CENTRAL & EASTERN EUROPEAN SUSTAINABLE ENERGY NETWORK
CEESEN-BENDER

CEESEN-BENDER

Building intErventions in vulNerable Districts against Energy poveRty

Deliverable 2.4

Synthesis report on demonstration buildings

Dissemination Level: Public

WP2 Reinforcing and adapting the governance and decision-making of building management actors to support the energy renovation of private multi-apartment buildings.

Warsaw, 2025

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V4	14.07.2025	Accepted comments and suggestions provided by DOOR (LP) and attachment of updated Annex 1.

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Background of the CEESEN-BENDER project

The main goal of the project "Building intErventions in vulNerable Districts against Energy poveRty" (i.e. CEESEN-BENDER), launched on September 1 2023, is **to empower and support vulnerable homeowners and tenants living in buildings built after the Second World War and before 1990's in 5 CEE countries**: Croatia, Slovenia, Estonia, Poland and Romania. The project will help them through the renovation process by identifying the main obstacles and creating trustworthy support services that include homeowners, their associations, and building managers.

Coordinated by Society for Sustainable Development Design (DOOR), the project CEESEN-BENDER brings together leading European researchers and experts in the field from six countries: **Croatia** (Society for Sustainable Development Design / DOOR, Medjimurje Energy Agency Ltd. / MENEA, EUROLAND Ltd. / Euroland, GP STANORAD Ltd. / GP STANORAD), **Estonia** (University of Tartu / UTARTU, Tartu Regional Energy Agency / TREA, The Estonian Union of Co-operative Housing Associations / EKYL), **Slovenia** (Local Energy Agency Spodnje Podravje / LEASP), **Romania** (Alba Local Energy Agency / ALEA, Municipality of Alba Iulia / ALBA IULIA), **Poland** (Mazovia Energy Agency / MAE, Housing Cooperative Warszawska Spółdzielnia Mieszkaniowa - The Warsaw Housing Cooperative / WSM), **Germany** (Climate Alliance) in addition to **Central Eastern European Sustainable Energy Network** (CEESEN).

The project CEESEN-BENDER is carried out from September 2023 until August 2026 and has a total budget of €1,85 million, of which €1,75 million is funded from the European Union's Programme for the Environment and Climate Action (LIFE 2021-2027) under grant agreement n° LIFE 101120994.

As stated, the **main objective** of CEESEN-BENDER is to empower and support vulnerable homeowners and renters living in multi-apartment buildings (MABs) through the renovation process by identifying the main obstacles, and creating trustworthy support services that include homeowners, their associations, and building managers.

Therefore, the **detailed objectives** for CEESEN-BENDER are stated below:

- The project will analyse the ownership structure and physical characteristics of buildings in the pilot sites in targeted regions to comprehensively understand the obstacles that impede or halt homeowner associations, landlords, and property managers from pursuing energy renovations.
- Project partners will identify both legislation and financial, and technical administrative obstacles for the renovation in pilot countries. The identification

of obstacles from the homeowners' perspective will help the creation of tailor-made solutions not only for homeowners but also for building managers, landlords, municipalities and other relevant stakeholders involved in the renovation process.

- Through the project, methods and tools that can be used to address different aspects of energy poverty will be developed. This includes:
    - Data gathering on energy poverty in the pilot sites;
    - A digital tool identifying buildings with high levels of energy poor households in the greatest need of renovation;
    - A model of potential savings in buildings undergoing renovation, and a tool for calculating the return on investment for energy renovations.
- 5 Pilot area roadmaps will be developed that prioritize building renovation based on their potential for maximizing emissions reduction via energy savings as well as an increase of quality of life and wellbeing for vulnerable homeowners.
- Within the 5 pilot areas, at least 30 building-level roadmaps will be created that specify the technical details for renovations. These pilot buildings will be supported in the entire pre-construction phase, drawing of plans, applying for permits, audits or other requirements and for financing. Plans will call for the decarbonization of the heating and cooling supply and integration of renewable energy sources (RES), to produce energy to cover its own consumption.
- Also, a support system for homeowners, municipalities, and other large owners of multi-apartment buildings (MABs) in targeted regions will be created to speed up the renovation process, by:
    - Advising at least 3.500 homeowners, landlords and building managers on legal, financial, technical and other aspects of energy renovations.
    - Advocating for changes of regulatory requirements and policies to lower the costs and time needed for the preparatory phase of projects.
    - Train at least 30 energy professionals on energy poverty and related topics.

1. Executive Summary

The aim of this Deliverable is to provide the building managers (or homeowner associations) and their tenants with an overview of the identified demonstration buildings in the pilot sites engaged in the project CEESEN-BENDER, which are renovated "model" multi-apartment buildings (MABs) with technical characteristics similar to those of the buildings targeted by the project in each partner country. The demonstration buildings share similar technical characteristics (size, age, type of building, etc.) as those targeted by the project. These buildings have already implemented modernization works. To achieve this, the document first describes the methodology applied by the project partners. The following chapter elaborates on the selected demonstration buildings, their characteristics, data and implemented renovation. The last part of the document presents the conclusions of the Synthesis Report on the selected demonstration buildings.

This Deliverable brings together various theoretical approaches, the authors' knowledge, and the expertise and experiences of the CEESEN-BENDER project partner consortium.

2. Introduction and relevance of the Deliverable

This deliverable provides a detailed analysis of energy renovation processes in selected **demonstration buildings** across the Central and Eastern European (CEE) region.
It presents best practices and technological solutions applied in these buildings, chosen for their representativeness of typical MABs in the region. These buildings serve as models for future energy renovation projects, aimed at improving energy efficiency and promoting sustainable development.

The renovations included a variety of technical measures, such as the modernization of heating systems, installation of renewable energy sources and improvements in thermal insulation. Collected data covers the technologies used (e.g., heat pumps, photovoltaics), financing mechanisms (e.g., preferential loans, national, EU funding) and renovation outcomes, such as energy savings, improved comfort, reduced operational costs. These results demonstrate the effectiveness of the solutions in terms of energy efficiency, CO_2 reduction and enhanced living conditions.

