CEESEN-BENDER

Building intErventions in vulNerable Districts against Energy poveRty

Deliverable 5.1

Building renovation roadmaps in 5 pilot areas

Building renovation roadmap for the pilot area Medjimurje County (Croatia)

Dissemination Level: Public

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V4	31.01.2026	Final documents in English and Croatian sent to the Project Officer (PO).

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1. Introduction

Medjimurje County's building stock is predominantly characterized by multiapartment buildings (MABs) constructed in the post – Second World War period up to the 1990s, which represent a significant opportunity and challenge in the context of the national and EU energy transition goals. These buildings are central to addressing energy poverty, reducing CO_2 emissions and improving the living conditions of a substantial portion of the population. However, the renovation sector faces a complex interplay of obstacles, including inadequate technical staff, high technical and financial scale of interventions, as well as varying levels of awareness and capacity among the tenants. This roadmap, developed within the project CEESEN-BENDER, provides a guiding framework for accelerating the energy renovation of this critical housing stock. It synthesizes data from detailed field surveys, technical analyses and financial assessments to identify priority buildings, outline actionable pathways and establish a model for socially inclusive, large – scale renovation in the pilot area.

2. Vision and objectives

The vision of this roadmap is to transform Medjimurje County into a model region for a socially just and climatically effective energy transition in the building sector. By 2030, it aims to establish a systemic, self – sustaining renovation ecosystem that prioritizes the most vulnerable households and the worst performing buildings. This ecosystem will be characterized by streamlined processes, accessible financing, strong multi stakeholder partnerships and integrated support services, ensuring that every renovation project not only achieves deep energy savings and CO_2 reduction, but also tangibly improves health, comfort and social cohesion within the community.

Furthermore, this roadmap aims to translate the overarching vision into concrete, measurable outcomes for Medjimurje County. Its specific objectives are:

1. Provide a data – driven estimation and ranking of MABs in the pilot area most in need of energy renovation, with a specific focus on those with high concentrations of households at risk of energy poverty.
2. Estimate the total investment required for large scale renovation and outline the projected return on investment (ROI).
3. Identify key stakeholder groups, including building managers, regional/local governments, supporting institutions and vulnerable tenants and define tailored strategies for their effective engagement throughout the renovation process.
4. Align the roadmap's actions with relevant national, regional and local planning documents to create synergies and influence the future allocation of renovation funds towards the identified priorities in Medjimurje County.
5. Utilize unique cross – country survey data from CEESEN-BENDER on the post – renovation benefits to health, thermal comfort and overall living conditions to quantify the social value of renovation beyond energy savings. These findings will directly inform regional and local policymaking and underpin a targeted public awareness campaign on the multiple benefits of renovation, emphasizing improved wellbeing and quality of life for vulnerable tenants.

3. Current status of legislative and regulatory frameworks for building renovation in Croatia

Successful, inclusive and timely building energy renovation requires a complex, yet coordinated system that connects policies, regulations, expertise and materials. These chapters describe how the European climate goals and directives are translated into concrete local activities through national legislation and strategic frameworks. They highlight the key drivers, financial mechanisms and technical and professional standards, which form the foundation for implementation that protects the environment, reduces energy poverty and improves the quality of life.

3.1. EU laws and regulations for energy renovation of MABs

The energy renovation process in Croatia is guided by EU policies and directives that set clear goals and obligations for member states. **The European Green Deal** defines the target of climate neutrality by 2050, while the **Fit for 55 package** translates this into binding measures, including a 55% reduction of GHG emissions by 2030. It also envisages establishing the Social Climate Fund to support vulnerable groups and ensure a fair transition. **The Renovation Wave Initiative** specifies the objectives for the building sector, doubling renovation rates by 2030 and focusing on the worst performing buildings. It links renovation with energy savings, job creation and poverty reduction, promoting integrated services for citizens through One – Stop – Shops. Two key EU directives, which provide the framework that member states implement through national regulations and plans are:

- **The Energy Performance of Buildings Directive (EPBD)** – introduces minimum energy performance standards, prioritizing older and inefficient buildings, as well as adoption of National renovation plans and Renovation passports
- **The revised Energy Efficiency Directive (EED)** – introduces stricter obligations for monitoring and reporting energy savings, with a particular focus on households affected by energy poverty. It also removes the possibility of using alternative measures instead of achieving actual energy savings, making compliance more binding for national and local authorities.

