REVERTER

Deep REnovation roadmaps to decrease households VulnERability to Energy poveRty

Project No. 101076277

Annexes to Deliverable 2.1
State-of-the-art review and assessment report

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10 Annex A: The REVERTER Project

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 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 28).

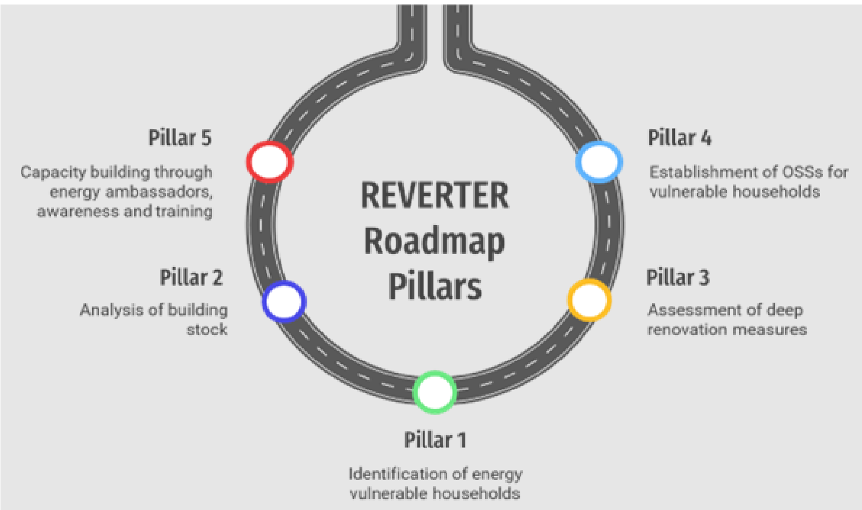


Figure 28: The five pillars of the project

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.

11 Annex B: EP and Deep Renovation in the EU Legislation

The topics of "Deep Renovation" and "Energy Poverty mitigation" reveal intertwined coherence in the "European Green Deal - Striving to be the first climate-neutral continent" initiative [6]:

> *Climate change and environmental degradation are an existential threat to Europe and the world. To overcome these challenges, the European Green Deal will transform the EU into a modern, resource-efficient and competitive economy, ensuring:*
> *- no net emissions of greenhouse gases by 2050*
> *- economic growth decoupled from resource use*
> *- no person and no place left behind* *(European Commission, 2023a)*

In the 2023 "Green Deal" a diversity of sectors – society and culture, buildings, energy, transport, agriculture, and industries – are matched in a common quest for a more sustainable, circular, competitive economy, a healthier and biodiverse environment and enhanced social cohesion through skills training and an inclusive transition. Although all sectors, directly and indirectly, impact REVERTER core topics, this brief will "cherry-pick" the European legislation to illustrate how and why Deep Renovation and Energy Poverty mitigation came to intersect.

This topic fulfils several portions of the REVERTER project, namely in the "Project summary":

> *"REVERTER will test the roadmaps by setting up a network of pilots in four different European countries, i.e. Bulgaria, Greece, Latvia and Portugal, that cover different climate regions and socioeconomic conditions, and through the engagement with local, national and EU stakeholder groups and experts it will embed the roadmaps in future policies for the reduction of energy poverty." (REVERTER consortium, 2022, p. 3)*

and relevant parts of Work package WP2 – State-of-the-art assessment and others.

> *"The assessment of national, regional and local policies, initiatives, strategies, targets, etc. in the EU and specifically in the four pilot areas regarding the alleviation of EP and the promotion of energy retrofits." (REVERTER consortium, 2022, p. 10)*

Beyond those, a significant motivation for the format that characterizes this long list of EU Directives, Regulations, Delegated Regulations and Communications is to deliver the:

[6] The European Green Deal portal (European Commission, 2023a) keeps track of the evolution of the roadmap compliance and required adjustments since the founding communication (The European Green Deal - Communication from the Commission to the European Parliament, the European Council, the Council, the European Economic and Social Committee and the Committee of the Regions, 2019)

> *"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 (e.g. NECP and LTRS) during the implementation of the project and within 5 years after its end, by engaging with policymakers and stakeholders (e.g. local and national governments, NGOs, ESCO companies, consumer unions, etc.). This will facilitate the market uptake of renovation approaches for the large-scale rollout of building-related interventions for vulnerable households."*
> *(REVERTER consortium, 2022, p. 109)*

This topic aims to give legal support to fulfilling the holistic views already formulated, and many others to be found in local areas, but that are still far from streamlined in local regulations and practices.

[2009] Directive 2009/72/EC common rules for the internal market in electricity References

Directive 2009/72/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in electricity and repealing Directive 2003/54/EC (Text with EEA relevance)", 2009, p. 65)

> *"7. Member States shall take appropriate measures to protect final customers, and shall, in particular, ensure that there are adequate safeguards to protect vulnerable customers. In this context, each Member State shall define the concept of vulnerable customers which may refer to energy poverty and, inter alia, to the prohibition of disconnection of electricity to such customers in critical times. Member States shall ensure that rights and obligations linked to vulnerable customers are applied." (Directive 2009/72/EC (Common Rules for the Internal Market in Electricity), 2009, p. 65)*
> *"(h) helping to achieve high standards of universal and public service in electricity supply, contributing to the protection of vulnerable customers and contributing to the compatibility of necessary data exchange processes for customer switching." (Directive 2009/72/EC (Common Rules for the Internal Market in Electricity), 2009, p. 81)*

References to vulnerable customers and Energy Poverty related topics appear in the Directives related to the internal markets of electricity and gas: customers." (Directive 2009/72/EC (Common Rules for the Internal Market in Electricity), 2009, p. 61)

[2014..] European Energy Security Strategy (EESS)

A sample of the "*Key facts and figures on EU energy security*" acknowledges the confirmed risks:

> *"Today, the EU imports 53% of the energy it consumes. Energy import dependency relates to crude oil (almost 90%), to natural gas (66%), and to a lesser extent to solid fuels (42%) as well as nuclear fuel (40%).*
> *Energy security of supply concerns every Member State, even if some are more vulnerable than others. (…) The most pressing energy security of supply issue is the strong dependence from a single external supplier. This is particularly true for gas, but also applies to electricity:*
> - *Six Member States depend from Russia as single external supplier for their entire gas imports (…)*
> - *For electricity, three Member States (Estonia, Latvia and Lithuania) are dependent on one external operator for the operation and balancing of their electricity network;*
>
> *The EU external energy bill represents more than €1 billion per day (…). The EU imports more than €300 billion of crude oil and oil products, of which one third from Russia.*

EU energy security has also to be seen in the context of growing energy demand worldwide, which is expected to increase by 27% by 2030, with important changes to energy supply and trade flows.”
(EC, 2014, p. 2)

EESS and the (Paris Agreement, 2015) will orient EU 2030/50 strategies towards local renewables.

[2014-19] Energy Union: a forward-looking climate policy

The Energy Union timeline (European Council, 2019) points to the 26/27 June 2014 European Council Conclusions as the initial inset in official European documents:

3. Towards an Energy Union with a forward-looking climate policy
Geopolitical events, the worldwide energy competition and the impact of climate change are triggering a rethink of our energy and climate strategy. We must avoid Europe relying to such a high extent on fuel and gas imports. To ensure our energy future is under full control, we want to build an Energy Union aiming at affordable, secure and sustainable energy. Energy efficiency is essential, since the cheapest and cleanest energy is that which is not consumed. In light of this challenge, our energy and climate policies for the upcoming five years must focus on:
• affordable energy for companies and citizens: by moderating energy demand thanks to enhanced energy efficiency; (…)
• secure energy for all our countries: by speeding up the diversification of energy supply and routes, including through renewable, safe and sustainable and other indigenous energy sources, as a means to reduce energy dependency, notably on a single source or supplier; (…)
• green energy: by continuing to lead the fight against global warming ahead of the United Nations COP 2015 meeting in Paris and beyond, including by setting ambitious 2030 targets that are fully in line with the agreed EU objective for 2050 *(*European Council 26/27 June 2014 Conclusions*, 2014)*

This transcript recalls that Europe´s (Paris Agreement, 2015) commitments match with the European Energy Security Strategy (EESS) (EC, 2014), enforced to reduce Europe’s high energy dependence on most fuel sources: from oil all the way to nuclear fuels, not much was sourced inside Europe. Energy Security is, and will be, an inherent priority for Europe.

These targets were progressively optimized, and ambitious, yet the conclusions of the meetings of 23/24 October and the proposal of 18 December 2014 privilege the greenhouse gas emissions reductions, and targets for renewable energy and energy efficiency, including Member States; and not mentioning vulnerable citizens.

[2015] Energy Union package "Clean Energy For All Europeans” & energy efficiency labelling

The Energy Union package continued to evolve along the same guidelines, and by 13 November 2015 a proposal emerged “*setting a framework for energy efficiency labelling (…) to encourage innovation and the production of evermore efficient products.*” (EC, 2015).

The underlying logic is that as old equipment reaches the end of life it is replaced by what is available in the market. Setting progressively higher efficiency thresholds for entry-level appliances would imply automatic renovation of all appliances in 10 to 15 years[7].

This energy efficiency labelling logic—something that is solved by itself with time—explains why appliances are (most of the times) excluded from "Deep Renovation" and "Energy Poverty Mitigation" support strategies.

[2016-19] "Clean Energy For All Europeans" legislative pact

This initiative was designed in 2016 and adopted in 2019[8] marking a milestone in the implementation of the 2015 Energy Union Package goals of increasing Europe's Energy Security, excessively dependent on imported fossil fuels and their price fluctuations, reducing carbon emissions with less polluting sources and empowering consumers towards prosumers:

> *The regulatory changes introduced by the current package and the shift from centralised conventional generation to decentralised, smart and interconnected markets will also make it easier for consumers to generate their own energy, store it, share it, consume it or sell it back to the market – directly or as energy cooperatives. Consumers will be able to offer demand response directly or through energy aggregators. New smart technologies will make it possible for consumers – if they choose to do so – to control and actively manage their energy consumption while improving their comfort. (EC, 2016b)*

This implied a transversal legislative overhaul only finished by 2019 with the "Clean Energy for All Europeans package" (EC & Directorate-General for Energy (EC), 2019). What is particularly relevant for the goals of REVERTER is that here "renovation" and "energy poverty" are referenced together in a high-level document:

> *The amendment of the Energy Performance of Buildings Directive will accelerate building renovation rates by reinforcing provisions on long-term building renovation strategies, with a view to decarbonising the building stock by mid-century. (…) The proposal calls on Member States to focus investments also on the energy poor, since energy efficiency is one of the best ways to address the root causes of energy poverty. (EC, 2016b)*

This document is clear on the goal of empowering consumers with more information on their consumption and costs, as energy illiteracy and the fear of change are widely reported in energy poverty projects and literature (Hearn & Castaño-Rosa, 2021).

The opening image of the "Clean Energy For All Europeans" (Figure 29) illustrates the intricate ambitions and interrelations. At this stage "citizens and consumers" were mostly assigned to the Digital Single Market, although references to vulnerable citizens and the creation of an Energy Poverty Observatory to "*provide better data on the problem and its solutions as well as to help Member States in their efforts to combat energy poverty*." were already present (EC, 2016b).

[7] This rule misses freezers built back in the nineties to last with powerful consumptions This essential appliance for people in poverty situation often aggravates energy poverty.

[8] The time frame between the original Energy Union formulation (2015), the (Clean Energy For All Europeans, 2016) and the final adoption

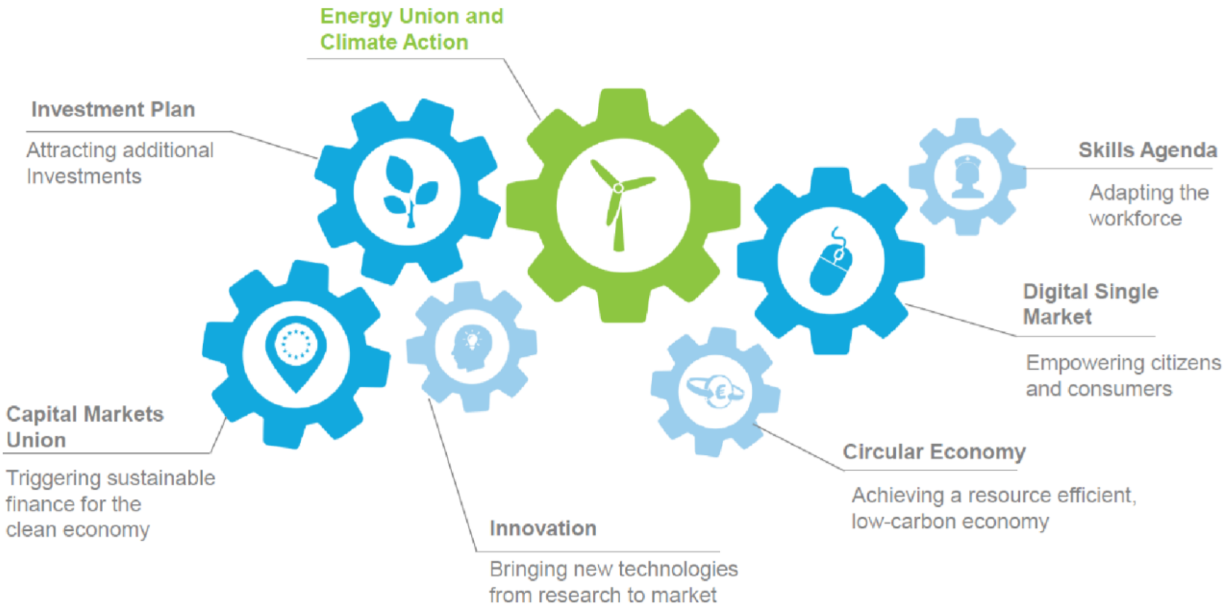


Figure 29: Modernization of the economy – Role of the Energy Union and Climate Action (EC, 2016b)

The 2016 formulation also depicts scenario proposals that will be key to achieving the 2030-2050 goals:

> *The regulatory changes introduced by the current package and the shift from centralised conventional generation to decentralised, smart and interconnected markets will also make it easier for consumers to generate their own energy, store it, share it, consume it or sell it back to the market – directly or as energy cooperatives. Consumers will be able to offer demand response directly or through energy aggregators. New smart technologies will make it possible for consumers – if they chose to do so – to control and actively manage their energy consumption while improving their comfort.*(EC, 2016b)

[2016] European Energy Poverty Observatory (EPOV)

The European Energy Poverty Observatory (EPOV) (Manchester Urban Institute, 2016) was an EU-supported initiative aiming at engendering:

> *transformational change in knowledge about the extent of energy poverty in Europe, and measures to combat it. (…) EPOV is geared at improving the transparency of information and policy by bringing together the disparate sources of data and knowledge that exist in varying degrees across the whole of the EU. It also provides a user-friendly and open-access resource that promotes public engagement as well as informed decision making by local, national and EU-level decision makers. The Observatory will support the work of interested stakeholders, based on a holistic approach to understanding and addressing energy poverty in the European Union.* *(Manchester Urban Institute, 2016)*

The EPOV builds on the information of the EVALUATE project (*EVALUATE Project*, 2013), proposing one of the “pre-official” definitions of Energy Poverty. EPOV was later continued by EPAH (DG Energy, 2023), in continuity with the original goal.