Sharing best practices in energy renovation is essential for advancing the sector and ensuring successful replication of projects. The demonstration buildings in this report provide case studies that can be replicated and adapted to different regional contexts. The lessons learned serve as benchmarks, helping to address common challenges in energy renovations, such as financial, regulatory, and technical barriers. Systematic knowledge exchange among stakeholders fosters the development of more effective strategies for energy-efficient building renovations, promoting broader adoption of best practices.

Collaboration with key stakeholders, including building managers, property owners, and local authorities is crucial for optimizing sustainable renovation strategies. This collaboration ensures efficient knowledge transfer, fosters innovation and supports the adaptation of scalable solutions. By leveraging collective expertise, this report highlights how these efforts contribute to a more energy-efficient and resilient built environment, ultimately reducing environmental impact and improving residents' quality of life.

3. Methodology

The development of this report is based on extensive collaboration between partner organizations across Central and Eastern Europe, including Croatia, Estonia, Poland, Romania, and Slovenia. Each partner was responsible for establishing cooperation with selected demonstration buildings, ensuring they matched the project's target buildings in terms of technical characteristics. The demonstration buildings, as outlined in **Task T2.5**, serve as models for energy renovation, representing typical multifamily residential buildings in the region.

To collect relevant data, project partners worked closely with representatives of the demonstration buildings. This cooperation facilitated the gathering of comprehensive data on various aspects of the renovation process, including energy savings, financial outcomes, improvements in health and comfort for residents, and challenges faced during the renovation.

The methodology followed included the following key steps:

1. **Engagement with building representatives:** Each project partner established a working relationship with the representatives of the demonstration buildings.

2. **Data collection**: Data was gathered from households and building managers, covering energy consumption, savings, financial outcomes, health and comfort improvements, and solutions for vulnerable residents. Additionally, the data included information about obstacles encountered during the renovation, such as financial constraints, regulatory issues, and coordination challenges.

3. **Collaboration**: Partners used shared tools, such as Excel spreadsheets and online platforms, to compile and analyze data on unrenovated and renovated buildings. This data has been collected in **Annex 1**. There are planned on-site visits to the demonstration buildings to share the best practices with the tenants and building managers of the associated partners to be conducted throughout the project's duration.

This methodology ensured that the final report is based on a comprehensive set of data and experiences, providing actionable insights to inform future energy renovation projects across the region.

4. Demonstration buildings overview

Demonstration buildings were selected by each of the project partners by the analysis of the similarities in the technical characteristics to those targeted by the project. **Demonstration buildings are located** in each of the project partners' countries, which are: Croatia (Čakovec Town), Estonia (Tartu City), Poland (Szczytno Town), Romania (Alba Iulia Municipality) and Slovenia (Ptuj Municipality).

Poland – Demonstration Building

Figure 1. Demonstration building in Poland.

The building is located at Śląska 12, in Szczytno Town. Constructed in 1974, the building exhibits a gross floor area of 1 907,52 m² distributed across four above-ground floors plus a basement, accommodating 40 apartments with an average area of 46,66 m². The heating system relies on a partially modernized radiator network powered by two NIBE F1345-60 ground-source heat pumps arranged in a cascade configuration with a total capacity of 120 kW. This system is supplemented by a 40 kW photovoltaic (PV) installation. Additionally, the building incorporates multiple energy generation systems: a 40 kW rooftop PV array, vacuum solar panels for domestic hot water (DHW) production, and a further 32 kW PV system mounted on the balcony structures. Annual electricity consumption for DHW is approximately 35 000 kWh, with an average quarterly consumption of around 300 m³ - equating to roughly 3,75 m³ per resident when water is heated to 58°C, while space heating demands about 70 000 kWh per year, supplemented by an externally sourced 25 000 to 32 000 kWh.

The ownership structure is predominantly private, with 92,5% of the building held under private ownership and the remaining 7,5% under public ownership.

Over the past eight years, there have been no recorded cases of energy poverty, despite the fact that about 87% of the residents are pensioners and retirees. This achievement is largely attributable to a proactive management approach that emphasizes maintaining the building in excellent technical condition through regular inspections, prompt repairs, and targeted modernization investments.

The building manager, who is also a resident, plays a crucial role by ensuring continuous and effective communication with all occupants. This close-knit community approach fosters daily interactions and rapid decision-making.lthough municipal housing residents are welcome to participate in annual meetings, they do not hold voting rights on resolutions.

Over the years, the building has undergone a series of renovations that have significantly improved its energy efficiency, thermal insulation, and overall safety. In 2005, a complete renovation of the stairwells, including the replacement of entrance doors and windows, was undertaken. This was followed in 2006 by a roof renovation that incorporated insulation for the roof-ceiling assembly, financed by a 60 000 PLN (13 954 EUR) loan. A major thermal modernization project was carried out between 2008 and 2009, during which vestibules were constructed 80% of the windows and balcony doors were replaced, and balcony renovations were completed with financial support from a 100 000 PLN (23 256 EUR). In 2010, the electrical installations in the basement and common areas were upgraded to a 24V system, and the horizontal water supply network was replaced, including the installation of a limescale removal device that not only improved drinking water quality but also extended the lifespan of heating elements by approximately 80%. Further external improvements were made in 2011 with the construction of sidewalks and a parking lot featuring a stormwater drainage system, an initiative that was self-financed at a cost of 70 000 PLN (16 279 EUR).

The integration of renewable energy sources was significantly advanced in 2014 with the installation of a 40 kW PV system on the building's roof and the deployment of the ground-source heat pumps. In 2016, the building's cold water supply risers were replaced, and a radio water meter reading system was installed, a project self-financed with 25 000 PLN (5 814 EUR). The DHW system was further enhanced in 2017 by incorporating renewable energy sources through air-water heat pumps and additional solar installations. In 2022, attached balconies were constructed and an extra 32 kW PV system was installed on the balcony structures to support DHW heating. Most recently, in 2024 a rainwater drainage system was constructed to channel roof runoff into a retention tank for irrigating the green areas in front of the community building, with part of this project financed through a 10% loan forgiveness mechanism from earlier funding.