Furthermore, the **National Recovery and Resilience Plan (NRRP)** based on the European Mechanism for Recovery and Resilience, provides the main financial mechanism for implementing these measures in all EU countries including funding for renovation of public and private buildings. At the regional level, Medjimurje County and its local self – government units (towns and municipalities) are responsible for applying these EU and national policies. Their task is to use available NRRP funds, comply with EPBD and EED requirements and coordinate local stakeholders, including building managers, energy experts and construction companies to support energy renovation and reduce energy poverty. The NRRP is entering its final implementation phase in 2025/2026. After its

completion, additional funding opportunities will be available through the Competitiveness and Cohesion Program 2021 – 2027, which will continue to support renovation projects also for an additional three years beyond the official validity period.

3.2. National laws and regulations for energy renovation of MABs

While the EU provides direction and funding, national legislatives and strategic frameworks define Croatia, its regional and local self – government units plan and implement energy renovation measures. It translates EU strategies into practical mandates, tools and financing for regional and local authorities. The **Long – term Strategy for the Renovation of the National Building Stock until 2050** is one of Croatia's key strategic documents, which sets national renovation goals and requires regional and local authorities to prioritize energy renovation of buildings in their areas. The Strategy also emphasizes support for vulnerable and energy poor households. Crucially, this Strategy is operationalized through specific programs and planning documents.

The Program for Energy Renovation of Multiapartment Buildings until 2030 is the most relevant national instrument for implementing energy renovation in this sector. It not only provides a regulatory framework, but also outlines concrete measures and indicators for reducing emissions and achieving energy savings in multiapartment buildings. At the legislative level, **the Energy Efficiency Act** and the **Energy Efficiency in Buildings Act** provide the legal foundation for renovation programs and funds. The Energy Efficiency in Buildings Act specifically governs the field of energy efficiency in buildings, including energy renovation, decarbonization, reduction of emissions, the building energy certification system and the fulfilment of basic requirements for energy efficiency and the thermal properties of structures. Together, these acts enable regional and local authorities to develop their own initiatives and ensure social equity by directing financial incentives toward low – income households and marginalized groups.

Furthermore, the Building Act and the **Ordinance on the Energy Performance of Buildings** establish binding technical standards and compliance requirements for all renovation works (such as thermal protection, nZEB standards and requirements for building elements such as windows and technical systems), ensuring quality and alignment with the **EU's Energy Performance of Buildings Directive (EPBD)**. Financially, the **National Recovery and Resilience Plan (NRRP)** operationalizes these goals by providing funding for the energy renovation of public and private buildings. In Medjimurje County, the NRRP is the main source of co – financing of the energy renovation of MABs, which directly supports the inclusion of low – income households in the period from 2021 to 2025. Alongside the NRRP, the **European Regional Development Fund (ERDF),** implemented through the **Competitiveness and Cohesion Program 2021 – 2027**, represents another key financial instrument supporting building renovation at the

regional and local level, whereby the specific calls for energy renovation under the same are still not published.

Finally, the overarching **Integrated National Energy and Climate Plan of the Republic of Croatia for the period 2021 – 2030 (NECP)** is a key planning document which, alongside the aforementioned laws and programs, sets the integrated energy and climate policy context for all renovation efforts. Together, the Long – term Renovation Strategy, the Program for Multiapartment Buildings, the Energy Efficiency Act, the Energy Efficiency in Buildings Act, the Building Act, the NECP, and financing instruments such as the NRRP and ERDF form a coherent national framework, which enables Medjimurje County to translate EU and national policies into effective, socially inclusive renovation actions.

3.3. Role of professional and material certification in ensuring renovation quality

The quality and success of building energy renovation in Croatia and also Medjimurje County relies on two key conditions: **authorized professionals** and **certified construction materials**. Their role is crucial for meeting technical standards, achieving savings, securing eligibility for funding and reaching climate goals, especially in projects involving vulnerable groups.