[2017] Enlarged EU stakeholder's participation

The participatory spirit of the time, embedded in the EPOV approach and facilitated by evolving interaction platforms, allowed for varied contributions from European stakeholders. Many recent decisions can be linked to studies calculating the impacts of ambitious goals by monetizing the benefits of lower PM2.5 levels and ozone pollution:

> *From a societal perspective, improving health of EU citizens and reducing energy poverty is more significant in the most ambitious energy savings scenario. (…) However, achieving these results requires tailored policy measures to ensure that ambitious energy renovation of existing buildings is undertaken, especially for buildings occupied by low-income families.* *(Amina SAHEB, 2017)*

Another document entitled "*Efficiency First in the Energy Union: Progress Report*" (Edith Bayer, 2017) graphs the contribution of diverse energy efficiency measures to the whole final energy consumption reduction. Figure 30, demonstrating the influence of final consumers in energy efficiency savings, may have helped to justify the New European Bauhaus (EC, 2023k), inclusion of participatory approaches and communities to maximize results.

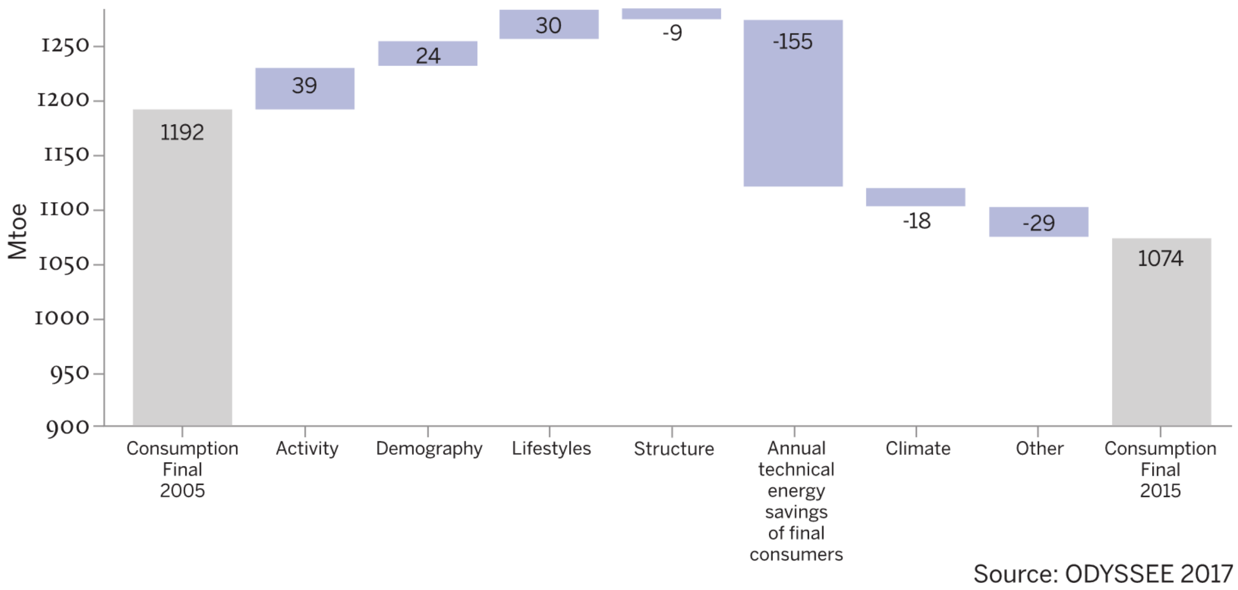


Figure 30: Extract from Efficiency First in the Energy Union: Progress Report" (Edith Bayer, 2017)

[2018] Regulation on the Governance of the Energy Union and Climate Action

Known as the 'European Climate Law', and aiming for a legally binding target towards net zero greenhouse gas emissions by 2050 the Regulation on the Governance of the Energy Union and Climate Action (Regulation (EU) 2018/1999, 2018) fostered a governance mechanism with National Energy and Climate Plans (NECP), detailed ahead, and National Long Term Strategies (NLTS), sectoral foresight to:

"the economic transformation needed and broader sustainable development goals, as well as move towards the long-term goal set by the Paris Agreement"[9].

The Climate Law defines most of the path REVERTER is now following:

The Climate Law includes:
- a legal objective for the Union to reach climate neutrality by 2050
- an ambitious 2030 climate target of at least 55% reduction of net emissions of greenhouse gases as compared to 1990, with clarity on the contribution of emission reductions and removals (...)
- stronger provisions on adaptation to climate change
- strong coherence across Union policies with the climate neutrality objective
- a commitment to engage with sectors to prepare sector-specific roadmaps charting the path to climate neutrality in different areas of the economy (EC, 2020c)

More than the reason for the name of the next goal, 'Fit for 55', the Climate Law already anticipates the need to prepare for a changing climate: adaptation will be key for resilience.

Due to their relevance, the National Energy and Climate Plans (NECPs) will be analysed in detail.

[2018..] National Energy and Climate Plans (NECPs) (part of the Climate Law)

(NECPs) are designed for 10-year periods (2021 to 2030) and updated in June 2023 in accordance with Article 14 of the Governance Regulation. The European Commission published these plans (EC, 2020c) and analysed them in "An EU-Wide Assessment of National Energy Plans, with Insights Informing Energy Poverty Strategies:

"Overall, the NECPs did not provide a clear prioritisation of funding needs regarding just transition, nor investment needs for reskilling and upskilling and for support of labour market adjustments. (…) Also related to a just transition, many NECPs address energy poverty. This is a major challenge, since close to 40 million Europeans were unable to afford keeping their home adequately warm in 2018. (…) To help Member States take more determined and targeted action against energy poverty, the Commission will adopt guidance on the definition and on indicators of energy poverty this autumn. (…) Lowering energy bills, alleviating energy poverty, and, in the long-run, improving public health and comfortable living, can make society more resilient to potential future crisis"

The insistence for "updates of their integrated national energy and climate plans" (EED_r2023, 2023, p. 33) clarifies its' relevance, while multiple stakeholder participation is enforced as:

"Multilevel climate and energy dialogue
Each Member State shall establish a multilevel climate and energy dialogue pursuant to national rules, in which local authorities, civil society organisations, business community, investors and other relevant stakeholders and the general public are able actively to engage and discuss the achievement of the Union's climate-neutrality objective set out in Article 2(1) of Regulation (EU) 2021/1119 and the different scenarios envisaged for energy and climate policies, including for the long term, and review progress, unless it already has a structure which serves the same purpose. Integrated national energy and climate plans may be discussed within the framework of such a dialogue.';" (EC, 2021c)

[9] The page on National Long-Term Strategies (European Commission, 2023b) depicts these plans.

As the partners National Energy and Climate Plans (NECPs)), will be key in the definition of strategies and roadmaps, Table 38 presents the links to the final NECP (submitted in 2019) and the draft updated NECPs (in 2023). Notice that Member States should submit the NECP 2021-2030 drafts by 30 June 2023. Although not yet validated, these missing NECP 2021-2030 drafts and **the final EPBD 2023 recast** Directive will be essential to design "future-proof" roadmaps.

Table 38:Links to National Energy and Climate Plans (NECPs) of REVERTER partners(EC, 2023j)

	Final NECP (2019)	**Updated draft (2023)**
Portugal	https://energy.ec.europa.eu/system/files/2020-06/pt_final_necp_main_en_0.pdf	https://commission.europa.eu/publications/portugal-draft-updated-necp-2021-2030_en
Greece	https://energy.ec.europa.eu/system/files/2020-03/el_final_necp_main_en_0.pd	Missing by Oct 2023
Latvia	https://energy.ec.europa.eu/system/files/2020-04/lv_final_necp_main_en_0.pdf	Missing by Oct 2023
Bulgaria	https://energy.ec.europa.eu/system/files/2020-06/bg_final_necp_main_en_0.pdf	Missing by Oct 2023

[2019] European Green Deal (2019)

A relevant twist occurs with the following EC cycle. The term "Energy union" is absent in this thread, and the preamble enforces a generational heading:

> *A Union that strives for more*
> *For the generation of my parents, Europe was an aspiration of peace in a continent too long divided.*
> *For my generation, Europe was an aspiration of peace, prosperity and unity that we brought to life through our single currency, free movement and enlargement.*
> *For the generation of my children, Europe is a unique aspiration. (...)   (Von der Leyen, 2019)*

A generational commitment based on the engagement of European citizens is organized into 6 main interconnected topics that reorganize existing work in a new way[10]:

> *1. A European Green Deal*
> *2. An economy that works for people*
> *3. A Europe fit for the digital age*
> *4. Protecting our European way of life*
> *5. A stronger Europe in the world*
> *6. A new push for European democracy   (idem)*

This document presents a holistic view of the European Union's direction in terms of international commitments, energy security, and well-being, where important notions stand out:

> *"The European Green Deal is our new growth strategy. It will help us cut emissions while creating jobs. At the core of it will be an industrial strategy that enables our businesses – big and small – to innovate and to develop new technologies while creating new markets. We will be global standard setters. This*

[10] Please notice that the lack of reference to energy poverty and vulnerable households in the "Energy union" strategy does not imply lack of interest in that topic, as documented ahead. Connecting Energy and citizens makes sense and fosters an idea of common goal, but also imposes challenges: EP related legislation formulated by "energy" legislators can be harder to understand and operationalise by those nearer to the vulnerable households.

is our competitive advantage. And it is the best way to ensure a level-playing field. But all of this has to serve the European people. They want and expect Europe to act on climate and environment. But they also need affordable, clean and secure energy. They need to be skilled to work in the jobs of tomorrow. They need to commute to those new jobs or to be connected from home. And we have to make sure that those needs are fulfilled in a sustainable way. It is a generational transition towards climate neutrality by mid-century. But this transition must be just and inclusive – or it will not happen at all."

(Von der Leyen, 2019, p. 8)

"Children living in poverty are more likely to become adults living in poverty. We need to break this dangerous cycle. We must do better."   (Von der Leyen, 2019)

In Conclusions and Recommendations (p.39) this intertwinement is explored as a trigger for new strategies. The green jobs Europe requires to fulfil the 2050 objectives imply attracting workers, hopefully with many of these children taken out of these poverty cycles.

Ursula von der Leyen's 27 November 2019 speech emphasizes the European Green Deal, the risks deriving from Climate Change and poverty, and the need to "*break through the glass ceilings (…) holding back people (…)"* (Von der Leyen, 2019b). In line with this spirit, the *European Commission Recommendation 2020/1563 on energy poverty* urges the EU Member States to take appropriate measures as:

"Adequate warmth, cooling, lighting, and efficient energy systems are essential services for social inclusion, guaranteeing a decent standard of living and health"
"Thus, tackling energy poverty might contribute to multiple benefits, including fewer expenses on health, improved comfort, the well-being of households, and improved household budgets with fewer expenditures on energy bills" *(ENER, COM, 2020)*

[2020/10] A renovation wave for Europe: greening our buildings, creating jobs, improving lives

Issued on the same day then the Energy Poverty Recommendation, addressed in the next topic, the "Renovation Wave" communication (EC, 2020b) defines the context in which renovations will occur, and the main beneficiaries: a "must-read" for those planning long term interventions using Deep Renovation to mitigate Energy Poverty. Although many of the referenced strategies are in force due to references in Directives, Regulations and Delegated Regulations, it is important to keep in mind that each individual item should be seen within the context they were designed.

The Renovation Wave communication, and in particular the conclusion below, details What—worst performing buildings—, Why—European commitments to Climate Change mitigation—, When—by 2030—, How—Deep Renovation—, Where—across Europe— and Who—an inclusive gathering of all stakeholders— will have to be included to make this common goal viable.

In 10 years, the buildings of Europe will look remarkably different. Buildings will be the microcosms of a more resilient, greener and digitalised society, operating in a circular system by reducing energy needs, waste generation and emissions at every point and reusing what is needed. (…).
District approaches will unite people and communities. Buildings will be less energy-consuming, more liveable, and healthier for everybody. Cities will become greener and better connected with nature.
New jobs and professional profiles will emerge. Europe's construction industry will thrive on the opportunities provided by a sustained rate of renovations and consolidate its global leadership in

innovative materials, turning the buildings sector from a carbon source into a carbon sink. Positive effects will spill over to other industrial ecosystems. New and larger markets for green construction and for green loan and mortgage financing will develop.
This Communication sets out a strategy to embrace, accelerate and drive such a transformation in a way that is underpinned by the climate neutrality objective, applies circularity principles, contributes to the Sustainable Development Goals and Europe's competitiveness and protects the right of everyone to have affordable, liveable, accessible and healthy housing while safeguarding cultural heritage.
(…) Renovation should be a shared project across Europe. The mobilisation and ownership of cities, local and regional authorities, stakeholders, national governments and citizens will be key to sustaining it. The Commission will work in close partnership with the Committee of the Regions and with local and municipal authorities including by using the Climate Pact. It will facilitate the exchange of good practices and mutual inspiration through cross-border networks such as EU committees, concerted actions or expert groups, stakeholder fora, the Covenant of Mayors and the Smart Cities Marketplace. The Renovation Wave can support recovery for the individuals and economy alike, and pursuing its benefits must be sustained over the long term. (…) Working together at all levels, we can make a European Renovation Wave happen. (EC, 2020b)

[2020] Commission Recommendation on Energy Poverty

The (Commission Recommendation (EU) 2020/1563 of 14 October 2020 on Energy Poverty, 2020) follows the recommendations of ('Electricity Directive' (EU) 2019/944, 2019)

«There is no standard definition of energy poverty, and it is therefore left to Member States to develop their own criteria according to their national context. However, the recently adopted legislative package provid es useful general principles and insights into the possible causes and consequences of energy poverty. It also underlines the importance of policies to tackle the problem, especially those associated with national energy and climate plans ('NECPs') and with long-term renovation strategies ('LTRSs')(9).»