These extensive renovation measures have resulted in marked improvements in energy efficiency and thermal insulation, leading to reduced heating energy consumption and lower maintenance costs, while significantly enhancing resident safety and comfort. The elimination of gas stoves and coal boilers has improved indoor air quality, and the modernization of the water supply system has ensured better water quality and extended the lifespan of heating components. Electrotechnical upgrades, including the conversion to a 24V system in common areas and the installation of multiple PV systems, have bolstered the building’s renewable energy portfolio, with plans to further diversify the energy mix through the addition of a wind energy generator in 2025.

The renovation process was supported by a series of financing schemes and expert collaborations. In 2014, a low-interest loan of 625 000 PLN (145 349 EUR) was obtained for the design and installation of the heat pumps and PV system - a loan that has since been fully repaid. In 2017, the renewable energy system project received 82% funding, amounting to 285 000 PLN (66 279 EUR). In 2022 a 680 000 PLN (158 140 EUR) loan enabled the construction of balconies and the installation of additional PV panels with a 10-year repayment plan. Finally, in 2024 the construction of the rainwater drainage system was partially financed through a mechanism that provided a 10% loan cancellation from the Stage I funding. Throughout these projects, architects, contractors, and structural engineers worked in close coordination to meet all technical, regulatory, and financial requirements, ultimately enhancing the building’s overall performance, sustainability and quality of life for its residents.

Romania – Demonstration Building

Figure 2. Demonstration building in Romania.

Constructed in 1978, the residential building located at Livezii 49, Alba Iulia Municipality, Romania, has a gross building area of 5 215 m² and a conditioned floor area of 4 518 m². It consists of four above-ground floors and accommodates 64 apartments, each with an average heated area of 70,59 m². The conditioned volume of the building is 11 749 m³.

Prior to renovation, the specific energy savings n amounted to 69,77 kWh/m² per year. Additionally, the specific cost reduction following the renovation was estimated at 4,33 EUR per m² per year, with a total annual cost reduction of approximately 305 EUR per apartment and 19 544 EUR for the entire building.

The building's heating system consists of individual natural gas units in each apartment, with electricity used as a secondary energy carrier. Electricity consumption remains at 11 kWh/m² per year, while DHW consumption is stable at 46,34 kWh/m² per year. The building's energy efficiency classification improved from Class B (2018) to Class A (2021).

The renovation primarily focused on thermal insulation measures, including roof and attic insulation, external wall insulation, replacement of exterior windows, balcony doors, and entrance doors with thermopane units, as well as waterproofing of the foundation and standard facade painting. These interventions significantly improved the building's energy performance, leading to enhanced thermal comfort, reduced heating costs, improved noise insulation, and lower indoor humidity levels, contributing to better air quality and a reduction in mold formation.

The building is entirely under private ownership, with no public ownership share. Before the renovation, approximately 40% to 60% of residents were at risk of energy poverty, particularly low-income individuals, elderly residents, single occupants, persons with chronic diseases, and persons with disabilities. However, the renovation did not include targeted solutions for vulnerable residents beyond the general improvements to the building envelope.

Building management responsibilities include tax collection for utilities, representation in public utility and administrative matters, supervision of maintenance works, handling resident complaints, and ensuring access control. Communication with residents is facilitated through posters at building entrances and the homeowners' association office, scheduled meetings, and digital channels such as phone, email, and utility payment applications.

The renovation project was implemented by the municipal department for residential building administration, covering 75% of renovation costs. The process faced delays due to bureaucratic complexities. The renovation works were subcontracted via public procurement and executed in compliance with national construction standards and regulations.

Slovenia – Demonstration Building

Figure 3. Demonstration building in Slovenia.

Constructed in 1989, the residential building is located at Ulica 25. maja 15, 17, 19 in Ptuj Municipality, Slovenia. The building encompasses a gross area of 5 798.2 m² distributed over eight floors, accommodating a total of 64 apartments with an average unit size of approximately 56,8 m². It is integrated into a district heating network that utilises a combination of wood biomass and natural gas.

The ownership structure is predominantly private, with 90% of the building held by private entities and the remaining 10% under public ownership. Although specific data regarding the number and types of vulnerable residents at risk of energy poverty are not available. The building management system is characterized by its integrated approach to handling both residential and commercial aspects. Responsibilities include the execution of routine and emergency maintenance tasks, along with the provision of accounting, bookkeeping, legal, and technical advisory services. Furthermore, the management is charged with developing and implementing a strategic maintenance plan, managing the reserve fund, mediating disputes among floor owners, and ensuring complete transparency in billing and cost allocation through permanent online access. Communication with residents is maintained via annual meetings, a dedicated web portal, email, and telephone, thereby facilitating effective and ongoing dialogue.

In terms of renovation, the building underwent targeted interventions aimed at enhancing its thermal performance. The construction measures focused primarily on the thermal insulation of the exterior walls and the replacement of windows and doors, actions that are expected to yield substantial energy savings. These upgrades lead to a reduction in energy consumption and associated costs while simultaneously enhancing indoor thermal comfort and overall living conditions, thereby resulting in additional health benefits through enhanced protection against external temperature fluctuations and noise.

It should be noted that the renovation did not include significant mechanical engineering or electrotechnical modifications, with financial constraints representing the primary obstacles during the implementation phase. The renovation process was executed by qualified architects and contractors, ensuring adherence to national regulations and the highest standards of construction quality.

Estonia – Demonstration Building

Figure 4. Demonstration building in Estonia.

The multi-apartment residential building located at Tähe 2 in Tartu City, Estonia, was originally constructed in 1964. It consists of 32 privately owned apartments, with a total gross building area of 1 776.4 m², of which 1 440 m² constitutes heated space. The structure spans four floors and has an average apartment size of 42,3 m².