Certification of Professionals

Authorized and certified construction professionals are essential for timely and high – quality implementation of energy renovation. In accordance with the **Regulations on building energy audits and energy certification**, energy audits and certificates for public buildings larger than 250 m², new buildings and buildings being sold or leased may only be carried out by authorized experts. They must hold a certificate issued by the Ministry of Physical Planning, Construction and State Assets and be registered in the **Register of authorized experts**. To obtain authorization, professionals must have appropriate higher education qualifications, relevant experience and completed specialist training. For more complex buildings, an interdisciplinary team is required (architects, civil, mechanical and electrical engineers). Authorized professionals are also required to undertake continuous professional development. In the renovation process, certified energy auditors, designers and engineers ensure that projects meet the minimum energy standards and technical requirements necessary for financing. Their accreditation is a prerequisite for applying to calls for proposals and serves as a guarantee of compliance with regulations. Given the social dimension of policies, projects involving low – income households are advised to also include project managers, social coordinators and community mediators to facilitate communication and tenant participation.

Labelling and Certification of Construction Materials

The effective implementation of energy renovation projects, particularly for MABs, depends on the use of construction materials, which comply with established European and national technical standards. The foundational framework is **CE marking**, the mandatory conformity mark for construction products placed on the market within the European Economic Area. For critical product categories such as external thermal insulation composite systems, windows or specific heating equipment, Croatian legislation additionally requires a **national certificate of conformity (HRN)**.

For energy renovation, the following material categories with verified performance characteristics are particularly important:

- **Thermal insulation materials** (e.g., expanded polystyrene, mineral wool) must have declared thermal conductivity (λ – value) and a reaction – to – fire class.
- **Windows and glazing** are determined by the thermal transmittance coefficient (Uw – value) of the entire assembly, the solar heat gain coefficient (g – value) and sound insulation (Rw).
- **Heating, ventilation, and air conditioning (HVAC) systems** must carry the **Energy related Products (ErP) label** (scale from A+++ to G).

In addition to mandatory certifications, voluntary **Environmental Product Declarations (EPDs)** provide a life cycle assessment and labels for low emissions of volatile organic compounds (**VOCs**, e.g., EMICODE) are recommended for protecting indoor air quality. A standardized approach to public procurement and supported private renovations must explicitly require CE and HRN marks, technical data sheets with declared performance characteristics and the manufacturer's installation instructions.

In conclusion, collaboration with local construction companies and professional chambers (Croatian Chamber of Civil Engineers – HKIG, Croatian Chamber of Architects – HKA) is key for a successful implementation of the renovation. For larger and more complex projects, it may be necessary to engage external authorized experts to strengthen capacities, meet deadlines and ensure the effective use of allocated funds. An integrated approach that equally values the expertise of people and the quality of materials is the basis for effective, durable and socially inclusive energy renovation in Medjimurje County.

4. Energy poverty in the pilot area Medjimurje County

Croatia has recently intensified efforts to address energy poverty, culminating in the adoption of an official definition in early 2025. Until then, no formal definition existed, and energy poverty was typically described in general terms. Because specific criteria for identifying energy poor households are still being refined, Croatian authorities and researchers often rely on proxy indicators (e.g. at – risk – of – poverty (AROP) and social exclusion (AROPE) rates, material deprivation levels) to gauge the scope of the problem. These indicators show that even before recent energy crises, a meaningful minority of Croatian households faced financial strain that could translate into energy affordability challenges.

Over the past decade, Croatia has launched several programs to improve residential energy efficiency and ease households' energy cost burdens, though a comprehensive national energy poverty alleviation program is still missing. Broad nationwide schemes, notably the Energy Renovation Program for Family Houses and similar programs for MABs have provided co – financing for insulation, efficient heating systems, RES integration and other retrofits. These initiatives, supported by domestic funds and EU cohesion policy, target the aging housing stock (much of it built prior to 1987) to reduce overall energy consumption and emissions while lowering utility bills for homeowners. In practice, however, they have generally not been limited to poor households. Eligibility depends on building status and co – ownership, with typical grants covering 60 to 80% of renovation costs.