(Commission Recommendation (EU) 2020/1563 of 14 October 2020 on Energy Poverty, 2020, p. 2)

[2021] 'Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality

«'Fit for 55': delivering the EU's 2030 Climate Target on the way to climate neutrality» ('Fit for 55', 2021, p. 0). The motto is clearly compelling, yet this must be framed as an "intermediary plan" for 2030:

«In this spirit, the package of proposals aims to make the EU 'fit for 55' and deliver the transformational change needed across our economy, society and industry. This is a collective responsibility and opportunity that must be open to all, whether innovators and investors, companies and cities, or consumers, households and individuals. We all share in the benefits of more space for nature, cleaner air, cooler and greener towns and cities, healthier citizens, lower energy use and bills, as well as new jobs, technologies and industrial opportunities. The challenge at the heart of the EU's green transition is how we can bring these benefits to all as quickly and as fairly as possible, while strengthening our competitiveness, creating the jobs of tomorrow and effectively addressing the costs and impacts of the transition.» ('Fit for 55', 2021, p. 1)

A later Commission Decision clearly validates the holistic vies enforced:

"(8) All initiatives under the 'Fit for 55 Package' to implement EU's 2030 climate and energy objectives, have been consistently designed to unfold synergies, to mitigate potentially negative distributional effects, including between Member States, particularly on the most vulnerable and energy poor (…)" (Commission Decision (EU) 2022/589 of 6 April 2022 Establishing the Composition and the Operational Provisions of Setting up the Commission Energy Poverty and Vulnerable Consumers Coordination Group, 2022, p. 2)

[2021-10] "Energy Efficiency First: from principles to practice"

"Energy Efficiency First: from principles to practice (EC.Rec. 'Energy Efficiency First', 2021, p. L 350/9)

"Recognise the role of energy efficiency in addressing other objectives, such as reduction of GHG emissions, pollutants and use of non-energy resources, improvement of health and comfort, reduction of energy poverty (…)
"Environmental, social and economic impacts, including distributional impacts and the alleviation of energy poverty, should be part of the assessment, applying the Life Cycle Assessment approach and proper carbon pricing assumptions;" (EC.Rec. 'Energy Efficiency First', 2021, pp. 16, 22)

[2021] "Tackling rising energy prices: a toolbox for action and support"

This Communication ((COM/2021/660 Final) 'a Toolbox for Action and Support', 2021) was a response to peaking energy prices, clarifying "state-aid" to facilitate Member States support to the economy, and proposing direct support to citizens:

"Member States could:
- Provide time limited compensation measures and direct support to energy-poor end-users including groups at risk, e.g. through vouchers or by covering parts of the energy bill, financed inter alia from the ETS revenues.
- Put in place and/or maintain safeguards to avoid disconnections from the energy grid or defer payments temporarily.
- Exchange best practices and coordinate measures through the Commission Energy poverty and vulnerable consumers coordination group."
((COM/2021/660 Final) 'a Toolbox for Action and Support', 2021, p. 8)

Although this was not a "decision-making" instrument, it is important to see such measures gaining force in response to a crisis:

"Energy efficiency lowers energy consumption and thus energy costs, but it requires investment. It addresses one of the root causes of energy poverty, notably through the improved energy performance of buildings and appliances. The Commission will also put forward a proposal to improve the energy performance of the European building stock. With certain renovation measures targeting social housing – and new rules for EU countries to measure and monitor figures for those that struggle to pay their energy bills – these building renovation rules will help to combat energy poverty."
((COM/2021/660 Final) 'a Toolbox for Action and Support', 2021, p. 18)

The topic of the green transition is again addressed:

"A successful green transition will lead the transformation not only towards clean energy, but also more energy efficiency and different use. The EU's commitment to significantly reduce its greenhouse gas emissions and fossil fuels consumption is fully confirmed by recent events. Measures need to be accelerated, both on the regulatory and investment side. The clean energy transition is the best insurance against price shocks like the one the EU is facing today. It's time to speed up."
((COM/2021/660 Final) 'a Toolbox for Action and Support', 2021, p. 20)

[2021] The New European Bauhaus: beautiful | sustainable | together

This initiative is described as "*a creative and transdisciplinary movement in the making* "(EC, 2021) designed to bridge the European Green Deal with our lives:

By creating bridges between different backgrounds, cutting across disciplines and building on participation at all levels, the New European Bauhaus inspires a movement to facilitate and steer the transformation of our societies along three inseparable values:
sustainability, from climate goals to circularity, zero pollution, and biodiversity
aesthetics, quality of experience and style beyond functionality
inclusion, from valuing diversity to securing accessibility and affordability
The New European Bauhaus brings citizens, experts, businesses, and institutions together to reimagine sustainable living in Europe and beyond. In addition to creating a platform for experimentation and connection, the initiative supports positive change also by providing access to EU funding for beautiful, sustainable, and inclusive projects. (EC, 2021)

Although the New European Bauhaus is still "in the making", its inclusion is justified by three main factors:

- Although massive building decarbonization is viable for a few years, its wide societal adoption is limited even by those who can afford it: it is more than a purely technical issue;
- Working at the neighbourhood/district scale facilitates wider societal benefits
- The spotlight on EU-wide "New European Bauhaus" style good practices seems to indicate that EU funding will privilege these approaches.

The New European Bauhaus "Inspiring projects and ideas" search tool ((European Union) EU, 2023) may be used to illustrate the training sessions with existing examples, and to guide the pilot teams with European-wide recognized good practices. Although by the time this deliverable is prepared (end of 2023) the search for keywords like "Energy Poverty" delivers no results, "Deep Renovation" highlights 3 and "energy" shows 21 results, most of which are architecture-related, the term "Community" is present in the majority of the results (42/75).

[2022] Energy Poverty and Vulnerable Consumers Coordination Group

This group was designed to connect the Commission and Member States

"Tasks of the Group 1.
The Group's tasks shall be:
(a) to serve as the main platform for the exchange of information and coordination between the Commission and Member States on questions relating to the design and implementation of Union legislation, programmes and policies addressing financially weak households or those affected by

energy poverty and vulnerable consumers, including in the context of affordability of energy, target ed renovation and energy efficiency measures and financing schemes at national level;
(b) to provide a forum for exchanging experiences, best practices and expertise in addressing vulnerable consumers and financially weak households or those affected by energy poverty, including at regional and local levels
(c) to assist the Commission and the Member States in designing policy initiatives, in particular in relation to their National Energy and Climate Plans, Integrated National Energy and Climate Progress Reports and related strategies." (EC, 2022)

[2023] EPBD 'Recast 2023' Texts Adopted by EP, 2023 [Mar 2023] (PROPOSAL)

There are significant clarifications in the 2023 EPBD recast proposal:

"Article 1 Subject matter
1. This Directive promotes the improvement of the energy performance of buildings and the reduction of greenhouse gas emissions from buildings within the Union, with a view to achieving a zero-emission building stock by 2050, taking into account the outdoor climatic conditions, the local conditions, the requirements for indoor environmental quality and the contribution of the building stock to demand-side flexibility for the purpose of improving energy system efficiency and cost-effectiveness.
2. This Directive lays down requirements as regards: (a) the common general framework for a methodology for calculating the integrated energy performance of buildings and building units; (b) the application of minimum requirements to the energy performance of new buildings and new building units; (c) the application of minimum requirements to the energy performance of: (i) existing buildings and building units that are subject to major renovation; (ii) building elements that form part of the building envelope and that have a significant impact on the energy performance of the building envelope when they are retrofitted or replaced; (iii) technical building systems whenever they are installed, replaced or upgraded; (d) the application of minimum energy performance standards to existing buildings and existing building units, in accordance with Articles 3 and 9; (da) a harmonised framework for assessing the life-cycle global warming potential; (db) solar energy in buildings; (dc) the phasing out of fossil fuel use in buildings; (e) renovation passports; (f) national building renovation plans; (g) sustainable mobility infrastructure in and adjacent to buildings; and (h) smart buildings; (ha) nature-based solutions that reinforce the good use and adaptation of the public space surrounding the buildings with elements such as wood materials, green roofs and facades and solutions that are inspired and supported by nature, which can simultaneously provide environmental, social and economic benefits and help build resilience; (i) energy performance certification of buildings or building units; (j) regular inspection of heating, ventilation and air-conditioning systems in buildings; (k) independent control systems for energy performance certificates, renovation passports, smart readiness indicators and inspection reports; (ka) the indoor environmental quality performance of buildings.
3. The requirements laid down in this Directive are minimum requirements and shall not prevent any Member State from maintaining or introducing more stringent measures.(…)"

(EPBD 'Recast 2023' Texts Adopted by EP, 2023, pp. 33–34)

[2023-05] Social Climate Fund [May 2023]

The 2050

[2019] European Green Deal (p.142) strategy towards economic growth decoupled from resource use refers to citizens' health and well-being as one of the key goals, while emphasizing that

> *this transition must be just and inclusive – or it will not happen at all.”* *(Von der Leyen, 2019, p. 8)*

The Social Climate Fund is referenced in the 'Fit for 55'

> *«a new Social Climate Fund will provide dedicated funding to Member States to support European citizens most affected or at risk of energy or mobility poverty, to accompany the introduction of the Emissions Trading to road transport and buildings. Energy poverty alone affects up to 34 million people in the European Union today. The Fund will help mitigate the costs for those most exposed to fossil fuel price increases during the transition.» (‘Fit for 55’, 2021, p. 4)*

In its inception the key strategies REVERTER pilots must act upon for maximum replicability are confirmed: REVERTER pilots and conclusions are “just-in-time” for influencing Member States' formalization of their “Social Climate Plans”

> *“Article 1 Subject matter and scope*
> *This Regulation establishes the Social Climate Fund (the ‘Fund’) for the period from 2026 to 2032. The Fund shall provide financial support to Member States for the measures and investments included in their Social Climate Plans (the ‘Plans’). The measures and investments supported by the Fund shall benefit households, micro-enterprises and transport users, which are vulnerable and particularly affected by the inclusion of greenhouse gas emissions from buildings and road transport within the scope of Directive 2003/87/EC, in particular households in energy poverty or households in transport poverty.”* *(Social Climate Fund (2023/955), 2023, p. 10)*

[2023-10] Renewable Energy Directive and the ReFuelEU Aviation Regulation

By the 9th of October 2023, the Commission adopted the Renewable Energy Directive and the ReFuelEU Aviation Regulation, placing the Fit for 55' legislative train[11] closer to arrival. Legally binding climate targets are now enforced across the main sectors of the economy:

> *The European Green Deal is delivering the change we need to reduce CO_2 emissions. It does so while keeping the interests of our citizens in mind, and providing opportunities for our European industry. The legislation to reduce our greenhouse gas emissions by at least 55% by 2030 is now in place, and I am very happy that we are even on track to overshoot this ambition. This is an important sign to Europe and to our global partners that the green transition is possible, that Europe is delivering on its promises.*
> *(EC, 2023e)*

[11]The progress can be observed at https://www.europarl.europa.eu/legislative-train/package-fit-for-55

Vulnerable citizens are defined:

“(76) In accordance with Article 9 of the Treaty on the Functioning of the European Union (TFEU), the Union’s energy efficiency policies should be inclusive and should therefore ensure equal access to energy efficiency measures for all consumers affected by energy poverty. Improvements in energy efficiency should be implemented as a priority among people affected by energy poverty, vulnerable customers and final users, people in low-income or medium income households, people living in social housing, older people as well as people living in rural and remote areas and in the outermost regions. In that context, specific attention should be paid to particular groups which are more at risk of being affected by energy poverty or are more susceptible to the adverse impacts of energy poverty, such as women, persons with disabilities, older people, children, and people with a minority racial or ethnic background. Member States can require obligated parties to include social aims in energy-saving measures in relation to energy poverty, and this possibility has already been extended to alternative policy measures and national energy efficiency funds. That should be transformed into an obligation to protect and empower vulnerable customers and final users and to alleviate energy poverty, while allowing Member States to retain full flexibility with regard to the type of policy measure, its size, scope and content. (…) Member States should make best possible use of public funding investments into energy efficiency improvement measures, including funding and financial facilities established at Union level. (77) Each Member State should define the concept of vulnerable customers, which may refer to energy poverty and, inter” (Energy Efficiency Directive (Recast), 2023, p. 15)

12 Annex C: Barriers for LTRS

Table 39: Barriers for LTRS.

Country	Type of barrier	Barrier
Greece	**Market**	High actual costs including hidden investment expenses
		Reduced access to funds
		Absence of energy, labelling and certification standards for the materials used in construction and the absence of integrated technical support by energy service providers
		Lack of skills and training among the actors involved
		No defined national standard is applied for taking adequate and certified measurements of the actual energy consumption in buildings
		Absence of energy data, as energy consumption files are not kept and/or updated
	Non-market	Lack of information and knowledge
		Uncertainty (regarding future developments in terms of technology, energy prices, regulatory framework)
Lithuania	**Planning stage barriers**	Insufficient interinstitutional coordination
		Unreliable (asymmetric) information
		Insufficient involvement of local self-government
	Barriers to developing support measures	Unattractive payback period for projects
		Partial price of energy
		Renovation becoming more expensive
		Full potential of renovation benefits not realized
		Sustainability of the transformation is not ensured
	Barriers to securing finance	Reluctance of building owners to borrow
		Inability of building owners to borrow (limited borrowing possibilities)
		Increased need for public finances
		Reluctance of financial institutions to lend (limited lending possibilities)
	Communications barriers	Insufficient information on the benefits of renovation
		Insufficient information on the inevitability of renovation
	Barriers to implementation	Insufficient managerial capacity of municipalities
		Barriers to the procurement process
		Poor quality investment plans
		Insufficient quality control of renovation implementation
		Restrictions on the workforce in the construction sector
		Insufficient motivation of public building managers
Croatia	**Financial**	Long return-on-investment period
		Limited financial capacity and access to capital of building owners
		Underdevelopment of financial instruments and contracting models
	Legal	No obligation to maintain/improve buildings
		Complex procedures and lengthy procurement procedures
		Unresolved property relations
	Social trends	Emigration and depopulation
		Availability of skilled labour

	Information	Lack of motivation without financial incentives
Latvia	**Private houses**	Difficult to choose an appropriate technological solution
		Doubts about the result
		Challenge of finding a solution of an appropriate quality at a reasonable price
		need for behavioural change
		Limited access to funding
	Apartment buildings	Lack of awareness/knowledge of the potential benefits
		Lack of initiative and bad/unsuccessful examples discourage applying for the programme
		Applying for the programme is considered bureaucratic
		Adopting a decision at a general meeting of the house with the required 67% majority of votes
		There is currently no 'stick' principle to encourage potential customers
		Complexity of project implementation, given that there are many parties involved in project implementation
		The prospects for regional development are uncertain
		Aid intensity and attracting grants are necessary to perform all planned works
		Extending maximum aid intensity beyond the most deprived persons
Finland	**Single-family and semi-detached houses**	The assessment of a building's energy efficiency depends on the initiative and activity of the owner
		Owners may refrain from implementing some repairs in fear of the repairs leading to other necessary repair actions
		Some residential buildings will not be permanently occupied
	Terraced houses/Blocks of flats	Responsibility for the activities of a housing company lies with the Board of Directors, which usually consists of lay members who may lack the knowledge, skills and time to actively participate in the preparation and commissioning of renovation projects
		Decisions on repairs can be overturned due to opposition from the shareholders. One underlying reason for such opposition may be a lack of funds.
		Some repairs are not implemented because of a fear of the repairs leading to other necessary repair actions
		If a terraced house includes a small number of housing units, a building-specific loan will not be granted
		To cover the repair costs in areas with a low cost level, other funding is required in addition to a bank loan
		Some terraced houses are about to become completely vacant or underused in areas suffering from depopulation
Spain	**-**	Financial barriers
		Negative collateral impact which receiving subsidies for renovation has on the families with the lowest incomes, as it has a negative effect on their personal income tax
		Lack of trust/quality
		Architectural barriers
		Ownership structure