The building is connected to a district heating network, which supplies both space heating and DHW. The energy carrier for heating is primarily biomass (over 90%), while natural gas is utilized for cooking. Electricity consumption is offset by an on-site PV system, which partially covers the building's energy demand and feeds excess electricity back into the grid. Prior to renovation, space heating relied entirely on district heating, consuming 289 MWh per year, while water heating and cooking were supported by natural gas (32,6 MWh per year) and overall electricity consumption amounted to 38,7 MWh per year. Post-renovation, space heating consumption was reduced to 105 MWh per year, water heating to 35 MWh per year, and natural gas usage dropped significantly to 5,2 MWh per year. Electricity consumption remained relatively stable at 40,2 MWh per year, with PV generation contributing 27,5 MWh annually, of which 19,3 MWh was fed into the grid.

Energy efficiency improvements were substantial, elevating the building's classification from an F-class (pre-renovation energy efficiency index of 257 kWh/m² per year) to an A-class (post-renovation index of 74 kWh/m² per year). The primary renovation measures included a full building envelope upgrade, incorporating insulation of external walls, roof, and first-floor flooring, as well as the complete replacement of all doors and windows. These interventions resulted in an energy performance certificate (EPC) based energy consumption reduction of 68%, with a 36% decrease in district heating demand, a marginal 1% reduction in electricity usage, and an 84% drop in natural gas consumption.

Mechanical engineering enhancements included the transition of DHW heating from natural gas to district heating and the implementation of centralized heating controls. Each apartment is now equipped with a central control unit, allowing room-based temperature regulation through radiator thermostats and control and monitor ventilation system. Building was equipped with a demand-based (CO2) heat recovery ventilation system, which adjusts airflow of the main unit and also regulates the apartment's VAV (Variable Air Volume) dampers according to occupancy needs. Electrical system upgrades included the installation of a PV plant and comprehensive modernization of the building's electrical infrastructure.

The renovation process encountered several obstacles, including resistance from some residents, financial liquidity challenges before securing grant approval, and difficulties in modifying the original construction plans. Nevertheless, the project was successfully completed with financial support covering approximately 50% of the total renovation costs.

The renovation was carried out by a multidisciplinary team comprising a technical consultant, architects, specialized designers, a primary construction contractor managing various subcontractors, and a supervisory body. Post-renovation consultation was provided to ensure continuous optimization and performance monitoring of the building's energy systems.

Croatia – Demonstration Building

Figure 5. Demonstration building in Croatia.

The residential building located at Uska 1 in Čakovec Town, Croatia, is a multia-partment structure built in 1970. It comprises a total gross construction area of 4 134,49 m², with 2 635,81 m² dedicated to residential use. The building consists of three floors and includes 49 apartments, with an additional eight business premises. Each apartment has an average area of approximately 57 m². The ownership structure is entirely private, with no public ownership.

The building operates on an individual heating system, with natural gas as the primary energy carrier for space heating, domestic hot water (DHW), and cooking. Electrical energy is also consumed for various household needs. The building's energy efficiency class is currently rated as B. Prior to renovation, no significant energy efficiency upgrades had been implemented.

The renovation process focused primarily on improving the thermal envelope of the building. Key construction measures included the installation of thermal insulation on the outer walls, roof, floor, and ceiling, as well as the complete replacement of external carpentry. These interventions aimed to reduce heat loss, improve indoor thermal comfort, and generate substantial energy savings.

Electrotechnical measures consisted of the replacement of indoor lighting systems to improve energy efficiency further. However, no mechanical engineering interventions, such as heat pump installations or DHW heat collectors, were implemented. Financial constraints represented a primary obstacle during the renovation process, as securing adequate funding was a significant challenge.

The renovation was executed by a team of architects and contractors. Financial support was obtained through a combination of a bank loan and co-financing which covered approximately 60% of the total renovation costs. This financial model played a crucial role in making the renovation economically viable for the residents.

The table below summarizes the modernization work carried out in each of the Demonstration buildings.

Table 1. Information on the renovation process in the selected demonstration buildings.

Construction measures	**Croatia**	**Estonia**	**Poland**	**Romania**	**Slovenia**
Thermal insulation of the outer shell - outside wall, roof, floor, ceiling	Yes	Yes	Yes	Yes	Yes
Replacement of external carpentry	Yes	Yes	Yes	Yes	Yes
Other				Waterproof building foundation and standard facade paint	
Mechanical engineering measures					
Heat pump			Yes		
DHW heat collectors			Solar		
Wood chip/pellet boiler or other type of boiler					
Other		DHW - district heating. Heat and ventilation control - very apartment has central control unit for room level heating control and apartment level demand-based (CO2) heat recovery ventilation system.	Limescale removal device		
Electrotechnical measures					
Replacement of indoor lightning	Yes	Yes (general areas)			
PV plant		Yes	Yes		
Other		System renewed	System renewed		

5. Conclusion

The analysis of selected demonstration buildings has enabled the extraction of key conclusions regarding modernization processes in terms of energy efficiency. The conducted research unequivocally demonstrated that, despite the prevailing private **ownership structure** (in Poland – 92,5%, in Slovenia – 90%), the thermal modernization of MABs is a complex, multi-stage process that requires interdisciplinary cooperation.

Most of the selected buildings do not have available **data on energy poverty**, except for two pilot sites in Poland and Romania. The Romanian partner estimates that in their selected building, the proportion of **vulnerable residents** has decreased from 60% to 40% as a result of the renovation. These residents include low-income individuals, such as the elderly, those living alone, individuals with chronic illnesses, and persons with disabilities. Furthermore, according to the Polish partner, energy poverty has not been observed in their building for the past eight years. In the Szczytno Town building, nearly 87% of the tenants are pensioners and retirees. The lack of data may be due to the fact that the issue of energy poverty is still not widely recognized or sufficiently addressed to be identified. Furthermore, the problem itself is highly sensitive and difficult to raise due to the financial and personal struggles faced by those who may be at risk.