To directly assist vulnerable groups, the government introduced a vulnerable customer energy subsidy in 2015 and 2016 (a monthly allowance offsetting utility bills for households who are benefiting from guaranteed minimal compensation). Additional targeted measures have been piloted more recently. In 2021, financed partly under the National Recovery and Resilience Plan (NRRP), Croatia launched a Program to Combat Energy Poverty in Assisted Areas (war affected and underdeveloped communities) for the period from 2021 until 2025. Backed by approximately 47 million EUR of nationally allocated funds, this program mapped around 400 energy inefficient, publicly owned MABs in areas of special state care and by the end of 2025 around 56 buildings have been renovated, while the remaining buildings should be renovated using future Social and Climate Fund funds. Additionally, the Government accolated 25 million EUR back in 2022 to Ministry of Economy to plan and open the call for energy poor households. In the meantime, the Environmental Protection and Energy Efficiency Fund (FZOEU) announced that the call should be opened sometime during 2026.

Local authorities are also starting to be more active. For example, the City of Zagreb adopted the Energy Poverty Alleviation Program through 2030, the first such municipal Program in Croatia, and provides a package of measures to energy poor households. By contrast, Medjimurje County has not yet adopted any dedicated regional program to combat energy poverty. The County participates in general national schemes and

EU projects (its energy agency, MENEA, has run small pilot initiatives such as free energy audits for vulnerable households in family houses through the project **CO-EMEP** (*Improvement of cooperation for better energy management and reduction of energy poverty in HU – HR cross – border*) under which 5 energy poor households were assessed and the project **I-PRODER** (*Challenges to prevent and address energy poverty*), under which 50 energy audits were carried out and households were provided with energy saving packages. However, these activities remain project based and limited in scope, while there is no standalone focused county level strategy or dedicated funding mechanism for energy poor households.

This section synthesizes available indicators and survey evidence to describe the contours of energy poverty affecting households in Medjimurje County. Because official statistics are often published at broader territorial levels, the starting point is Northern Croatia (NUTS – 2), which includes Medjimurje County (NUTS – 3). In February 2025, Croatia introduced an official definition of energy poverty, but operational criteria for classifying households remain unsettled. Consequently, assessments typically include several proxy indicators, such as **at – risk – of – poverty (AROP)**, **at – risk – of – poverty or social exclusion (AROPE)**, material deprivation and low work intensity, which are usually sourced primarily from the annual EU - SILC (EU Survey on Income and Living Conditions) and other official national and regional sources.

