficiency in apartment buildings-improve living conditions, energy and cost savings". These activities will be combined with Riga's city pilot activities, strengthening the impact of the project.

Benefits for target group(s): The OSS will recommend implementing certain energy efficiency measures; will provide recommendations on quality standards and pricing for construction works. Besides such benefits as improved welfare and indoor comfort, lower utility bills for homeowners, OSS can address several market gaps, including offering a smooth renovation journey for the homeowners, forming a trustworthy process for the homeowner to find reliable and accredited experts, reliable renovation advice and result guarantees, and address coordination gaps in the construction value chain. In addition, OSS can contribute to making deep renovations more attractive for the homeowner by packaging technical and financial solutions and by demonstrating the long-term value of deep renovations. According to 2021 data, there are at least 3000 persons in Riga municipality, asking for financial support regarding housing issues. Pensioners and low-income households are particularly in need of co-finance, grant schemes for energy efficiency implementation. The OSS will advise flat owners on the project financing, using their resources, available subsidies and other financing means. It will also assist in the preparation of the application to the municipal subsidy scheme. In the best-case scenario (deep renovation), the homeowner can reach up to 50% energy savings, thereby decreasing his overall utility bill by 40%.

Pilot 4. Coimbra, Portugal

The Pilot area at a glance: The Coimbra Pilot will focus on developing 2 roadmaps (for buildings and houses) targeted to consumers who are particularly vulnerable concerning thermal comfort levels in their homes. Solutions will not focus only on the building envelope and energy-efficient appliances but also on the urgent need to switch fossil fuel-based heating and cooking systems using gas to electricity by promoting solar thermal and photovoltaics, as well as its integration in REC. The Coimbra Municipality has around 141,000 inhabitants (2021), located in the Centre Portugal Region. Its population is considerably aged, with an ageing index of 203.9 against the Portuguese average of 157.4 and the EU27 average of 132.3. In 2018, the Gini Coefficient in the region was 4.7. Although with limitations regarding indicators and hard data, it is well known that the region has an at-risk-of-poverty rate of 17.3%. At-risk or EP vulnerable households have been signalled by the Municipality services working in the field. However, due to the shortage of public budgets and other priorities (e.g., investing in public infrastructures or services, security, etc., which are more visible for citizens), programs dedicated to building renovations are scarce and actions to tackle EP have been limited. The Coimbra Pilot will be focused on the most vulnerable households of the Municipality of Coimbra, who live in social houses under the management of the Municipality. The Coimbra Municipal Housing Park - MHP (social housing) consists of a total of 854 dwellings, with different typologies, integrating building apartments and houses dispersed over the city. The buildings have been built before the first building code entered in force in 1990, and therefore those buildings do

not have any thermal insulation. Part of the MHP in the city centre has recently undergone some retrofits, but the actions taken were mainly on painting the façades. Hence, the existing potential for energy renovations is high. Moreover, a large share of inhabitants is elderly and low educated, who cannot afford to carry out improvements and construction works or do not have the knowledge on how to start the renovation journey, and therefore a holistic approach is required to have a high impact. Sound impartial advice on what is best for improving the overall environment and actions geared towards behavioural changes and capacity building can lead to significant improvements in households' well-being.

Main target group(s): The Coimbra Pilot is focused on the most vulnerable households of the Municipality of Coimbra and includes a population of about 150 citizens, who live in social houses under the management of the Municipality, in the poorest neighbourhood of the city; inhabitants facing the higher risk of poverty, mainly single parents, especially woman, unemployed and families with more than 3 children.