Across all cases, targeted energy interventions, such as upgrading the building envelope, replacing outdated fenestration, and integrating renewable energy systems like photovoltaic (PV) installations, ground-source heat pump, and air-water heat pumps, have yielded significant **reductions** in energy consumption. For example, the Estonian building achieved a substantial decrease in its space heating demand, dropping from 289 MWh/year to 105 MWh/year, while the Romanian building advanced its energy efficiency classification from Class B to Class A.

Additional benefits included financial savings on energy costs and enhanced occupant well-being, as the improved thermal conditions contributed to greater comfort and overall satisfaction of the residents.

It is clear that the renovation process is not a one-time intervention, but rather a multi-stage effort that unfolds over a defined period of time. Given its complexity and the need for involvement across various areas, it demands the **collaboration** of multiple stakeholders and specialists. Furthermore, a common challenge observed among the selected demonstration buildings is the issue of delays in the planned renovation works.

The primary barrier to carrying out modernization in multia-partment buildings is a **lack of funding**. The mentioned before renovation works were made possible largely due to the support of external financing sources or schemes. Without such financial assistance, the high costs of thermal modernization would place a significant burden on tenants, even when distributed among a large group. Moreover, the process of securing external funding can be challenging and time-consuming, particularly when essential data or documents are missing, making it difficult to meet the requirements of specific funding applications or the long processing time and application review. It is visible that the highly determined individuals or building representatives play a crucial role in the MAB renovation process.

In addition, the evidence from these case studies underscores the importance of developing comprehensive renovation strategies that integrate both technical innovation and socio-economic considerations. Establishing robust data collection systems to monitor energy consumption and assess energy poverty is essential for fine-tuning future projects. By strengthening collaboration among technical experts, financial institutions, and community stakeholders, subsequent interventions can better address funding challenges, streamline administrative processes, and ensure that the benefits of modernization are equitably distributed among all residents.

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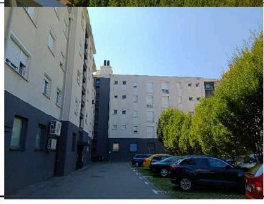
Annex 1

Task 2.5 “Analysis of demonstration buildings”

Analyse the overall context of the selected demonstration buliding(s)

Name of the partner:	Medjimurje Energy Agency Ltd.
Country:	Croatia
Region:	Medjimurje County

Information about the demonstration building(s)

	Building
General information about the building	
Location (address, cadastral unit)	Uska 1, 40000 Čakovec (Medjimurje county, Croatia) Cadastral unit: 2311/1 ; 2311/2 ; 2311/3
Photos	     
Homeowner structure	
Private ownership (%)	100
Public ownership (%)	0
Energy poverty data	
Number of vulnerable residents at risk of energy poverty	Data not available
Types of vulnerable residents	Data not available
Role and involvement of building managers *(explain their role, responsibilities and other relevant tasks)*	The manager is the project manager, contracts the contractor, submits the building to a tender for co-financing
Communication with landlords, homeowners/tenants *(communication methods, frequency of communication, tenant's attitude and engagement, etc.)*	Meetings with co-owners
Technical characteristics of the building	
Year of construction	1970
Gross building area (m2)	Gross construction area = 4.134,49 m2 Area used for housing = 2.635,81 m2
Number of floors	3
Number of apartments	49 (57 with the business premises)
Average apartment area	Approximately 57 m2
Heating system (individual, central, district) - on apartment and building level	Individual
Type of energy carrier/s (natural gas, coal, wood, etc.)	Natural gas
Energy consumption (electrical, heating and DHW) *(if available)* - on apartment and building level	Electrical, heating and DHW
Energy efficiency class *(if available)*	B
Information on previous renovations (year, implemented measures)	/

Informations on the renovation process

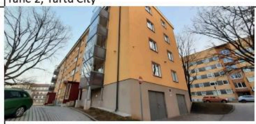
Construction measures		Outcomes and benefits of renovations	
Thermal insulation of the outer shell - outside wall, roof, floor, ceiling	Thermal insulation of the outer shell - outside wall, roof, floor, ceiling, replacement of external carpentry	*Energy savings*	Energy savings
Replacement of external carpentry		*Financial*	
Other		*Health and other benefits*	

Mechanical engineering measures		**Data on obstacles faced before and during the**	
Heat pump	/	*Energy savings*	Financial
DHW heat collectors		*Financial*	
Wood chip/pellet boiler or other type of boiler		*Health and other benefits*	
Other		*Other*	
Electrotechnical measures	Replacement of indoor lightning	**Solutions for vulnerable residents - especially ones in the risk of energy poverty**	/
Replacement of indoor lightning			
PV plant			
Other			
Experts included in the renovation process (*architects, contractors, structural engineers, etc.*)	Arhitects and contractors	**If the financial instruments, financing schemes, models funding sources were used, please mention and shortly describe**	Bank loan, Call "Energy renovation of multi-apartment buildings" (co-financing by the EU (60%))

Analyse the overall context of the selected demonstration buliding(s)

Name of the partner:	TREA
Country:	EStonia
Region:	Tartu City

Information about the demonstration building(s)

	Building
General information about the building	Multi-apartment building with 32 apartments, constructed in 1964, renovated in 2018–2019.
Location (address, cadastral unit)	Tähe 2, Tartu City
Photo	
Homeowner structure	
Private ownership (%)	100
Public ownership (%)	0

Energy poverty data	
Number of vulnerable residents at risk of energy poverty	N/A
Types of vulnerable residents	N/A

Role and involvement of building managers (*explain their role, responsibilities and other relevant tasks*)	MAB side leading role in renovation was on the one member of the apartment assoction board member

Communication with landlords, homeowners/tenants (*communication methods, frequency of communication, tenant's attitude and engagement, etc*.)	Continuous, as needed for information and decision-making