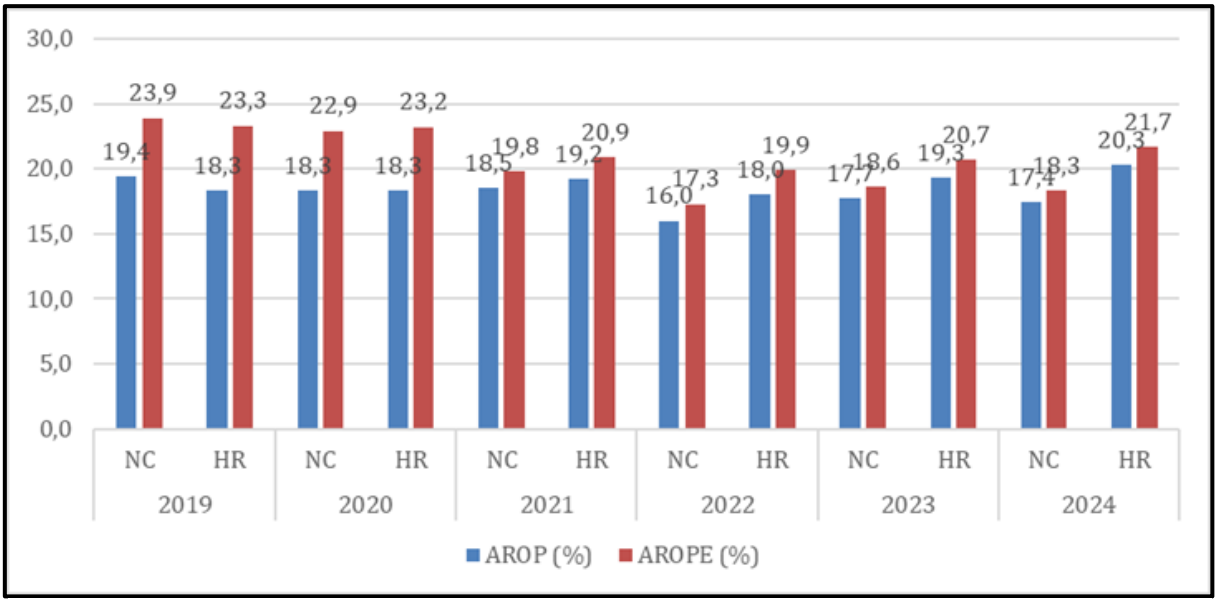

Figure 1: Indicators of at – risk – of – poverty rates (AROP) and persons at – risk – of – poverty and social exclusion (AROPE), in 2023 and for the six – year period (2019 – 2024) in Northern Croatia (NC) and Croatia (HR)

Source: Croatian Bureau of Statistics, indicators of poverty and social exclusion in 2024, 2026 (https://podaci.dzs.hr/2025/hr/97251)

Through this lens, the recent AROP/AROPE pattern in Northern Croatia places Medjimurje County within a region of varied risk. For context, the Ministry of Regional

Development's 2016 "Poverty Map" estimated the County's AROP at 15%, underscoring that county level vulnerability has been significant despite the smoothing effect of regional totals.

To complement income based risk, administrative data on the applied social welfare rights offer more insights on the possible extent and intensity of poverty in Medjimurje County. Across 2019 to 2023, the share of guaranteed minimum benefit (GMB) users averaged roughly 2,9% of the County population. This somewhat aligns with national rates of severe material deprivation (2,3% in 2024) and points to segments of society and households most exposed to multiple forms of poverty and exclusion. Fuel cost support (firewood) was disbursed to 1.266 households in 2019, 1.130 in 2020 and 1.038 in 2021 (later figures not available), reinforcing that affordability challenges extend into the energy domain.

Table 1: Overview of indicators (number of beneficiaries) on the realized social welfare rights in Medjimurje County in the reference period

	2019	2020	2021	2022	2023
Guaranteed minimum benefit (GMB) (total)	3.541	3.069	2.931	3.144	3.896
GMB beneficiaries (% of total population of Medjimurje County)	3,1	2,7	2,6	3,0	3,0
Compensation for firewood costs (total)	1.266	1.130	1.038	-	-

Source: Ministry of Labor, Pension System, Family and Social Policy, Statistical Reports, 2026 (https://mrosp.gov.hr/strategije-planovi-programi-izvjesca-statistika/4165)

Labor market precarity is another structural driver. A standard EU – SILC indicator, the share of people living in very low work intensity households, is tracked at NUTS – 2 and, where available, helps interpret supplement energy poverty risk indicators to further assess vulnerability. Higher prevalence typically coincides with elevated AROPE and greater bill payment vulnerability. Data is published by Eurostat for NUTS 2 level and Household Budget Survey. As visible from the figure, the share of people living in very low work intensity households fell steadily in both Croatia and Northern Croatia from 2021 to 2023 (Croatia: 7.5→6.3→5.5%; Northern Croatia: 5.5→5.3→3.5%). Northern Croatia tracked below the national level throughout and posted a sharper improvement by 2023, widening its advantage.