		Challenges from the cultural point of view, such as encouraging a culture of maintenance and preventive conservation, especially with regard to the common elements of multi-family residential buildings
		Limited awareness on the part of developers, who, when it comes to making the relevant decisions, at times opt for conventional heating and cooling solutions for their buildings, without giving sufficient thought to the inclusion of renewable energy.
		Difficult to change the existing distributions of building types, or to make them more flexible, and it also makes it difficult to reach agreements regarding common elements
Hungary	**-**	High implicit discount rates on the part of owners
		Lack of information
		Uncertainties about returns
		Long payback periods
		Organizational barriers due to the different uses or ownerships
		ESCOs (low global price of energy prices, high volume of EU non-refundable funds, high costs of refurbishment of the public building, ESCO company cannot be involved in a project where EU funds are used, since all EU funds are subject to the condition that a given asset/investment is owned by the applicant or is activated by the applicant and must ensure its maintenance/operation for a given period of time.)
		Accessibility barriers during renovations
Romania	**For all types of buildings**	Public policies: low energy prices (especially for heating), absence of a cost-optimization methodology framework
		Technical: low reference values (poor heating), part of the building stock has old structural and safety deficiencies, requiring reinforcement interventions prior to EE interventions; different quality of the documents prepared by building energy auditors (including inconsistency in data reporting, the fact that the accuracy of the data written in EPC/audit reports/inspection reports is uncontrollable or unverifiable)
		Financial: high commercial interest rates, lack of guarantees or over-guaranteeing, small projects leading to high transaction and development costs, lack of creditworthy borrowers and of specialized credit products (dedicated to major energy renovation of buildings)
		Institutional and informational: lack of adequate data on buildings and energy use, limited capacity for monitoring implementation/contractors or insufficient monitoring tools, lack of knowledge on the opportunities and benefits of energy efficiency, which is due to a deficient information/training system in terms of quantity and quality and which drives certain behavioural inertia
	Multi-family buildings	Public policies: billing not based on actual apartment consumption, legislation on owners' associations providing for collective decision-making, lack of interest on the part of owners' associations or poor ability to borrow from banks, to pay debts, low quality district heating services
		Financial: low income/low disposable income of homeowners, owners' associations that are not creditworthy, generating dependency on public grants

		Institutional and informational: lack of clear and reliable mechanisms for renovation works, mistrust towards payment of instalments by neighbors, lack of control possibility (thermostatic valves in radiators), lack of information on costs incurred with poor air quality
	Single-family houses	Public policies: low prices/non-regulated solid fuels, lack of standards for existing heating equipment/boilers and buildings, lack of legislation on non-clean fuels that influence air quality and generate CO_2 emissions
		Financial: low income/low disposable income of property owners, high immediate costs and long repayment periods, higher costs for clean fuels, insufficient access to existing programmes
		Institutional and informational: lack of clear and reliable mechanisms for energy renovation, lack of information on costs incurred with poor indoor air quality
Bulgaria	**Innovation, research and development**	High price of innovative technologies
		Lack of social and economic studies of the effects of housing renovation, including its broader benefits
		Inadequate support for research and development, the design and implementation of demonstration projects showcasing new or improved renovation technologies and the multiplication of best practices
	Technical barrier	Lack of technical capacity at the level of local authorities
		A high share of vacant housing units in a building
		Limited technical passports issued
		Lack of a database of publicly owned and residential buildings
		The lack of regular maintenance of residential buildings
		Difficulties in implementing energy efficiency measures in buildings that are not connected to centralized energy supply systems
		Development of EU law and standardization of construction materials
	Information and capacity related	Underdeveloped culture of renovating buildings
		Lack of awareness among the broader public of the advantages of major renovation
		Lack of training on energy efficiency projects
		Shortage of construction workers and specialists
		Insufficiently qualified and experienced actors in the supply chain
		Lack of accessible, quality advice on the measures and steps
		Barriers to conducting analyses and reporting on renovation plans and programmes at national and local level
		Lack of reliable information about the results of renovation programmes
	Financial barrier	Limited access to financing
		Lack of sufficient financial resources to allow home owners to undertake energy efficiency upgrades on their own
		The need for co-financing and the lack of a well-developed social safety net
		The low creditworthiness of the owners' association
		The average size of energy efficiency projects is often small
		Perception of risk by financing institutions
		Poor coordination of policies on building stock renovation

	Legislative and regulatory	Non-market energy prices make investments in the major renovation of buildings less attractive
		High intensity of grant assistance (100 %), which creates unrealistic expectations
		Lack of predictability and poor long-term planning of renovation programs
		Practices of poor and inefficient management of multi-family buildings
		Structure of ownership in residential buildings
		Lack of measures to promote heating from cost-effective and environmentally friendly sources
		Using polluting solid fuels
		Lack of incentives for achieving the nZEB standard
		Insufficient administrative capacity for nZEBs
		Lack of a study and criteria at national level to assess the readiness of buildings for smart management
		Lack of regulatory conditions for the repurposing and subsequent re-use of products from construction waste
		Lack of coordination with other strategic and programme documents at national and local level
		Dynamic development and complex structure of energy efficiency legislation
		Putting in place the 'Energy Efficiency First' principle
Portugal	-	High renovation cost
		Relatively long periods of amortization and risks
		Lack of awareness
		Limited access to financing
		Lack of skilled labor
		Complex regulatory framework
		Building design constraints
		Limited Availability of Products and Services
		Constraints arising from the owner/tenant relationship
		Lack of demand for financial products and mechanisms
		Complexity of applying to the available financing instruments
		Natural ageing of materials and lack of maintenance

13 Annex D: Reference Buildings

13.1 Brezovo – Single-Family Building

I. Building location and dimensions

1.1. Approximate building picture (real life picture or sketch up)	
1.2. Building dimensions and orientation	
1.3. Building location	**Bulgaria**
1.4. Building type	**Single/Multifamily building**

II. Basic information about the building

2.1. Typical construction year		1974
2.2. Floors	2.2.1. is there a basement (yes/ no)	Yes
	2.2.2. number of standard floors (number)	3
	2.2.3. number of technical floors (number)	0
2.3. Apartments	2.3.1 apartment count	6
	2.3.2. total area (m^2) (without loggias and balconies)	384
	2.3.3. height of premises (m)	2,7
	2.3.4. calculation temperature (°C)	22,0

	2.3.5. other information	-		
2.4. Stairwells	2.4.1. count of stairwells	3		
	2.4.2. area (m^2)			
	2.4.3. height of premises (m)	2,7		
	2.4.4. calculation temperature (°C)	17,0		
	2.4.5. other information	-		
2.5. Basement, attic, roof floor, attic floor	2.5.1. name of the space	Basement	-	-
	2.5.2. area (m^2)	128	-	-
	2.5.3. height of premises (m)	2,7	-	-
	2.5.4. calculation temperature (°C)	-	-	-
	2.5.5. area of calculation if heated (m^2)	-	-	-
	2.5.6. other information	-	-	-
2.6. Total calculation area – heated area space (m^2)		384		
2.7. External dimensions of the building (if the building has an irregular shape, a sketch is attached to the annex)		length (m)		
		width (m)		
		height (m)		

III Existing building envelope

3.1. Information on each type of external enclosing structure covering the heated spaces included in the total calculation area

No p.k.	Enclosing structure	Material(s)	Thickness	Material heat conductivity λ or U value*	Area
			mm		m^2
1	2	3	4	5	6
1.	External walls of apartments	Brick walls Internal/external coatings	250 40	λ = 0,52 λ = 0,70	369
2.	Windows	Double glazing PVC/AL			68,60

		Wooden frames				
3.	Combined roof covering in apartments	Hollow reinforced concrete panel Slag	220 120	λ = 0,65 λ = 0,21	128	
4.	Basement covering	Hollow reinforced concrete panel Slag	220 50	λ = 0,65 λ = 0,21	128	
5.	New windows in apartments	Double-glazed units in AL/ PVC frames		U = 2,60	N	7,9
					E	13,7
					S	27,4
					W	19,6
6.	Old wooden windows in apartments	Double glazing in a combined wooden frame		U = 2,6	N	
					E	
					S	
					W	
7.	Exterior doors of the building	Metal		U = 3,2	N	12,8
					E	
					S	
					W	
8.	Exterior doors of the building	Wooden		U = 3,6	N	
					E	
					S	
					W	
9.	Staircase windows	Double glazing in a combined wooden frame		U = 2,8	N	
					E	
					S	
					W	-
10.	Roof hatch	Metal		U = 2,0	3,8	

*Heat conductivity values λ for materials in W/mK or U values for windows and doors in W/m^{2}K.

IV Technical systems and energy distribution of the building

4.1. Ventilation systems in building areas

		ZONE 1
4.1.1. Rooms with natural ventilation	1.1.1. calculation area, m^2	328
	1.1.2. volumes, m^3	726
	1.1.3. air exchange intensity used in the calculation, including leaching (1/h)	0,55
	1.1.4. Air flow delivery temperature, °C	0,0
4.1.2. Rooms with mechanical ventilation	1.2.1. calculation area, m^2	-
	1.2.2. volumes, m^3	-
	1.2.3. calculated intensity of air exchange used, (1/h)	-
	1.2.4. calculated infiltration used, (1/h)	-
	1.2.5.Air flow delivery temperature, °C	-

4.2. Heat supply/production

4.2.1. Heat energy production. Please, describe how heat energy is supplied to the building:

Building is connected to the district heating system. The heat energy from DH is used to ensure heating of apartments and to prepare hot water.	
Seasonal coefficient of performance	1
Emissions factor for heating system, t/MWh	0,483
Energy price and unit of measure	110 EUR/MWh

Hot water distribution system

Average hot water supply temperature (°C)	55	
Cold water inlet temperature (°C)	10	
Hot water preparation		Preparation in the heating unit
		centralized supply
	X	Individual

		Other, please describe:
Seasonal coefficient of performance	1	
Emissions factor for hot water preparation, t/MWh	0,483	
Energy price and unit of measure	110 EUR/MWh	

4.3. Cooling energy. Please, describe how cooling is provided in the building:

Some apartments have decentralized split-type cooling units. Estimated COP of the cooling units is 3.	
Seasonal coefficient of performance	3
Emissions factor for electricity, t/MWh.	0,483
Energy price and unit of measure	120 EUR/MWh

5. Energy efficiency measure analysis

5.1. Summary of building renovation Package 1

Energy needs reduction	**49,0%**
Delivered energy reduction	**55,7%**
CO_2 emissions reduction	**55,7%**
SPBT	**24,5**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**0,9**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	61,3	159,7	16,2	42,1	19,08	128 887,09 €	21,17	5 260,24 €
Cooling needs	7,7	20,1	11,8	30,7				
DHW preparation	14,8	38,6	14,8	38,6				

	218,4		**111,3**	

Renovation Package 2 description

Walls	**Walls are insulated with a 50mm thick layer of mineral wool insulation** with a heat conductivity rating of λ≤0,039 W/mK.
Roof	**Roof is insulated with a 100mm thick layer of rigid mineral wool** insulation boards with a heat conductivity rating of λ≤0,039 W/mK.
Basement	The building plinth is additionally insulated with a 100mm thick layer of XPS with a heat conductivity rating of λ≤0,036 W/mK, at least 50cm below grade level to ensure insulation layer extension below ground freezing layer.
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,40 W/m^{2}K
Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,1 W/m^{2}K
Technical systems	-

5.2. Summary of building renovation Package 2

Energy needs reduction	**55,4%**
Delivered energy reduction	**64,5%**
CO_2 emissions reduction	**64,5%**
SPBT	**23,7**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**1,2**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	61,3	159,7	8,3	21,7	29,57	144772,39 €	24,54	6 097,28 €
Cooling needs	7,7	20,1	14,2	37,1				
DHW preparation	14,8	38,6	14,8	38,6				
		218,4		**97,4**				

Renovation Package 2 description

Walls	**Walls are insulated with a 120mm thick layer of mineral wool insulation** with a heat conductivity rating of λ≤0,039 W/mK.
Roof	**Roof is insulated with a 150mm thick layer of rigid mineral wool** insulation boards with a heat conductivity rating of λ≤0,039 W/mK.
Basement	**Unheated basement ceiling is insulated with a 100mm thick** layer of mineral wool insulation with a heat conductivity rating of λ≤0,03 W/mK. The building plinth is additionally insulated with a 100mm thick layer of XPS with a heat conductivity rating of λ≤0,039 W/mK, at least 100cm below grade level to ensure insulation layer extension below ground freezing layer.
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,40 W/m^{2}K
Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,1 W/m^{2}K
Technical systems	-

5.3. Summary of building renovation Package 3

Energy needs reduction	**55,4%**
Delivered energy reduction	**84,2%**
CO_2 emissions reduction	**84,2%**
SPBT	**19,7**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**1,1**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	61,3	159,7	8,3	21,7	33,72	156772,39 €	32,02	7 955,05 €
Cooling needs	7,7	20,1	14,2	37,1				
DHW preparation	14,8	38,6	14,8	38,6				
		218,4		**97,4**				

Renovation Package 3 description

Walls	Walls are insulated with a 120mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,039 W/mK.
Roof	Roof is insulated with a 150mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,039 W/mK.
Basement	Unheated basement ceiling is insulated with a 100mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,041 W/mK. The building plinth is additionally insulated with a 100mm thick layer of XPS with a heat conductivity rating of λ≤0,036 W/mK, at least 50cm below grade level to ensure insulation layer extension below ground freezing layer.
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,40 W/m^2K
Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,1 W/m^2K
Technical systems	High-efficient individual A2A heat pumps A2W heat pump for DHW

13.2 Brezovo – Multi-Family Building

I. Building location and dimensions

1.1. Approximate building picture (real life picture or sketch up)	
1.2. Building dimensions and orientation	
1.3. Building location	**Bulgaria**
1.4. Building type	**Multifamily building**

II. Basic information about the building

2.1. Typical construction year		1975
2.2. Floors	2.2.1. is there a basement (yes/ no)	Yes
	2.2.2. number of standard floors (number)	5
	2.2.3. number of technical floors (number)	0
2.3. Apartments	2.3.1 apartment count	25
	2.3.2. total area (m^2) (without loggias and balconies)	1725
	2.3.3. height of premises (m)	2,7
	2.3.4. calculation temperature (^oC)	22,0

	2.3.5. other information	-		
2.4. Stairwells	2.4.1. count of stairwells	2		
	2.4.2. area (m^2)			
	2.4.3. height of premises (m)	2,7		
	2.4.4. calculation temperature (°C)	17,0		
	2.4.5. other information	-		
2.5. Basement, attic, roof floor, attic floor	2.5.1. name of the space	Basement	-	-
	2.5.2. area (m^2)	345	-	-
	2.5.3. height of premises (m)	2,7	-	-
	2.5.4. calculation temperature (°C)	-	-	-
	2.5.5. area of calculation if heated (m^2)	-	-	-
	2.5.6. other information	-	-	-
2.6. Total calculation area – heated area space (m^2)				
2.7. External dimensions of the building (if the building has an irregular shape, a sketch is attached to the annex)		length (m)		
		width (m)		
		height (m)		