Technical characteristics of the building		
Year of construction	1964	
Gross building area (m2)	1776,4 (heated sapce 1440)	
Number of floors	4	
Number of apartments	32	
Average apartment area	42,3	
Heating system (individual, central, district) - on apartment and building level	District heating for space heating and water heating	
Type of energy carrier/s (natural gas, coal, wood, etc.)	District heating (90+% biomass) for space heating and water heating, Natural gas for cooking, electricity	
Energy consumption (electrical, heating and DHW) (*if available*) - on apartment and building level	Space heating (normalized): 105 MWh/a; Water heating: 35 MWh/a; Natural gas: 5,2 MWh/a. Building electricity consuption: 40,2 MWh/a (Electricty (from grid): 32 MWh/a, Electricty to grid (19,3 MWH/a), Electricity (total PV prduction): 27,5 MWh)	BEFORE RENOVATION: District heating (only sapce heatign): 289 MWh/a; Natural gas (cooking and water heating): 32,6 MWh/a; Electricty: 38,7 MWh
Energy efficiency class (*if available*)	A-class (energy efficiency index: 74 kWh/m2*a, A-class if below 105 kWh/m2*a)	Before renovation: F-class (energy efficiency index: 257 kWh/m2*a)
Information on previous renovations (year, implemented measures)	Deep renovation 2018-2019 - full enevelope, electricty system, ventilation (heat-recovery, apartment base CO2 control), PV system, energy monitoring system	

Informations on the renovation process

Construction measures *Thermal insulation of the outer shell - outside wall, roof,* *Replacement of external carpentry* *Other*	Full enevelope (all doors and windows replacement; insulated walls, roof, floor of first floor)	**outcomes and benefits of renovations** *energy savings* *financial* *health and other benefits*	EPC based reduction 68%, DH reduction -36%; Electricy reduction -1%, Nautral gas reducion -84%
Mechanical engineering measures *Heat pump* *DHW heat collectors* *Wood chip/pellet boiler or other type of boiler* *Other*	Water heating from gas to district heating, Heat control: every apartment has central control unit with room based (room radiator thermostat) control	**data on obstacles faced before and during the r** *energy savings* *financial* *health and other benefits* *Other*	There was oposition by some members to renovate, there was soem cash flow challgenses before submitting the grant and problems with modifying the construcion project
Electrotechnical measures *Replacement of indoor lightning* *PV plant* *Other*	System renewed, PV plant installed	**solutions for vulnerable residents - especially ones in the risk of energy poverty**	N/a, in general due grants 50% of costs were covered
Experts included in the renovation process (*architects, contractors, structural engineers, etc.*)	Techical consultant, architect/designer, specail parts desingers, main constrction contractor (different subcontractors), supervisor, post-renovation consulation (TREA)	**If the financial instruments, financing schemes, models funding sources were used, please mention and shortly describe**	H2020 project, National reconstrction grant

Analyse the overall context of the selected demonstration buliding(s)

Name of the partner:	MAE
Country:	Poland
Region:	Mazovia

Information about the demonstration building(s)

	Building
General information about the building	
Location (address, cadastral unit)	Śląska 12, 12-100 Szczytno
Photo	
Homeowner structure	
Private ownership (%)	92,5
Public ownership (%)	7,5

Energy poverty data	
Number of vulnerable residents at risk of energy poverty	0
Types of vulnerable residents	In the building for about 8 years there is no phenomenon of energy poverty where the overwhelming majority of residents are pensioners and retirees this is a very large group and in the scale of residents of the building occupies 87% of its population.

Role and involvement of building managers (*explain their role, responsibilities and other relevant tasks*)	Maintenance of the building in good technical condition, i.e., perform in a timely manner regular technical inspections, take care of ongoing repairs, modernization, and above all, carry out investments from which in the future will provide residents with benefits , safety, savings and environmental protection at the stage of use which has a direct impact on the protection of the health of residents / liquidation of gas stoves, coal boiler room.

Communication with landlords, homeowners/tenants *(communication methods, frequency of communication, tenant's attitude and engagement, etc* .)	The "ŚLĄSKA 12" building in Szczytno has developed a management model over the years that fosters strong cooperation between residents and the management, creating a sense of community akin to a large family. This approach, based on mutual trust, has proven effective in managing the building. Daily communication is maintained as the manager is also a resident, ensuring timely updates and swift decision-making. In our community, we do not differentiate between owners and tenants. All residents, including those in municipal housing, are invited to annual meetings and can participate in discussions, though they do not have voting rights on resolutions.

Technical characteristics of the building	
Year of construction	1974
Gross building area (m2)	1907,52 m2
Number of floors	4 floors plus a basement
Number of apartments	40
Average apartment area	46,66 m2
Heating system (individual, central, district) - on apartment and building level	modernized radiator system, powered by two NIBE F1345 – 60 ground-source heat pumps with a capacity of 120 kW, operating in a cascade system, supplemented by 40 kW of photovoltaic energy.
Type of energy carrier/s (natural gas, coal, wood, etc.)	The heat carriers in the building are solar energy (40 kW photovoltaic panels), vacuum solar panels for heating domestic hot water, and an additional 32 kW photovoltaic system installed on the front of the building's balconies.
Energy consumption (electrical, heating and DHW) (*if available)* - on apartment and building level	Annual electricity consumption for heating domestic hot water amounts to 35,000 kWh. Average quarterly hot water consumption in the building is approximately 300 m3, equating to about 3.75 m3 of hot water heated to 58°C per resident. Annual electricity consumption for heating the apartments is around 70,000 kWh. To meet this electricity demand, an additional 25,000 to 32,000 kWh is purchased annually from an external energy provider.
Energy efficiency class (*if available*)	-