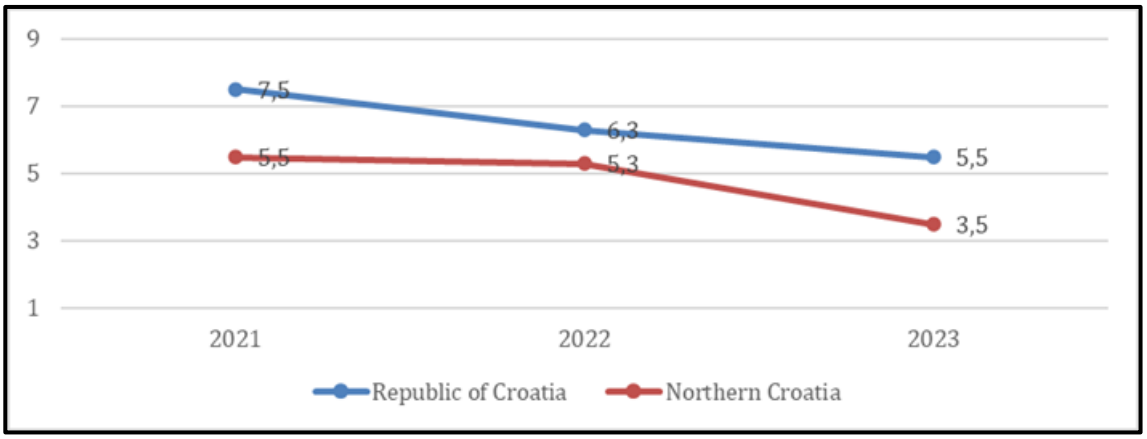

Figure 2: Population (%) living in households with very low work intensity

Source: Croatian Bureau of Statistics, indicators of poverty and social exclusion in 2024, 2026 (https://podaci.dzs.hr/2025/hr/97251)

For assessing energy poverty, the indicators shown in Figure 2 are routinely used. They come from the EU – SILC framework and are collected across EU member states; for variable (C), data are available at the NUTS – 2 level. EPAH also includes these indicators among its recommended metrics for energy poverty assessment. Overall, the NUTS – 2 picture for Northern Croatia contextualizes Medjimurje County, where gaps in county level data call for caution when generalizing. However, taken together, AROP/AROPE trends, social assistance use and very – low – work – intensity shares point to a setting in which a meaningful minority faces significant financial strain, conditions that heighten the risk of energy poverty, especially when prices climb or housing is inefficient.

To move from regional aggregates to practical experience, the focus was on the CEESEN-BENDER pilot survey conducted in the town of Čakovec, the largest urban centre and so – called capital of Medjimurje County and the locus of the project's Croatian fieldwork. The study sampled adult tenants in MABs constructed between 1945 and 1991, with a split between renovated and unrenovated buildings (minimum of 200 households in each group, total of approx. 400). Data were gathered face – to – face by trained interviewers between April and November 2024, using a structured questionnaire (≈219 variables) spanning housing/renovation and energy poverty, quality of housing, health and socio – demographics.

The comparative analysis of the survey data across all 5 CEESEN-BENDER pilot areas [see project Article on the results of survey on energy consumption, energy needs and behaviour of energy poor homeowners, 2025] provides robust evidence that energy renovation is consistently associated with significant co – benefits beyond energy savings. Tenants of renovated buildings report:

- Higher perceived energy efficiency and overall building satisfaction
- Improved winter and summer thermal comfort

- Reduced prevalence of building deficiencies linked to health risks (e.g., mold, dampness, drafts)
- A greater sense of being informed about building – level decisions
- These findings underscore that renovation is not merely a technical or financial intervention, but a crucial public health and social policy tool. The data provides a compelling, evidence – based narrative for awareness campaigns aimed at homeowners and landlords, moving the discourse from cost to investment in long – term wellbeing and community resilience.

The results highlight how renovation status of MABs correlates with household experiences of affordability, thermal comfort and satisfaction with housing quality, all key dimensions for estimating local energy poverty risk. For instance, in Čakovec, the aforementioned arrears on utility bills in the last 12 months were reported by 3,0% of the tenants in unrenovated buildings (1,5% once, 1,5% two or more times). Among the tenants in renovated buildings, 3,5% reported arrears (1,5% once, 2,0% two or more times).