III Existing building envelope

3.1. Information on each type of external enclosing structure covering the heated spaces included in the total calculation area

No p.k.	Enclosing structure	Material(s)	Thickness	Material heat conductivity λ or U value*	Area
			mm		m^2
1	2	3	4	5	6
1.	External walls of apartments	Concrete walls Internal/external coatings	250 40	λ = 0,52 λ = 0,70	965
2.	Windows	Double glazing PVC/AL			372

		Wooden frames Metal windows				
3.	Combined roof covering in apartments				424	
4.	Basement covering				424	
5.	New windows in apartments	Double-glazed units in AL/ PVC frames		U = 2,60	N	8,84
					E	96,5
					S	6,6
					W	143,7
6.	Old wooden windows in apartments	Double glazing in a combined wooden frame		U = 2,88	N	
					E	28,3
					S	
					W	23,8
7.	Exterior windows of the building	Metal		U = 6,66	N	6,6
					E	15,3
					S	6,6
					W	32,6
8.	Exterior doors of the building	Wooden		U = 6,66	N	
					E	14,3
					S	6,60
					W	
9.	Staircase windows	Double glazing in a combined wooden frame		U = 2,8	N	
					E	
					S	
					W	-
10.	Roof hatch	Metal		U = 2,0	3,8	

IV Technical systems and energy distribution of the building

4.1. Ventilation systems in building areas

		ZONE 1
4.1.1. Rooms with natural ventilation	1.1.1. calculation area, m^2	1725
	1.1.2. volumes, m^3	3859
	1.1.3. air exchange intensity used in the calculation, including leaching (1/h)	0,58
	1.1.4. Air flow delivery temperature, °C	0,0
4.1.2. Rooms with mechanical ventilation	1.2.1. calculation area, m^2	-
	1.2.2. volumes, m^3	-
	1.2.3. calculated intensity of air exchange used, (1/h)	-
	1.2.4. calculated infiltration used, (1/h)	-
	1.2.5.Air flow delivery temperature, °C	-

4.2. Heat supply/production

4.2.1. Heat energy production. Please, describe how heat energy is supplied to the building:

Building provides heat energy via split-type air conditioners.	
Seasonal coefficient of performance	2,07
Emissions factor for heating system, t/MWh	0,483
Energy price and unit of measure	120 EUR/MWh

Hot water distribution system

Average hot water supply temperature (°C)	55	
Cold water inlet temperature (°C)	10	
Hot water preparation		Preparation in the heating unit
		centralized supply
	X	Individual

		Other, please describe:
Seasonal coefficient of performance	1	
Emissions factor for hot water preparation, t/MWh	0,483	
Energy price and unit of measure	120 EUR/MWh	

4.3. Cooling energy. Please, describe how cooling is provided in the building:

Some apartments have decentralized split-type cooling units. Estimated COP of the cooling units is 3.	
Seasonal coefficient of performance	3
Emissions factor for electricity, t/MWh.	0,483
Energy price and unit of measure	120 EUR/MWh

5. Energy efficiency measure analysis

5.1. Summary of building renovation Package 1

Energy needs reduction	**56,6%**
Delivered energy reduction	**58,7%**
CO_2 emissions reduction	**58,7%**
SPBT	**22,4**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**2,1**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	258,0	149,6	56,0	32,5	89,87	241 296,52 €	43,36	10 772,75 €
Cooling needs	43,7	25,3	67,2	39,0				
DHW preparation	13,8	8,0	13,8	8,0				
		182,9		**79,4**				

Renovation Package 1 description

Walls	Walls are insulated with a 120mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,039 W/mK.
Roof	Roof is insulated with a 150mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,039 W/mK.
Basement	Unheated basement ceiling is insulated with a 100mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,036 W/mK. The building plinth is additionally insulated with a 50mm thick layer of XPS with a heat conductivity rating of λ≤0,039 W/mK, at least 100mm below grade level to ensure insulation layer extension below ground freezing layer.
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,40 W/m^{2}K
Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,1 W/m^{2}K
Technical systems	-

5.2. Summary of building renovation Package 2

Energy needs reduction	**57,4%**
Delivered energy reduction	**59,6%**
CO_2 emissions reduction	**59,6%**
SPBT	**23,3**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**2,2**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	258,0	149,6	52,3	30,3	96,12	254 837,73€	44,03	10 939,16 €
Cooling needs	43,7	25,3	68,3	39,6				
DHW preparation	13,8	8,0	13,8	8,0				
		182,9		**78,0**				

Renovation Package 1 description

Walls	Walls are insulated with a 150mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,039 W/mK.
Roof	Roof is insulated with a 200mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,039 W/mK.
Basement	Unheated basement ceiling is insulated with a 100mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,039 W/mK. The building plinth is additionally insulated with a 50mm thick layer of XPS with a heat conductivity rating of λ≤0,039 W/mK, at least 100mm below grade level to ensure insulation layer extension below ground freezing layer.
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,40 W/m^{2}K
Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,1 W/m^{2}K
Technical systems	-

5.3. Summary of building renovation Package 3

Energy needs reduction	**57,4%**
Delivered energy reduction	**65,4%**
CO_2 emissions reduction	**65,4%**
SPBT	**24,3**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**1,9**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	258,0	149,6	52,1	30,2	92,75	291 427,73 €	48,37	12 016,37 €
Cooling needs	43,7	25,3	68,4	39,7				
DHW preparation	13,8	8,0	13,8	8,0				
		182,9		**77,8**				

Renovation Package 2 description

Walls	Walls are insulated with a 150mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,039 W/mK.
Roof	Roof is insulated with a 200mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,039 W/mK.
Basement	Unheated basement ceiling is insulated with a 100mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,039 W/mK. The building plinth is additionally insulated with a 100mm thick layer of XPS with a heat conductivity rating of λ≤0,039 W/mK, at least 100mm below grade level to ensure insulation layer extension below ground freezing layer.
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,40 W/m^2K
Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,1 W/m^2K
Technical systems	A2W heatpump for DHW

13.3 Brezovo – Public Building

I. Building location and dimensions

1.1. Approximate building picture (real life picture or sketch up)	
1.2. Building dimensions and orientation	
1.3. Building location	**Bulgaria**
1.4. Building type	**Public building – School with Sports hall**

II. Basic information about the building

2.1. Typical construction year		1965
2.2. Floors	2.2.1. is there a basement (yes/ no)	Yes
	2.2.2. number of standard floors (number)	3
	2.2.3. number of technical floors (number)	0
2.3. Apartments	2.3.1 apartment count	1
	2.3.2. total area (m^2) (without loggias and balconies)	2030
	2.3.3. height of premises (m)	2,7
	2.3.4. calculation temperature (°C)	22,0

	2.3.5. other information	-		
2.4. Stairwells	2.4.1. count of stairwells	2		
	2.4.2. area (m^2)			
	2.4.3. height of premises (m)	2,7		
	2.4.4. calculation temperature (°C)	17,0		
	2.4.5. other information	-		
2.5. Basement, attic, roof floor, attic floor	2.5.1. name of the space	Basement	-	-
	2.5.2. area (m^2)	819,0	-	-
	2.5.3. height of premises (m)	2,7	-	-
	2.5.4. calculation temperature (°C)	-	-	-
	2.5.5. area of calculation if heated (m^2)	-	-	-
	2.5.6. other information	-	-	-
2.6. Total calculation area – heated area space (m^2)		2030		
2.7. External dimensions of the building (if the building has an irregular shape, a sketch is attached to the annex)		length (m)		
		width (m)		
		height (m)		

III Existing building envelope

3.1. Information on each type of external enclosing structure covering the heated spaces included in the total calculation area

No p.k.	Enclosing structure	Material(s)	Thickness	Material heat conductivity λ or U value*	Area
			mm		m^2
1	2	3	4	5	6
1.	External walls of apartments	Concrete walls Internal/external coatings	380 40	λ = 0,52 λ = 0,70	1485
2.	Windows	Double glazing PVC/AL			334

		Wooden frames Metal windows				
3.	Combined roof covering in apartments				819	
4.	Basement covering				819	
5.	New windows in apartments	Double-glazed units in AL/ PVC frames		U = 2,60	N	12,65
					E	12,6
					S	163,5
					W	1,4
6.	Old wooden windows in apartments	Double glazing in a combined wooden frame		U = 2,88	N	24,35
					E	57,6
					S	56,4
					W	7
7.	Exterior windows of the building	Metal		U = 6,66	N	2,1
					E	8,2
					S	6,2
					W	
8.	Exterior doors of the building	Metal		U = 6,66	N	
					E	
					S	
					W	
9.	Staircase windows	Double glazing in a combined wooden frame		U = 2,8	N	
					E	
					S	
					W	
10.	Roof hatch	Metal		U = 2,0	3,8	

IV Technical systems and energy distribution of the building

4.1. Ventilation systems in building areas

		ZONE 1
4.1.1. Rooms with natural ventilation	1.1.1. calculation area, m^2	2030
	1.1.2. volumes, m^3	7096
	1.1.3. air exchange intensity used in the calculation, including leaching (1/h)	1,70
	1.1.4. Air flow delivery temperature, °C	0,0
4.1.2. Rooms with mechanical ventilation	1.2.1. calculation area, m^2	-
	1.2.2. volumes, m^3	-
	1.2.3. calculated intensity of air exchange used, (1/h)	-
	1.2.4. calculated infiltration used, (1/h)	-
	1.2.5.Air flow delivery temperature, °C	-

4.2. Heat supply/production

4.2.1. Heat energy production. Please, describe how heat energy is supplied to the building:

Building is connected to the district heating system. The heat energy from DH is used to ensure heating of apartments and to prepare hot water.	
Seasonal coefficient of performance	0,90
Emissions factor for heating system, t/MWh	0,220
Energy price and unit of measure	60 EUR/MWh

Hot water distribution system

Average hot water supply temperature (°C)	55	
Cold water inlet temperature (°C)	10	
Hot water preparation		Preparation in the heating unit
		centralized supply
	X	Individual

		Other, please describe:
Seasonal coefficient of performance	1	
Emissions factor for hot water preparation, t/MWh	0,483	
Energy price and unit of measure	110 EUR/MWh	

4.3. Cooling energy. Please, describe how cooling is provided in the building:

Some apartments have decentralized split-type cooling units. Estimated COP of the cooling units is 3.	
Seasonal coefficient of performance	3,8
Emissions factor for electricity, t/MWh.	0,483
Energy price and unit of measure	110 EUR/MWh

5. Energy efficiency measure analysis

5.1. Summary of building renovation Package 1

Energy needs reduction	**50,8%**
Delivered energy reduction	**58,2%**
CO_2 emissions reduction	**52,5%**
SPBT	**15,9**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**1,7**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	294,9	145,3	106,6	52,5	77,04	193 039,10 €	44,44	12 157,06 €
Cooling needs	35,6	17,5	47,7	23,5				
DHW preparation	16,2	8,0	16,2	8,0				
		170,8		**84,0**				

Renovation Package 1 description

Walls	Walls are insulated with a 50mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,039 W/mK.
Roof	Roof is insulated with a 100mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,039 W/mK.
Basement	The building plinth is additionally insulated with a 50mm thick layer of XPS with a heat conductivity rating of λ≤0,036 W/mK, at least 500m below grade level to ensure insulation layer extension below ground freezing layer.
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,40 W/m^2K
Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,1 W/m^2K
Technical systems	-

5.2. Summary of building renovation Package 2

Energy needs reduction	**56,6%**
Delivered energy reduction	**65,6%**
CO_2 emissions reduction	**59,0%**
SPBT	**16,3**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**2,0**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m^2	MWh	kWh/m^2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	294,9	145,3	82,1	40,5	97,62	222 719,10 €	49,87	13 653.92 €
Cooling needs	35,6	17,5	51,9	25,6				
DHW preparation	16,2	8,0	16,2	8,0				
		170,8		**74,0**				

Renovation Package 2 description

Walls	Walls are insulated with a 120mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,039 W/mK.
Roof	Roof is insulated with a 150mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,039 W/mK.
Basement	The building plinth is additionally insulated with a 100mm thick layer of XPS with a heat conductivity rating of λ≤0,036 W/mK, at least 100mm below grade level to ensure insulation layer extension below ground freezing layer.
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,40 W/m^{2}K
Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,1 W/m^{2}K
Technical systems	-

5.3. Summary of building renovation Package 3

Energy needs reduction	**57,7%**
Delivered energy reduction	**84,8%**
CO_2 emissions reduction	**69,3%**
SPBT	**19,1**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**1,8**

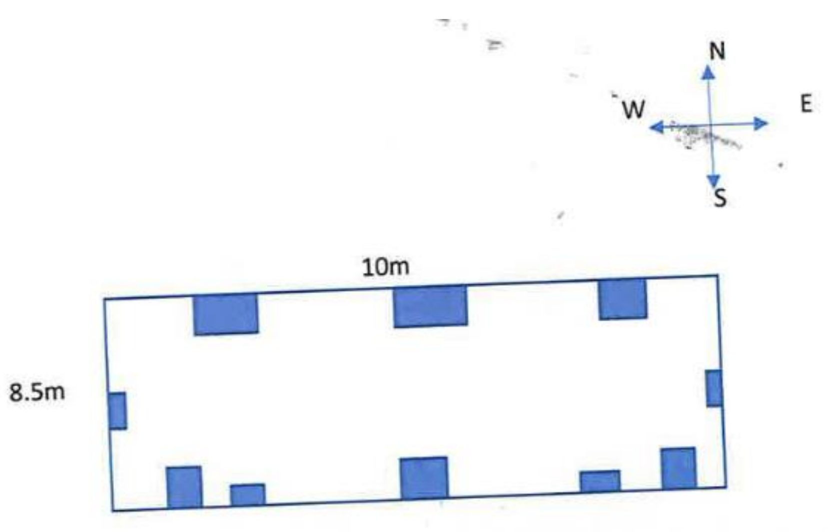
	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	294,9	145,3	76,7	37,8	108,33	312092,10 €	58,63	16 315,35 €
Cooling needs	35,6	17,5	53,6	26,4				
DHW preparation	16,2	8,0	16,2	8,0				
		170,8		**72,3**				

Renovation Package 3 description

Walls	Walls are insulated with a 150mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,039 W/mK.
Roof	Roof is insulated with a 200mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,039 W/mK.
Basement	Unheated basement ceiling is insulated with a 100mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,046 W/mK. The building plinth is additionally insulated with a 100mm thick layer of XPS with a heat conductivity rating of λ≤0,039 W/mK, at least 100mm below grade level to ensure insulation layer extension below ground freezing layer.
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,40 W/m^{2}K
Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,1 W/m^{2}K
Technical systems	New A2A heat pump is installed; SCOP > 3,35 W/W