Information on previous renovations (year, implemented measures)	2005: Complete renovation of stairwells, including replacement of entrance doors and windows. 2006: Roof renovation with insulation of the building's roof-ceiling/loan of 60,000 PLN. 2008-2009: Building thermal modernization, construction of vestibules with the installation of entrance doors, balcony renovations, and replacement of windows and balcony doors in apartments. 80% of windows and doors were replaced / loan of 100,000 PLN from the Cooperative Bank. 2010: Replacement of electrical installations in the basement and common areas, stairwells converted to 24V, replacement of the horizontal water supply network with the installation of a limescale removal device "IMPULS" (improves drinking water quality by eliminating limescale and extends the lifespan of heaters by approximately 80%). 2011: Construction of sidewalks in front of the building and a parking lot with a stormwater drainage system. Self-financed 70,000 PLN. 2014: Construction of a photovoltaic system on the building's roof with a capacity of 40 kW, installation of heat pumps with a capacity of 120 kW. 2016: Replacement of cold water supply risers in the building, installation of radio water meter reading system / self-financed 25,000 PLN. 2017: Construction of a domestic hot water system based on renewable energy sources and air-water heat pumps, and solar installation. 2022: Construction of attached balconies. Installation of a 32 kW photovoltaic system on the steel structure of the balconies for heating domestic hot water. 2024: Construction of a rainwater drainage system from the building's roof to a retention tank for watering green areas in front of the community building.

Informations on the renovation process

Construction measures		**outcomes and benefits of renovations**	
Thermal insulation of the outer shell - outside wall, roof,	Thermal modernization of the building in 2008-2009, including roof and ceiling insulation and the replacement of windows and balcony doors.	*energy savings*	Improved energy efficiency, reduced heating energy consumption.
Replacement of external carpentry	Replacement of window and door joinery in 2008-2009 (80% of windows and doors were replaced).	*financial*	Lower maintenance costs for apartments, better thermal insulation.
Other	Renovation of stairwells and replacement of entrance doors in 2005.	*health and other benefits*	Improved safety and comfort for residents, enhanced building aesthetics.
Mechanical engineering measures		**data on obstacles faced before and during the**	
Heat pump	Installation of two NIBE F1345-60 ground-source heat pumps with a capacity of 120 kW in 2014.	*energy savings*	Reduced heating costs, increased energy efficiency of the building.
DHW heat collectors	Solar installation for heating domestic hot water in 2017.	*financial*	Lower water heating costs, independence from gas.
Wood chip/pellet boiler or other type of boiler	None (heat pumps and solar energy were used).	*health and other benefits*	Elimination of gas heaters and coal boilers, improved indoor air quality.
Other	Modernization of the water supply system with the installation of the "IMPULS" limescale removal device in 2010.	*Other*	Extended lifespan of heating elements, improved water quality.
Electrotechnical measures		**solutions for vulnerable residents - especially ones in the risk of energy poverty**	For the past 8 years, energy poverty has not been an issue in the building.
Replacement of indoor lightning	Replacement of electrical installations in basements and stairwells with a 24V system in 2010.		
PV plant	Installation of a 40 kW photovoltaic system on the building's roof in 2014 and an additional 32 kW system on balconies in 2022.		
Other	Installation of a wind energy generator planned for 2025.		

Experts included in the renovation process (*architects, contractors, structural engineers, etc.*)	Architects, contractors, structural engineers.	**If the financial instruments, financing schemes, models funding sources were used, please mention and shortly describe**	Stage I – 2014: Low-interest loan from WFOŚiGW in Olsztyn for the design and installation of heat pumps and a photovoltaic system (625,000 PLN, repaid). Stage II – 2017: 82% funding by the Marshal's Office of the Warmian-Masurian Voivodeship for the renewable energy system (cost 285,000 PLN). Stage III – 2022: Loan from WFOŚiGW in Olsztyn for the construction of balconies and installation of PV panels (680,000 PLN, 10-year repayment). Stage IV – 2024: Financing with a 10% loan forgiveness from Stage I for the construction of a rainwater drainage system.

Analyse the overall context of the selected demonstration buliding(s)

Name of the partner:	ALEA
Country:	RO
Region:	ALBA county (Centru developmnet region)

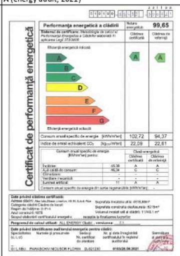
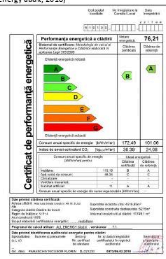
Information about the demonstration building(s)

	Building
General information about the building	
Location (address, cadastral unit)	**BL.8**Address (street): LIVEZII 49 ALBA IULIA
Mini-map	
Map access	https://maps.app.goo.gl/n8QcqZyirN1mpG9g9
Photo 1	
Photo 2	
Homeowner structure	
Private ownership (%)	100
Public ownership (%)	0

Energy poverty data		Before renovation:
Number of vulnerable residents at risk of energy poverty	≃40%	≃60%
Types of vulnerable residents	-low income residents -elderly -single living -persons with chronic diseases -persons with disabilities	

Role and involvement of building managers (*explain their role, responsibilities and other relevant tasks*)	-make posters and building-level announcements -collect taxes on utilities from residents -representing the building for public utilities -representing the building for public administration -collect complains from residents -supervise maintenance work at the building -ensure access to the building for the residents

Communication with landlords, homeowners/tenants *(communication methods, frequency of communication, tenant's attitude and engagement, etc .)*	-posters/printed sheets at MAB entrances -posters/printed sheets at homeowners association cash desk -scheduled homeowners meetings -city hall homeowners meetings -phone/mail/email/utilities payment app

Technical characteristics of the building		
Year of construction	1978	
Gross building area (m2)	5215	
Conditioned floor area (m2)	4518	
Conditioned volume (m3)	11749	
Number of floors	4	
Number of apartments	64	
Average apartment area	70	
Heating system (individual, central, district) - on apartment and building level	Individual, natural gas	
Type of energy carrier/s (natural gas, coal, wood, etc.)	Natural gas (for heating) + electricity	Before renovation:
Energy consumption (electrical, heating and DHW) (*if available)* - on apartment and building level	-heating **45,38** kWh/m2,yr -hot water **46,34** kWh/m2,yr -electricity **11** kWh/m2,yr	-heating **115,15** kWh/m2,yr -hot water **46,34** kWh/m2,yr -electricity **11** kWh/m2,yr
Specific energy consumtion (energy audit)	**102,72** kWh/m2,yr	**172,49** kWh/m2,yr
Specific emissions (energy audit)	**22,09** kgCO2/m2,yr	**36,39** kgCO2/m2,yr
Energy efficiency class (*if available*)	**A** (energy audit, 2021)	**B** (energy audit, 2018)
Energy audit snapshot		
Information on previous renovations (year, implemented measures)	Partial renovation works made by some apartment owners (not certified)	