The Pilot process: ISR is the leader of the Pilot implementation in close collaboration with the Municipality of Coimbra (MCM), in particular, the Social Housing Department which will act as a capacity building facilitator. The MCM will establish contacts with the households, will collaborate in the engagement strategy, empowerment, and commitment of the target group seeking healthier contexts. The objective is to implement, test, and evaluate the roadmap(s) that will be developed to help the communities to find strategies at the local level, customised for the region and the specified target groups, to better manage their resources and skills towards improving their comfort in buildings while ensuring a low energy consumption. This will include the following activities: (a) assessment of EP status by means of existing and tailor-made indicators and collected data; (b) analysis of the pilot building stock; (c) establishment and operation of an OSS for vulnerable households; (d) training of 6 persons for the operation of the OSS; (e) recruitment and training of 10 volunteers, from the students' community, from organisations assisting vulnerable households, personnel of municipalities, etc., acting as RAs; (f) organisation of 200 on site-visits by the RAs to social houses to promote the OSS, provide advice on energy behaviour and install low-cost measures in certain circumstances to provide immediate relief in 4 houses; (g) organisation of 10 capacity building events on-site (e.g., energy cafés, DIY renovations workshops, etc.) to boost proper energy usage behaviours, promote energy literacy, and help individuals and communities to make informed sustainable energy decisions.

Benefits for target group(s): Besides contributing to decarbonisation of the city and the renovation of social housing park, the Pilot brings additional benefits for the target group, namely: a better environment for people to be in and better life experience; improved thermal comfort and, to some extent, indoor air quality and health; better management of their budgets; increase energy literacy but also digital literacy by helping them with

existing tools/simulators and platforms; ensuring they are prepared to resurgences of Coronavirus and other pandemics; raising awareness and willingness to make good choices, regarding energy use and sustainability (for example, since the Municipality is involved, promotion of urban vegetable gardens will be possible); etc. Another important benefit regards the consciousness of the right to live with a certain minimum condition and gives them strength to ask for advice and information without feelings of shame or embarrassment, towards a just transition.

Annex II: Impacts calculation table

Activities	Brezovo	Athens urban area	Riga	Coimbra
Population of reference (persons)	7,000	3,000,000	614,618	141,000
Percentage of energy poor	Based on Eurostat indicators: 30 %; Below the poverty line 39,5 %; Based on 'subjective' indicators: > 48 %	Based on 'objective' indicators: 5-10%; Based on 'subjective' indicators: 21.5%-24.5%	Based on 'objective' indicators: 0.5%; Based on 'subjective' indicators: 26,2%	Based on 'objective' indicators: 4.7%; Based on 'subjective' indicators: 17.3%
Number of buildings in the area of interest	2,900	390,500	10,648	40,701
Percentage of poor performing buildings	>90%	62%	56.3%	70%
Number of EAs trained	min. 15	min. 30	10	10
Number of household visits	400	600	200	200
	Brezovo	**Athens urban area**	**Riga**	**Coimbra**
Population of reference (households)	2,900	1,000,000	204,873	82,004
Percentage of energy poor (households)	48%	15%	26.2%	17.3%
Number of energy poor households	1,392	150,000	53,677	14,187
% of households approached through media campaigns	20%	10%	10%	10%
Households approached through media campaigns	278	15,000	5,368	1,419
Households approached through visits	500	600	200	200
Households approached through social engagement events	200	100	100	100
% visits to the OSS through media campaigns	15%	10%	10%	10%
% visits to the OSS through visits	60%	50%	50%	50%
% visits to the OSS through social engagement events	15%	30%	30%	30%
Total number of visits to the OSS	372	1830	667	272
% enrollment to (subsidised) retrofit programs	20%	15%	50%	15%
Average final energy consumption per HH.year (kWh)	9200	10640	5258	8407

Average final energy consumption per vulnerable HH.year (kWh)	11040	6916	3418	5465
Energy savings factor (behavioural change)	4%	5%	5%	5%
% of households changing their behaviour	40%	40%	40%	40%
% of households helped to improve their quality of life	50%	50%	50%	50%
Energy savings factor (retrofits)	55%	40%	40%	40%
Energy savings per vulnerable HH.year	6072	2766	1367	2186
Primary energy savings conversion factor	**2.1**	**1.6**	**1.3**	**1.6**
Average retrofit cost per house	**18000**	**10000**	**251355**	**20000**
kg CO_2 per kWh_{th} (based on the energy mix and the CO_2 emission factors)	**0.43**	**0.2**	**0.145**	**0.1333**