13.4 Athens – Single-Family Building

I. Building location and dimensions

1.1. Approximate building picture (real life picture or scetch up)	
1.2. Building dimensions and orientation	

1.3. Building location	**Athens, Greece**
1.4. Building type	**Single family building**

II. Basic information about the building

2.1. Typical construction year		1960 – 1970		
2.2. Floors	2.2.1. is there a basement (yes/ no)	Yes		
	2.2.2. number of standard floors (number)	1		
	2.2.3. number of technical floors (number)	0		
2.3. Apartments	2.3.1 apartment count	1		
	2.3.2. total area (m^2) (without loggias and balconies)	85,2		
	2.3.3. height of premises (m)	2,75		
	2.3.4. calculation temperature (°C)	20,0		
	2.3.5. other information	-		
2.4. Stairwells	2.4.1. count of stairwells	-		
	2.4.2. area (m^2)	-		
	2.4.3. height of premises (m)	3,05		
	2.4.4. calculation temperature (°C)	17,0		
	2.4.5. other information	-		
2.5. Basement, attic, roof floor, attic floor	2.5.1. name of the space	Basement	-	-
	2.5.2. area (m^2)	85,2	-	-
	2.5.3. height of premises (m)	3,10	-	-
	2.5.4. calculation temperature (°C)	-	-	-
	2.5.5. area of calculation if heated (m^2)	-	-	-
	2.5.6. other information	-	-	-
2.6. Total calculation area – heated area space (m^2)		85,2		
2.7. External dimensions of the building		length (m)	10	

(if the building has an irregular shape, a sketch is attached to the annex)	width (m)	8,5
	height (m)	3,05

III Existing building envelope

3.1. Information on each type of external enclosing structure covering the heated spaces included in the total calculation area

No p.k.	Enclosing structure	Material(s)	Thickness	Material heat conductivity λ or U value*	Area	
			mm		m²	
1	2	3	4	5	6	
1.	External walls of detached house	Silica brick walls Finishing layer	150 15	λ = 0,800 λ = 0,780	72,4	
5.	Roof of apartment building	Reinforced concrete panel Plaster/cement mortar	350 25	λ = 2,3 λ = 0,780	85,2	
7.	Basement covering	Hollow reinforced concrete panel Slag/stone chips	30 20	λ = 1,51 λ = 0,25	85,2	
9.	New windows in apartments	Double-glazed units in PVC frames with thermal break (titl & turn window)		U = 1,15	N	7,2
					E	3,6
					S	11,4
					W	0,5
10.	Old metal windows in detached house	Metal - Single glazing		U = 4,10	N	7,2
					E	3,6
					S	11,4
					W	0,5
11.	Old Exterior doors of the building	Metal – Single glazing		U = 4,5	N	8,70
					E	-
					S	8,76
					W	-

12.	New exterior doors of the building (living room – front entrance)	Double-glazed in PVC frames with thermal break		U = 1,20	N	-
					E	-
					S	8,76
					W	-
13	New exterior doors of the building (bedrooms)	Double-glazed in PVC frames with thermal break		U = 1,20	N	8,70
					E	-
					S	-
					W	-
					W	-

*Heat conductivity values λ for materials in W/mK or U values for windows and doors in W/m²K.

IV Technical systems and energy distribution of the building

4.1. Ventilation systems in building areas

		ZONE 1
4.1.1. Rooms with natural ventilation	1.1.1. calculation area, m^2	85,2
	1.1.2. volumes, m^3	234,3
	1.1.3. air exchange intensity used in the calculation, including leaching (1/h)	0,5
	1.1.4. Air flow delivery temperature, °C	0,0
4.1.2. Rooms with mechanical ventilation	1.2.1. calculation area, m^2	-
	1.2.2. volumes, m^3	-
	1.2.3. calculated intensity of air exchange used, (1/h)	-
	1.2.4. calculated infiltration used, (1/h)	-
	1.2.5.Air flow delivery temperature, °C	-

4.2. Heat supply/production

4.2.1. Heat energy production. Please, describe how heat energy is supplied to the building:

Building is connected to the oil boiler heating system. An electric water heater is used to prepare hot water.

Seasonal coefficient of performance	0,87
Emissions factor for heating system, t/MWh	0,264
Energy price and unit of measure	125 EUR/MWh

Hot water distribution system

Average hot water supply temperature (^{o}C)	55	
Cold water inlet temperature (^{o}C)	5	
Hot water preparation	X	Preparation in the heating unit (water heater/electric boiler)
		centralized supply
		Individual
		Other, please describe:
Seasonal coefficient of performance	1	
Emissions factor for hot water preparation, t/MWh	0,5333	
Energy price and unit of measure	240 EUR/MWh	

4.3. Cooling energy. Please, describe how cooling is provided in the building:

Some apartments have decentralized split-type cooling units. Estimated COP of the cooling units is 3.	
Seasonal coefficient of performance	2
Emissions factor for electricity, t/MWh.	0,533
Energy price and unit of measure	240 EUR/MWh

5. Energy efficiency measure analysis

5.1. Summary of building renovation Package 1

Energy needs reduction	**0,0%**
Delivered energy reduction	**64,3%**
CO_2 emissions reduction	**35,6%**

SPBT	**2,9**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**0,2**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	26,1	306,6	26,1	306,6	0,64	5 200,00 €	3,58	1 794,22 €
Cooling needs	6,6	77,5	6,6	77,5				
DHW preparation	0,7	8,0	0,7	8,0				
		392,1		**392,1**				

Renovation Package 1 description

Walls	-
Roof	-
Basement	-
Doors	-
Windows	-
Technical systems	Heat pump

5.2. Summary of building renovation Package 2

Energy need reduction	**53,7%**
Delivered energy reduction	**80,4%**
CO_2 emissions reduction	**64,7%**
SPBT	**9,5**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**0,9**

	Before measures	After measures	Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction

	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	26,1	306,6	7,5	88,3	5,54	29.408,04 €	6,50	3 111,23 €
Cooling needs	6,6	77,5	7,3	85,2				
DHW preparation	0,7	8,0	0,7	8,0				
		392,1		**181,5**				

Renovation Package 1 description

Walls	Walls will be insulated with a 150mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,039 W/mK.
Roof	Roof will be insulated with a 200mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,039 W/mK.
Basement	Unheated basement walls will be insulated with a 50mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,034 W/mK.
Doors	-
Windows	-
Technical systems	Heat pump

5.3. Summary of building renovation Package 3

Energy needs reduction	**70,3%**
Delivered energy reduction	**88,4%**
CO_2 emissions reduction	**79,0%**
SPBT	**12,1**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**1,4**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	26,1	306,6	4,5	52,3	11,16	45.357,74 €	7,94	3 760,13 €
Cooling needs	6,6	77,5	4,8	56,2				
DHW preparation	0,7	8,0	0,7	8,0				

	392,1		116,5

Renovation Package 1 description

Walls	Walls will be insulated with a 150mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,039 W/mK.
Roof	Roof will be insulated with a 200mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,039 W/mK.
Basement	Unheated basement walls will be insulated with a 50mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,034 W/mK.
Doors	All metal single-glazed doors will be replaced by double –glazed ones having thermal break (U for living room/bedrooms-overlapping slider - 1,20 W/m^2K)
Windows	All singe-glazed windows will be replaced by double-glazed windows in PVC frame with U value of 1,10 W/m^2K
Technical systems	Heat pump and solar water heater

13.5 Athens – Multi-Family Building

I. Building location and dimensions

1.1. Approximate building picture (real life picture or scetch up)	
1.2. Building dimensions and orientation	
1.3. Building location	**Athens, Greece**
1.4. Building type	**Multifamily building**

II. Basic information about the building

2.1. Typical construction year		1960 – 1970		
2.2. Floors	2.2.1. is there a basement (yes/ no)	Yes		
	2.2.2. number of standard floors (number)	4		
	2.2.3. number of technical floors (number)	0		
2.3. Apartments	2.3.1 apartment count	4		
	2.3.2. total area (m^2) (without loggias and balconies)	400		
	2.3.3. height of premises (m)	2,75		
	2.3.4. calculation temperature (°C)	20,0		
	2.3.5. other information	-		
2.4. Stairwells	2.4.1. count of stairwells	5		
	2.4.2. area (m^2)	14		
	2.4.3. height of premises (m)	3,05		
	2.4.4. calculation temperature (°C)	17,0		
	2.4.5. other information	-		
	2.5.1. name of the space	Basement	-	-
	2.5.2. area (m^2)	100	-	-

2.5. Basement, attic, roof floor, attic floor	2.5.3. height of premises (m)	2,95	-	-
	2.5.4. calculation temperature (°C)	-	-	-
	2.5.5. area of calculation if heated (m^2)	-	-	-
	2.5.6. other information	-	-	-
2.6. Total calculation area – heated area space (m^2)		400		
2.7. External dimensions of the building (if the building has an irregular shape, a sketch is attached to the annex)		length (m)	13	
		width (m)	12	
		height (m)	13,5	

III Existing building envelope

3.1. Information on each type of external enclosing structure covering the heated spaces included in the total calculation area

No p.k.	Enclosing structure	Material(s)	Thickness	Material heat conductivity λ or U value*	Area	
			mm		m^2	
1	2	3	4	5	6	
1.	External walls of apartments (N & S)	Silica brick walls Plaster/cement mortar	150 25	λ = 0,800 λ = 0,780	118 (S)+ 134 (N) = 252	
3.	External walls of staircases	Silica brick walls Plaster/cement mortar	150 25	λ = 0,800 λ = 0,780	16	
5.	Roof of apartment building	Reinforced concrete panel Plaster/cement mortar	300 25	λ = 2,2 λ = 0,780	100	
7.	Basement covering	Hollow reinforced concrete panel Slag	20 20	λ = 1,51 λ = 0,25	100	
9.				U = 1,15	N	-

	New windows in apartments	Double-glazed units in PVC frames with thermal break (titl & turn window)			E	3,52
					S	-
					W	-
10.	Old metal windows in apartments	Metal - Single glazing		U = 4,10	N	-
					E	3,52
					S	-
					W	-
11.	Old Exterior doors of the building (S & N)	Metal – Single glazing		U = 4,0	N	-
					E	44 (S) + 28 (N) = 72
					S	-
					W	-
12.	New exterior doors of the building (living room)	Double-glazed in PVC frames with thermal break		U = 1,20	N	-
					E	44
					S	-
					W	-
13	New exterior doors of the building (bedrooms)	Double-glazed in PVC frames with thermal break		U = 1,15	N	-
					E	28
					S	-
					W	-
14.	Staircase windows	Metal – Single glazing		U = 4,10	N	-
					E	4
					S	-
					W	-

*Heat conductivity values λ for materials in W/mK or U values for windows and doors in W/m^{2}K.

IV Technical systems and energy distribution of the building

4.1. Ventilation systems in building areas

		ZONE 1
4.1.1. Rooms with natural ventilation	1.1.1. calculation area, m^2	400
	1.1.2. volumes, m^3	1100

	1.1.3. air exchange intensity used in the calculation, including leaching (1/h)	0,5
	1.1.4. Air flow delivery temperature, °C	0,0
4.1.2. Rooms with mechanical ventilation	1.2.1. calculation area, m^2	-
	1.2.2. volumes, m^3	-
	1.2.3. calculated intensity of air exchange used, (1/h)	-
	1.2.4. calculated infiltration used, (1/h)	-
	1.2.5.Air flow delivery temperature, °C	-

4.2. Heat supply/production

4.2.1. Heat energy production. Please, describe how heat energy is supplied to the building:

Building is connected to the oil boiler heating system. An electric water heater is used to prepare hot water.	
Seasonal coefficient of performance	0,87
Emissions factor for heating system, t/MWh	0,264
Energy price and unit of measure	125 EUR/MWh

Hot water distribution system

Average hot water supply temperature (°C)	55	
Cold water inlet temperature (°C)	5	
Hot water preparation	X	Preparation in the heating unit (water heater/electric boiler)
		centralized supply
		Individual
		Other, please describe:
Seasonal coefficient of performance	1	
Emissions factor for hot water preparation, t/MWh	0,533	

Energy price and unit of measure	240 EUR/MWh

4.3. Cooling energy. Please, describe how cooling is provided in the building:

Some apartments have decentralized split-type cooling units. Estimated COP of the cooling units is 3.	
Seasonal coefficient of performance	3
Emissions factor for electricity, t/MWh.	0,533
Energy price and unit of measure	240 EUR/MWh

5. Energy efficiency measure analysis

5.1. Summary of building renovation Package 1

Energy needs reduction	**0,0%**
Delivered energy reduction	**60,4%**
CO_2 emissions reduction	**31,8%**
SPBT	**10,8**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**0,7**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	32,8	82,1	32,8	82,1	3,04	24 400,00 €	4,49	2 256,08 €
Cooling needs	9,0	22,4	9,0	22,4				
DHW preparation	4,8	12,0	4,8	12,0				
		116,5		**116,5**				

Renovation Package 1 description

Walls	-
Roof	-
Basement	-
Doors	-

Windows	-
Technical systems	Heat pump

5.2. Summary of building renovation Package 2

Energy needs reduction	**51,7%**
Delivered energy reduction	**76,9%**
CO_2 emissions reduction	**60,3%**
SPBT	**16,4**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**0,9**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	32,8	82,1	8,2	20,4	7,66	66.616,00 €	8,51	4 061,28 €
Cooling needs	9,0	22,4	9,5	23,8				
DHW preparation	4,8	12,0	4,8	12,0				
		116,5		**56,2**				

Renovation Package 2 description

Walls	Walls will be insulated with a 100mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,038 W/mK.
Roof	Roof will be insulated with a 150mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,040 W/mK.
Basement	Unheated basement walls will be insulated with a 100mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,036 W/mK.
Doors	-
Windows	-
Technical systems	Heat pump

5.3. Summary of building renovation Package 3

Energy needs reduction	**61,6%**
Delivered energy reduction	**88,4%**
CO_2 emissions reduction	**80,1%**
SPBT	**20,8**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**1,7**

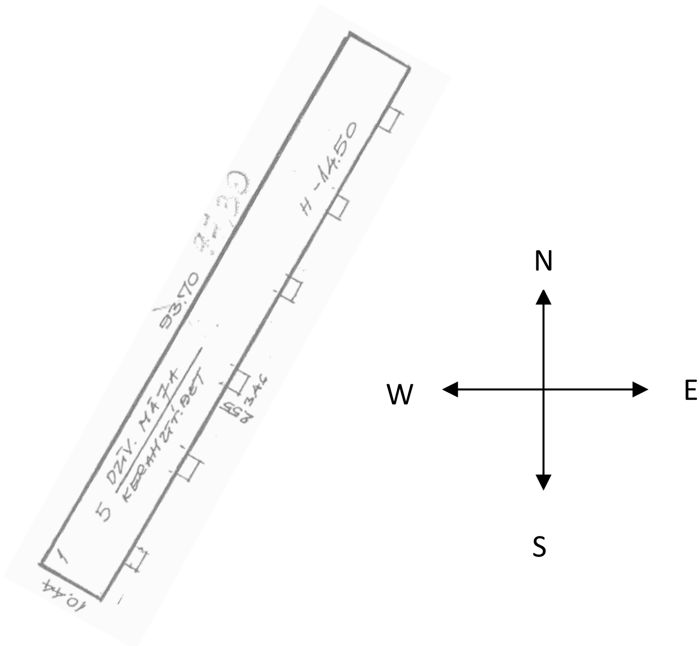
	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	32,8	82,1	2,6	6,5	19,03	110 685,60 €	11,31	5 323,95 €
Cooling needs	9,0	22,4	10,5	26,2				
DHW preparation	4,8	12,0	4,8	12,0				
		116,5		**44,7**				