Indicator and unit	Numeric value	
Price of natural gas (EUR/kWh)	0,062	E.ON Romania, 2024
Average apartment heated area (m2)	70,59	
Specific natural gas consumption before (kWh/m2,yr)	115,15	energy audit
Specific natural gas consumption after (kWh/m2,yr)	45,38	energy audit
Natural gas consumption before (kWh/apartment,yr)	8 129	
Natural gas consumption after (kWh/apartment,yr)	3 204	
Energy savings (kWh/apartment,yr)	4 925	
Specific energy savings after renovation (kWh/m2,yr)	**69,7700**	
Specific cost reduction after renovation (EUR/m2,yr)	**4,32574**	

Detalii preț E.ON Actual Gas

Estimated energy savings per building (kWh/year)	315 221
Estimated energy savings per apartment (kWh/year)	4 925
Estimated cost reduction per building (EUR/year)	19 544
Estimated cost reduction per apartment (EUR/year)	305

Informations on the renovation process

Construction measures *Thermal insulation of the outer shell - outside wall, roof,* *Replacement of external carpentry* *Other*	Roof/attic insulation and consolidation, insulating the building walls (envelope), replacing exterior windows/balcony doors/entrance doors with thermopane windows/doors, building foundation waterproofing and standard facade paint	**outcomes and benefits of renovations** *energy savings* *financial* *health and other benefits*	Energy savings: reduction in natural gas consumption (~60% compared to non-renovated state) per apartment: ; Cost reduction: ~300 EUR/year per apartment, ~20.000 EUR/year per building; Health benefits: better cold/heat wave protection for indoor spaces, better outside noise attenuation, decrease of mold and mold spores
Mechanical engineering measures *Heat pump* *DHW heat collectors* *Wood chip/pellet boiler or other type of boiler* *Other*	Renovation works for this building did not include mechanical engineering measures	**data on obstacles faced before and during the renovatio** *energy savings* *financial* *health and other benefits* *Other*	There is an extensive biurreaucratic process for implementing the project and the renovation works for MABs. This often results in unscheduled delays. Municipal department for the admistration of residential buildings stock is the implementer of this project.
Electrotechnical measures *Replacement of indoor lightning* *PV plant* *Other*	Renovation works for this building did not include electrotehnical measures or other types of works	**solutions for vulnerable residents - especially ones in the risk of energy poverty**	Renovation works for this building did not include solutions for vulnerable residents, other that the genergal intervation to the building envelope
Experts included in the renovation process (*architects, contractors, structural engineers, etc.*)	Renovation works were subcontracted by the municipalty by public procurmement procedure and the renovation works/selection of construction materials was done in compliance to national laws and regulations	**If the financial instruments, financing schemes, models funding sources were used, please mention and shortly describe**	Renovation works were financed by EU Cohesion fund - Regional Operational Programme 2014-2020 Axis 3, Investemnt piority 3.1 Supporting energy efficiency, smart energy management and the use of energy from renewable sources in public infrastructures, including public buildings and the housing sector, Operation A - Residential Buildings (Cofinancing rate: 75%)

Analyse the overall context of the selected demonstration buliding(s)

Name of the partner:	LEASP
Country:	SI
Region:	Podravje

Information about the demonstration building(s)

	Building
General information about the building	
Location (address, cadastral unit)	Ulica 25 maja 15, 17, 19; 2250 Ptuj
Photo	
Homeowner structure	
Private ownership (%)	90
Public ownership (%)	10

Energy poverty data	
Number of vulnerable residents at risk of energy poverty	not available
Types of vulnerable residents	not available

Role and involvement of building managers (*explain their role, responsibilities and other relevant tasks*)	Integrated management of residential and commercial buildings, carrying out routine and emergency maintenance work, accounting and bookkeeping services, legal and technical advice, development and implementation of a maintenance plan, management of the reserve fund, mediation between floor owners, ensuring transparency in billing and cost sharing (permanent online access).

Communication with landlords, homeowners/tenants *(communication methods, frequency of communication, tenant's attitude and engagement, etc .)*	anual meetings,web portal, e-mailphone.

Technical characteristics of the building	
Year of construction	1989
Gross building area (m2)	5.798,2 m2
Number of floors	8
Number of apartments	64
Average apartment area	56,8
Heating system (individual, central, district) - on apartment and building level	district heating
Type of energy carrier/s (natural gas, coal, wood, etc.)	wood biomass/natural gas
Energy consumption (electrical, heating and DHW) (*if available)* - on apartment and building level	
Energy efficiency class (*if available*)	
Information on previous renovations (year, implemented measures)	

Informations on the renovation process

Construction measures	Thermal insulation of the outside walls, replacement of windows and doors	**outcomes and benefits of renovations**	energy savings
Thermal insulation of the outer shell - outside wall, roof,		*energy savings*	
Replacement of external carpentry		*financial*	
Other		*health and other benefits*	
Mechanical engineering measures		**data on obstacles faced before and during the r**	
Heat pump		*energy savings*	
DHW heat collectors		*financial*	
Wood chip/pellet boiler or other type of boiler		*health and other benefits*	
Other	-	*Other*	financial
Electrotechnical measures		**solutions for vulnerable residents - especially ones in the risk of energy poverty**	-
Replacement of indoor lightning			
PV plant			
Other	-		
Experts included in the renovation process (*architects, contractors, structural engineers, etc.*)	Architects and contractors	**If the financial instruments, financing schemes, models funding sources were used, please mention and shortly describe**	reserve fund, ECO fund

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