Households also report taking specific savings measures to cope with high energy bills. In unrenovated buildings, 18,0% reduced heating use, 14,0% reduced window opening and ventilation, 13,5% cut spending on basic needs (medicines, clothing), 11,5% reduced hot water use, 10,5% reduced lighting and 3,0% cut food purchases. In renovated buildings, these shares are lower for most items: 6,5% reduced heating use, 5,5% reduced window opening and ventilation, 2,5% cut spending on basic needs, 6,0% reduced hot water use, 3,5% reduced lighting, while 14,5% report savings on food purchases.

When it comes to winter comfort in Čakovec, tenants of unrenovated buildings mostly describe their living conditions as pleasant (54,0%) or neither pleasant or unpleasant (neutral) (22,5%), with smaller shares calling them unpleasant (2,0%) or extremely unpleasant (1,0%), while none selected extremely pleasant (0,0%). The mean comfort score is 3,9 (1 – 5), and 9,5% report they cannot afford adequate warmth. In renovated buildings, the distribution shifts upward: pleasant 61,0% and extremely pleasant 34,5%, with neutral 3,0%, unpleasant 1,0%, and extremely unpleasant 0,0%. The mean rises to 4,3, and 2,5% of the tenants reports they cannot afford adequate warmth.

Turning to summer conditions in Čakovec, tenants of unrenovated buildings most often describe their comfort as pleasant (52,0%) or neutral (22,0%), with 5,5% calling it unpleasant and 2,0% extremely unpleasant, while 18,5% selected extremely pleasant. The mean summer comfort score is 3,8 (1 – 5), and 9,5% report they cannot afford cooling, an indicator of summer energy poverty. In renovated buildings, the pattern again shows reduced risk to energy poverty, with the percentage of survey respondents describing their perceived comfort levels as follows: pleasant 60,0% and extremely pleasant 28,0%, with neutral 9,5%, unpleasant 2,0%, and extremely unpleasant 0,5%. The

abovementioned mean rises to 4,1, and 6,0% report they cannot afford cooling, marking a lower incidence of summer energy poverty than in the unrenovated stock, but ultimately indicating greater risk of energy poverty in summer than during the winter.

Concerning housing conditions inside dwellings in Čakovec, tenants of unrenovated buildings most often report draught and damp related issues: 20,5% experience draught through the door and 14,5% through the windows, 24,0% report mold on walls or ceilings, 13,5% damp walls, 5,5% damp floors and 5,5% wet foundations. Other reported problems include leaking roofs (6,0%), rot in window frames (6,0%), rot in door frames (4,5%) and rot in floors (2,5%). In renovated buildings, the reported shares are lower on these same items: draught through the door 6,5% and through the windows 2,0%, mold on walls or ceilings 8,0%, damp walls 5,5%, damp floors 1,0%, and wet foundations 1,5%. Additional items include leaking roofs (1,5%), rot in window frames (1,0%), rot in door frames (0,5%), and rot in floors (0,5%).

Read together, these results characterize energy poverty in Croatia's pilot area Medjimurje County as a layered problem with energy renovation of MABs associated with clear comfort and condition gains and more modest shifts in affordability. The data gathered in the town of Čakovec present this picture in concrete numbers, while remaining gaps in county level data argue for cautious conclusions and continued tracking of the same indicators over time. At this stage, without detailed county level data on household energy spending, budget allocations and energy consumption patterns, energy poverty should be assessed through a broad set of indicators to locate both its extent and intensity across the region.

5. MAB renovation in the pilot area Medjimurje County

Medjimurje County combines a variety of private and public buildings, whereby the private ones are divided into residential and non – residential. Regarding the residential buildings stock, most of the buildings are family homes, owned by private persons, while a smaller amount falls to MABs, owned either by the tenants or the local self – government units. This chapter presents the current status of the legal frameworks, technical conditions, stakeholders, drivers and difficulties, as well as most prioritized MABs for energy renovation in Medjimurje County according to the data collected within the project CEESEN-BENDER.