Renovation Package 3 description

Walls	Walls will be insulated with a 100mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,038 W/mK.
Roof	Roof will be insulated with a 150mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,040 W/mK.
Basement	Unheated basement walls will be insulated with a 100mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,036 W/mK.
Doors	All metal single-glazed doors will be replaced by double –glazed ones having thermal break (U for living rooms- overlapping slider - 1,20 W/m^{2}K & U for bedrooms - pocket slide opening – 1,15 W/m^{2}K)
Windows	All singe-glazed windows will be replaced by double-glazed windows in PVC frame with U value of 1,15 W/m^{2}K
Technical systems	Heat pump and solar water heaters

13.6 Riga – Multi-Family Building

I. Building location and dimensions

1.1. Approximate building picture (real life picture or scetch up)	
1.2. Building dimensions and orientation	
1.3. Building location	**Riga, Latvia**
1.4. Building type	**Multifamily building**

II. Basic information about the building

2.1. Typical construction year		1960. – 1990,		
2.2. Floors	2.2.1. is there a basement (yes/ no)	Yes		
	2.2.2. number of standard floors (number)	5		
	2.2.3. number of technical floors (number)	0		
2.3. Apartments	2.3.1 apartment count	90		
	2.3.2. total area (m^2) (without loggias and balconies)	3472,4		
	2.3.3. height of premises (m)	2,5		
	2.3.4. calculation temperature (°C)	20,0		
	2.3.5. other information	-		
2.4. Stairwells	2.4.1. count of stairwells	6		
	2.4.2. area (m^2)	445,5		
	2.4.3. height of premises (m)	2,5		
	2.4.4. calculation temperature (°C)	17,0		
	2.4.5. other information	-		
2.5. Basement, attic, roof floor, attic floor	2.5.1. name of the space	Basement	-	-
	2.5.2. area (m^2)	1015,8	-	-
	2.5.3. height of premises (m)	2,3	-	-
	2.5.4. calculation temperature (°C)	-	-	-
	2.5.5. area of calculation if heated (m^2)	-	-	-
	2.5.6. other information	-	-	-
2.6. Total calculation area – heated area space (m^2)		3917,9		
2.7. External dimensions of the building (if the building has an irregular shape, a sketch is attached to the annex)		length (m)	97,3	
		width (m)	10,4	
		height (m)	14,5	

III Existing building envelope

3.1. Information on each type of external enclosing structure covering the heated spaces included in the total calculation area

No p.k.	Enclosing structure	Material(s)	Thickness	Material heat conductivity λ or U value*	Area
			mm		m^2
1	2	3	4	5	6
1.	External walls of apartments	Concrete panels with expanded clay Plaster	300 20	λ = 0,4 λ = 0,51	1968,7
2.	Interwindow blocks	Wooden frame Loose mineral wool filling	50 150	λ = 0,21 λ = 0,15	183,8
3.	External walls of staircases	Expanded clay concrete panels Plaster	300 20	λ = 0,4 λ = 0,51	114,2
4.	Interwindow blocks in staircases	Wooden frame Loose mineral wool filling	50 100	λ = 0,21 λ = 0,15	40,9
5.	Combined roof covering in apartments	Hollow reinforced concrete panel Slag	220 120	λ = 0,65 λ = 0,21	922,9
6.	Combined roof covering in staircase	Hollow reinforced concrete panel Slag	220 120	λ = 0,65 λ = 0,21	89,1
7.	Basement covering	Hollow reinforced concrete panel Slag	220 50	λ = 0,65 λ = 0,21	926,7
8.	Basement covering	Hollow reinforced concrete panel Slag	220 50	λ = 0,65 λ = 0,21	89,1
9.	New windows in apartments	Double-glazed units in PVC frames		U = 1,6	N 20,48 E 573,12

					S	25,6
					W	574,64
10.	Old wooden windows in apartments	Double glazing in a combined wooden frame		U = 2,8	N	5,12
					E	143,28
					S	-
					W	271,14
11.	Exterior doors of the building	Metal		U = 3,2	N	-
					E	32,3
					S	-
					W	-
12.	Exterior doors of the building	Wooden		U = 3,6	N	-
					E	6,5
					S	-
					W	-
13.	Staircase windows	Double glazing in a combined wooden frame		U = 2,8	N	-
					E	151,68
					S	-
					W	-
14.	Roof hatch	Metal		U = 2,0	3,8	

*Heat conductivity values λ for materials in W/mK or U values for windows and doors in W/m²K.

IV Technical systems and energy distribution of the building

4.1. Ventilation systems in building areas

		ZONE 1
4.1.1. Rooms with natural ventilation	1.1.1. calculation area, m^2	3472,4
	1.1.2. volumes, m^3	8681,0
	1.1.3. air exchange intensity used in the calculation, including leaching (1/h)	0,59
	1.1.4. Air flow delivery temperature, °C	0,0
4.1.2. Rooms with mechanical ventilation	1.2.1. calculation area, m^2	-
	1.2.2. volumes, m^3	-

	1.2.3. calculated intensity of air exchange used, (1/h)	-
	1.2.4. calculated infiltration used, (1/h)	-
	1.2.5.Air flow delivery temperature, °C	-

4.2. Heat supply/production

4.2.1. Heat energy production. Please, describe how heat energy is supplied to the building:

Building is connected to the district heating system. The heat energy from DH is used to ensure heating of apartments and to prepare hot water.	
Seasonal coefficient of performance	1
Emissions factor for heating system, t/MWh	0,264
Energy price and unit of measure	120 EUR/MWh

Hot water distribution system

Average hot water supply temperature (°C)	55	
Cold water inlet temperature (°C)	5	
Hot water preparation	X	Preparation in the heating unit
		centralized supply
		Individual
		Other, please describe:
Seasonal coefficient of performance	1	
Emissions factor for hot water preparation, t/MWh	0,109	
Energy price and unit of measure	300 EUR/MWh	

4.3. Cooling energy. Please, describe how cooling is provided in the building:

Some apartments have decentralized split-type cooling units. Estimated COP of the cooling units is 3.

Seasonal coefficient of performance	3
Emissions factor for electricity, t/MWh.	0,109
Energy price and unit of measure	180 EUR/MWh

5. Energy efficiency measure analysis

5.1. Summary of building renovation Package 1

Energy needs reduction	**54,1%**
Delivered energy reduction	**59,2%**
CO_2 emissions reduction	**63,4%**
SPBT	**20,6**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**2,7**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	716,7	128,6	240,2	43,1	327,82	1,077M€	124,10	52 396,32€
Cooling needs	31,5	5,7	79,6	14,3				
DHW preparation	44,6	8,0	44,6	8,0				
		142,3		**65,4**				

Renovation Package 1 description

Walls	Walls are insulated with a 150mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,039 W/mK.
Roof	Roof is insulated with a 250mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,039 W/mK.
Basement	Unheated basement ceiling is insulated with a 100mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,041 W/mK. The building plinth is additionally insulated with a 100mm thick layer of XPS with a heat conductivity rating of λ≤0,036 W/mK, at least 50cm below grade level to ensure insulation layer extension below ground freezing layer.
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,8 W/m^{2}K

Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,1 W/m^{2}K
Technical systems	-

5.2. Summary of building renovation Package 2

Energy needs reduction	**54,5%**
Delivered energy reduction	**30,2%**
CO_2 emissions reduction	**64,2%**
SPBT	**19,0**
Renovation material embodied CO2 net offset with energy consumption related CO_2 emissions in years	**2,5**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	716,7	128,6	235,5	42,3	309,54	1,006 M €	125,27	52 852,94 €
Cooling needs	31,5	5,7	80,5	14,4				
DHW preparation	44,6	8,0	44,6	8,0				
		142,3		**64,7**				

Renovation Package 2 description

Walls	Walls are insulated with a 150mm thick layer of EPS NEO 80 insulation with a heat conductivity rating of λ≤0,035 W/mK.
Roof	Roof is insulated with a 250mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,039 W/mK.
Basement	Unheated basement ceiling is insulated with a 100mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,041 W/mK. The building plinth is additionally insulated with a 100mm thick layer of XPS with a heat conductivity rating of λ≤0,036 W/mK, at least 50cm below grade level to ensure insulation layer extension below ground freezing layer.
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,8 W/m2K

Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,1 W/m2K
Technical systems	-

5.2. Summary of building renovation Package 3

Energy needs reduction	**55,6%**
Delivered energy reduction	**61,5%**
CO2 emissions reduction	**65,6%**
SPBT	**20,8**
Renovation material embodied CO2 net offset with energy consumption related CO2 emissions in years	**2,5**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	716,7	128,6	224,9	40,4	321,01	1,120 M€	127,99	53 903,96 €
Cooling needs	31,5	5,7	82,7	14,8				
DHW preparation	44,6	8,0	44,6	8,0				
		142,3		**63,2**				

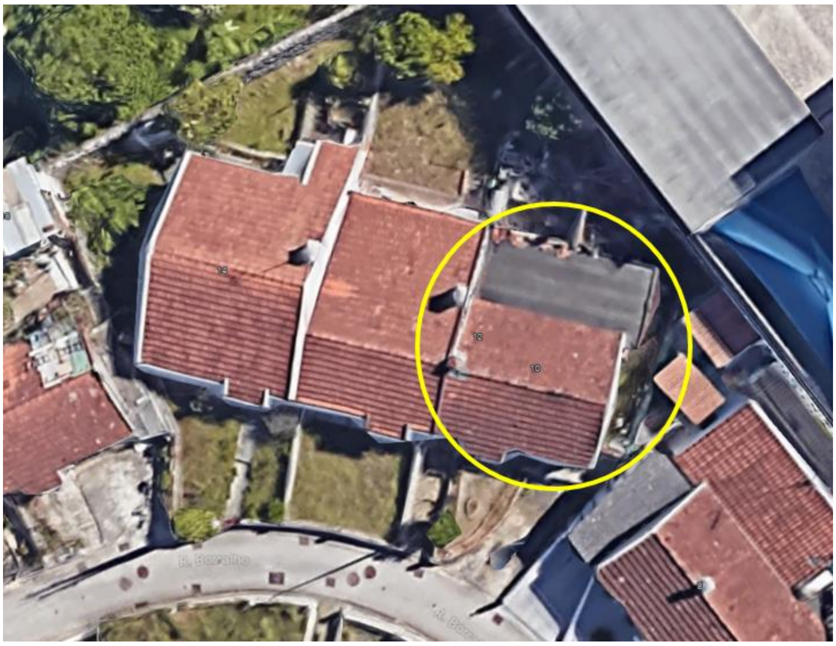
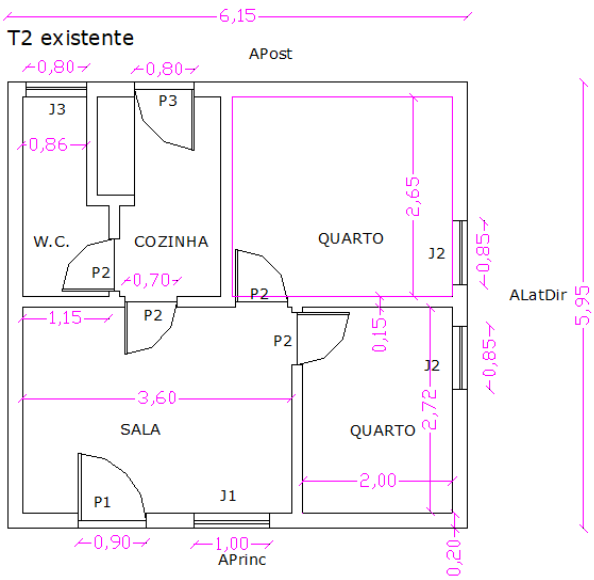
Renovation Package 2 description

Walls	Walls are insulated with a 200mm thick layer of EPS NEO 80 insulation with a heat conductivity rating of λ≤0,035 W/mK.
Roof	Roof is insulated with a 250mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,039 W/mK.
Basement	Unheated basement ceiling is insulated with a 100mm thick layer of mineral wool insulation with a heat conductivity rating of λ≤0,041 W/mK. The building plinth is additionally insulated with a 100mm thick layer of XPS with a heat conductivity rating of λ≤0,036 W/mK, at least 50cm below grade level to ensure insulation layer extension below ground freezing layer.
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,8 W/m2K

Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,1 W/m2K
Technical systems	Walls are insulated with a 150mm thick layer of EPS NEO 80 insulation with a heat conductivity rating of λ≤0,035 W/mK.

13.7 Coimbra – Single-Family Building

I. Building location and dimensions

1.1. Approximate building picture (real life picture or scetch up)	
1.2. Building dimensions and orientation	

II. Basic information about the building

2.1. Typical construction year		1960. – 1990,
2.2. Floors	2.2.1. is there a basement (yes/ no)	No
	2.2.2. number of standard floors (number)	1

	2.2.3. number of technical floors (number)	0		
2.3. Apartments	2.3.1 apartment count	1		
	2.3.2. total area (m²) (without loggias and balconies)	60.9		
	2.3.3. height of premises (m)	2.8		
	2.3.4. calculation temperature (°C)	19,0		
	2.3.5. other information	-		
2.4. Stairwells	2.4.1. count of stairwells	n/a		
	2.4.2. area (m²)	n/a		
	2.4.3. height of premises (m)	n/a		
	2.4.4. calculation temperature (°C)	n/a		
	2.4.5. other information	-		
2.5. Basement, attic, roof floor, attic floor	2.5.1. name of the space	-	-	-
	2.5.2. area (m²)	-	-	-
	2.5.3. height of premises (m)	-	-	-
	2.5.4. calculation temperature (°C)	-	-	-
	2.5.5. area of calculation if heated (m²)	-	-	-
	2.5.6. other information	-	-	-
2.6. Total calculation area – heated area space (m²)		60.9		
2.7. External dimensions of the building (if the building has an irregular shape, a sketch is attached to the annex)		length (m)	5.95	
		width (m)	6.15	
		height (m)	3	

III Existing building envelope

3.1. Information on each type of external enclosing structure covering the heated spaces included in the total calculation area

No.	Enclosing structure	Material(s)	Thickness	Material heat conductivity λ or U value*	Area
			mm		m²

1	2	3	4	5	6	
1.	External walls of apartments	Exterior plaster Cement/sand bloc Interior gypsum plaster	30 200 20	U = 2.10	63.57	
2.	Roof	Wood support layer Interior gypsum plaster	70 20	U = 1.76	36.6	
3.	Floor on ground	Concrete Stone chips Sand	20 500 1000	U = 0.297	36.6	
4.	Old wooden windows in	Single glazing in a wooden frame		U = 5.1	N	1.98
					E	-
					S	2.97
					W	-
5.	Exterior doors	Wooden doors		U = 4.4	3.4	

*Heat conductivity values λ for materials in W/mK or U values for windows and doors in W/m^{2}K.

IV Technical systems and energy distribution of the building

4.1. Ventilation systems in building areas

		ZONE 1
4.1.1. Rooms with natural ventilation	1.1.1. calculation area, m^2	60.9
	1.1.2. volumes, m^3	170,5
	1.1.3. air exchange intensity used in the calculation, including leaching (1/h)	0.633
	1.1.4. Air flow delivery temperature, °C	14.8
4.1.2. Rooms with mechanical ventilation	1.2.1. calculation area, m^2	-
	1.2.2. volumes, m^3	-
	1.2.3. calculated intensity of air exchange used, (1/h)	-
	1.2.4. calculated infiltration used, (1/h)	-
	1.2.5.Air flow delivery temperature, °C	-

4.2. Heat supply/production

4.2.1. Heat energy production. Please, describe how heat energy is supplied to the building:

The heating is provided by electric heating system	
Seasonal coefficient of performance	1
Emissions factor for heating system, t/MWh	0,151
Energy price and unit of measure	196 EUR/MWh

Hot water distribution system

Average hot water supply temperature (°C)	60	
Cold water inlet temperature (°C)	15	
Hot water preparation	X	Preparation in the heating unit
		centralized supply
		Individual
		Other, please describe:
Seasonal coefficient of performance	1	
Emissions factor for hot water preparation, t/MWh	0,151	
Energy price and unit of measure	196 EUR/MWh	

4.3. Cooling energy. Please, describe how cooling is provided in the building:

Cooling is provided via split-type air conditioners.	
Seasonal coefficient of performance	2
Emissions factor for electricity, t/MWh.	0,151
Energy price and unit of measure	196 EUR/MWh

5. Energy efficiency measure analysis

5.1. Summary of building renovation Package 1

Energy needs reduction	**8,2%**
Delivered energy reduction	**68,7%**
CO_2 emissions reduction	**68,7%**
SPBT	**4,3**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**1,8**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	8,5	140,0	7,8	128,6	1,68	5 242,50 €	0,95	1 228.16 €
Cooling needs	0,2	3,8	0,2	2,7				
DHW preparation	0,5	8,0	0,5	8,0				
		151,7		**139,3**				

Renovation Package 1 description

Walls	Walls are not insulated
Roof	Roofs are not insulated
Floor on ground	Floor on ground is not insulated
Doors	Old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,8 W/m^{2}K
Windows	Old wooden windows are changed with double glazing windows in PVC frame with a combined U value of 1,6 W/m^{2}K. Additional shading during summer time to reduce cooling loads.
Technical systems	Introduction of "A class" inverter heat pump for heating and cooling (COP3/EER2,6) and air-water heat pump compact system (COP 2,6) for DWH

5.2. Summary of building renovation Package 2

Energy needs reduction	**64,0%**
Delivered energy reduction	**66,7%**
CO_2 emissions reduction	**66,6%**
SPBT	**12,6**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**2,1**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	8,5	140,0	2,3	37,2	1,94	16 169,10 €	0,92	1 288.01 €
Cooling needs	0,2	3,8	0,6	9,5				
DHW preparation	0,5	8,0	0,5	8,0				
		151,7		**54,7**				

Renovation Package 2 description

Walls	Walls are insulated with a 80mm thick layer of Isodur thermal plaster with a heat conductivity rating of λ≤0,05 W/mK.
Roof	Roof is insulated with a 80mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,05 W/mK.
Floor on ground	Floor on ground is not insulated
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,8 W/m2K
Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,6 W/m2K
Technical systems	-

5.3. Summary of building renovation Package 3

Energy needs reduction	**64,0%**
Delivered energy reduction	**87,2%**
CO_2 emissions reduction	**87,2%**
SPBT	**12,3**

Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**2,1**

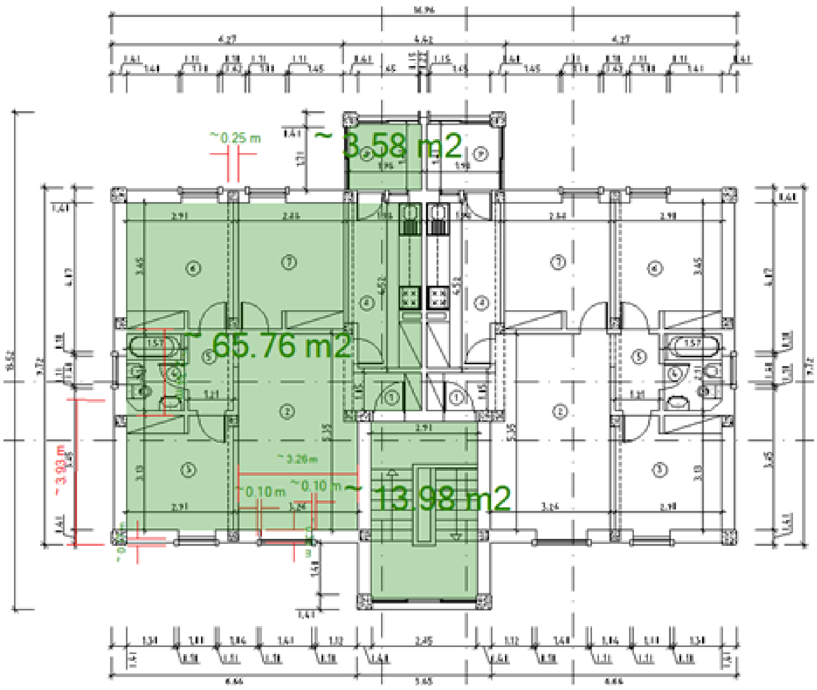
	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m^2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	8,5	140,0	2,3	37,2	2,58	19 169,10 €	1,20	1 560.38 €
Cooling needs	0,2	3,8	0,6	9,5				
DHW preparation	0,5	8,0	0,5	8,0				
		151,7		54,7				

Renovation Package 3 description

Walls	Walls are insulated with a 40mm thick layer of Isodur thermal plaster with a heat conductivity rating of λ≤0,05 W/mK.
Roof	Roof is insulated with a 80mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,05 W/mK.
Floor on ground	Floor on ground is not insulated
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,8 W/m2K
Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,6 W/m2K
Technical systems	Introduction of “A class” inverter heat pump for heating and cooling (COP3/EER2,6)

13.8 Coimbra – Multi-Family Building

I. Building location and dimensions

1.1. Approximate building picture (real life picture or scetch up)	
1.2. Building dimensions and orientation	

II. Basic information about the building

2.1. Typical construction year		1960. – 1990,
2.2. Floors	2.2.1. is there a basement (yes/ no)	No

	2.2.2. number of standard floors (number)	4		
	2.2.3. number of technical floors (number)	0		
2.3. Apartments	2.3.1 apartment count	8		
	2.3.2. total area (m^2) (without loggias and balconies)	528		
	2.3.3. height of premises (m)	2,8		
	2.3.4. calculation temperature (°C)	20,0		
	2.3.5. other information	-		
2.4. Stairwells	2.4.1. count of stairwells	1		
	2.4.2. area (m^2)	14		
	2.4.3. height of premises (m)	2,8		
	2.4.4. calculation temperature (°C)	17,0		
	2.4.5. other information	-		
2.5. Basement, attic, roof floor, attic floor	2.5.1. name of the space	Basement	-	-
	2.5.2. area (m^2)	132	-	-
	2.5.3. height of premises (m)	0.5	-	-
	2.5.4. calculation temperature (°C)	-	-	-
	2.5.5. area of calculation if heated (m^2)	-	-	-
	2.5.6. other information	-	-	-
2.6. Total calculation area – heated area space (m^2)		528		
2.7. External dimensions of the building (if the building has an irregular shape, a sketch is attached to the annex)		length (m)	17	
		width (m)	9.7	
		height (m)	11.9	

III Existing building envelope

3.1. Information on each type of external enclosing structure covering the heated spaces included in the total calculation area

No p.k.	Enclosing structure	Material(s)	Thickness	Material heat conductivity λ or U value*	Area	
			mm		m^2	
1	2	3	4	5	6	
1.	External walls of apartments	Plaster Hollow Brick _0.11 Air Gap_0.04 Hollow Brick _0.15 Render	20 110 40 150 30	U = 0,94	292.72	
2.	Interwindow blocks	n/a				
3.	External walls of staircases	Non-heated in PT				
4.	Interwindow blocks in staircases	Non-heated in PT				
5.	Combined roof covering in apartments	Hollow reinforced concrete panel slab	330	U = 2,21	132	
6.	Combined roof covering in staircase	Non-heated in PT				
7.	Basement covering	Hollow reinforced concrete panel slab	220	U = 1,3	132	
8.	Basement covering					
9.	New windows in apartments	Double-glazed units in PVC frames (115,18)		U = 1,6	N	27,84
					E	13,68
					S	59,98
					W	13,68
10.	Old wooden windows in apartments	Double glazing in a combined wooden frame		U = 3,4	N	27,84
					E	13,68
					S	59,98

					W	13,68
11.	Exterior doors of the building	Non-heated in PT			N	-
					E	-
					S	-
					W	-
12.	Exterior doors of the building	Non-heated in PT			N	-
					E	-
					S	-
					W	-
13.	Staircase windows	Non-heated in PT			N	-
					E	-
					S	-
					W	-
14.	Roof hatch	Metal		U = 2,0	1	

*Heat conductivity values λ for materials in W/mK or U values for windows and doors in W/m²K.

IV Technical systems and energy distribution of the building

4.1. Ventilation systems in building areas

		ZONE 1
4.1.1. Rooms with natural ventilation	1.1.1. calculation area, m^2	528
	1.1.2. volumes, m^3	1478.4
	1.1.3. air exchange intensity used in the calculation, including leaching (1/h)	0,59
	1.1.4. Air flow delivery temperature, °C	
4.1.2. Rooms with mechanical ventilation	1.2.1. calculation area, m^2	-
	1.2.2. volumes, m^3	-
	1.2.3. calculated intensity of air exchange used, (1/h)	-
	1.2.4. calculated infiltration used, (1/h)	-
	1.2.5.Air flow delivery temperature, °C	-

4.2. Heat supply/production

4.2.1. Heat energy production. Please, describe how heat energy is supplied to the building:

The building has no centralized heating systems. Heating provided by Joule effect	
Seasonal coefficient of performance	1
Emissions factor for heating system, t/MWh	0,162
Energy price and unit of measure	422 EUR/MWh

Hot water distribution system

Average hot water supply temperature (°C)	60	
Cold water inlet temperature (°C)	15	
Hot water preparation	X	Preparation in the heating unit
		centralized supply
		Individual
		Other, please describe:
Seasonal coefficient of performance	1	
Emissions factor for hot water preparation, t/MWh	0,162	
Energy price and unit of measure	422 EUR/MWh	

4.3. Cooling energy. Please, describe how cooling is provided in the building:

Some apartments have decentralized split-type cooling units. Estimated COP of the cooling units is 2.6.	
Seasonal coefficient of performance	2,6
Emissions factor for electricity, t/MWh.	0,162
Energy price and unit of measure	422 EUR/MWh

5. Energy efficiency measure analysis

5.1. Summary of building renovation Package 1

Energy needs reduction	**15,7%**
Delivered energy reduction	**69,1%**
CO_2 emissions reduction	**69,1%**
SPBT	**3,8**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**2,3**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	57,6	109,2	54,5	103,3	17,18	74 225,80 €	7,53	19 665,75 €
Cooling needs	10,8	20,5	2,5	4,8				
DHW preparation	4,2	8,0	4,2	8,0				
		137,6		**116,1**				

Renovation Package 1 description

Walls	Walls are not insulated (Insulation not supported (for now) in the new Energy Poverty mitigation support)
Roof	Roofs are not insulated (Insulation not supported (for now) in the new Energy Poverty mitigation support)
Basement	Unheated basement ceiling (Insulation not supported (for now) in the new Energy Poverty mitigation support)
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,8 W/m^2K
Windows	All old wooden windows are changed with double glazing windows in PVC frame with a combined U value of 1,6 W/m^2K. Additional shading during summer time to reduce cooling loads.
Technical systems	Introduction of “A class” inverter heat pump for heating and cooling (COP3/EER2,6) and air-water heat pump compact system (COP 2,6)

5.2. Summary of building renovation Package 2

Energy needs reduction	**65,9%**
Delivered energy reduction	**69,1%**
CO_2 emissions reduction	**69,1%**
SPBT	**7,5**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**3,8**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	57,6	109,2	12,5	23,7	28,40	146 819,80 €	7,53	19 666,54 €
Cooling needs	10,8	20,5	8,1	15,3				
DHW preparation	4,2	8,0	4,2	8,0				
		137,6		**47,0**				

Renovation Package 2 description

Walls	Walls are insulated with a 80mm thick layer of Isodur thermal plaster with a heat conductivity rating of λ≤0,05 W/mK.
Roof	Roof is insulated with a 80mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,05 W/mK.
Basement	Unheated basement ceiling is insulated with a 80mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,05 W/mK.
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,8 W/m2K
Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,6 W/m2K
Technical systems	-

5.3. Summary of building renovation Package 3

Energy needs reduction	**61,5%**
Delivered energy reduction	**63,3%**

CO_2 emissions reduction	**65,0%**
SPBT	**6,6**
Renovation material embodied CO_2 net offset with energy consumption related CO_2 emissions in years	**2,7**

	Before measures		After measures		Renovation GWP	Renovation cost	Energy related emissions reduction	Energy cost reduction
	MWh	kWh/m2	MWh	kWh/m^2	tCO2	EUR	tCO2/year	EUR/year
Heating energy needs	57,6	109,2	17,3	32,7	25,25	119 270,20 €	9,52	17 997,80 €
Cooling needs	10,8	20,5	6,4	12,2				
DHW preparation	4,2	8,0	4,2	8,0				
		137,6		**52,9**				

Renovation Package 3 description

Walls	Walls are insulated with a 40mm thick layer of Isodur thermal plaster with a heat conductivity rating of λ≤0,05 W/mK.
Roof	Roof is insulated with a 80mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,05 W/mK.
Basement	Unheated basement ceiling is insulated with a 80mm thick layer of rigid mineral wool insulation boards with a heat conductivity rating of λ≤0,05 W/mK.
Doors	All old wooden staircase entrance doors are changed with insulated metal doors with a U value of 1,8 W/m2K
Windows	All old wooden windows are changed with triple glazing windows in PVC frame with a combined U value of 1,6 W/m2K
Technical systems	-