5.1. Regional and local frameworks for energy renovation of MABs

As described in chapter 4, the energy renovation of MABs in Medjimurje County is regulated by a range of national legal acts, strategies and action plans. These documents establish the foundation for a more regulated renovation process for both public and private buildings, providing guidance, information and funding opportunities to entities and owners at all levels. Although most regulations cover the topic of energy renovation in general one of the most relevant documents is the Program for Energy Renovation of Multiapartment Buildings until 2030, which, as stated before, presents a national plan adopted by the Government of the Republic of Croatia that provides a dedicated framework for improving the energy performance of MABs, setting, thereby, clear objectives to reduce energy consumption and CO_2 emissions, improve living comfort and increase the safety and resilience of the housing stock.

At the regional level, Medjimurje County, follows the recommendations of different regional plans in order to further promote and foster the energy renovation of public and private buildings. While none of the regional plans focus exclusively on MABs, the key documents guiding the County's approach to improving energy efficiency and promoting RES in its building stock are summarized in the table below.

Table 2: Documents addressing the topic of energy renovation of buildings in Medjimurje County

Regional documents		
Title	Development Plan of Medjimurje County	Energy Efficiency Action Plan of Medjimurje County
Validity period	Approximately 7 years	3 years
Purpose	Defining priorities and specific objectives aimed at achieving a focused, sustainable and inclusive development of the County.	Defining specific objectives, measures and activities aimed at improving the energy efficiency of the County.

Key topics	• Sustainable economy (market competitiveness, innovation, entrepreneurship and investments) • Healthy, inclusive and resilient society (social services, health care, education, sports and recreation, culture and social inequalities) • Green and Digital County (environmental and digital capacities and infrastructure, RES, energy efficiency)	• Analysis of the current situation and needs (energy consumption and needs, consumption indicators) • Goals and estimated savings (energy efficiency objectives, total planned energy savings and CO_2 emission reduction) • Measures and Indicators (in sectors such as buildings, transport, public sector, other) • Financial framework (required investments and improvements, financing strategies)
Focus areas of energy renovation of buildings	Measures and objectives for: • Energy efficiency improvements of public (schools, kindergartens, healthcare facilities, administrative buildings) and residential buildings • Energy renovation (thermal insulation, replacement of carpentry, efficient heating and cooling systems) • Use of renewable energy sources (PV and solar panels, heat pumps and biomass boilers on public buildings) • Reduction of energy consumption and CO_2 emissions • Contribution to climate change mitigation and adaptation	Measures and indicators for: • Increasing energy efficiency and use of RES (thermal insulation of walls, roofs, and floors, replacement of carpentry with energy efficient alternatives, upgrading heating, cooling, and ventilation systems, installation of RES based systems (PV and solar panels, heat pumps and biomass boilers) • Achievement of the planned energy savings and CO_2 emission reduction • Identifying funding opportunities on EU, national and, eventual, regional levels

Source: Development Plan of Medjimurje County for the period to 2027, 2025 (https://www.redea.hr/wp-content/uploads/2024/04/PLAN-RAZVOJA-MZ-2021-2027.pdf), Energy Efficiency Action Plan of Medjimurje County for the Period from 2025 to 2027, 2025 (link is not available)

The main Croatian pilot area for the project CEESEN-BENDER is Medjimurje County, with the town of Čakovec selected as the specific focus for in – depth analysis of the building stock. Čakovec shares the County's commitment to advancing energy renovation as part of the broader environmental and climate objectives. As Medjimurje County in general, the town of Čakovec, also, fosters and promotes energy renovation of buildings, contributing, thereby, to the region's environmental and climate objectives.

The building stock in the town of Čakovec is divided to public (in the ownership of the County, Town and other public entities) and private buildings (in the ownership of companies, private persons and other private entities). This distinction is crucial because the energy renovation process for each sector is governed and guided by different sets of national and regional regulations and frameworks. Specific local regulations, strategies, action plans and other binding frameworks regarding the energy renovation of buildings valid in the town of Čakovec currently do not exist.

5.2. MAB context

MABs represent a significant share of the residential building stock in the town of Čakovec, but also play an important role in the overall energy consumption and climate changes. Due to their age, outdated construction methods, inefficient building envelopes, external carpentry and obsolete technical systems, most of the existing MABs exhibit high energy loses. These deficiencies contribute to increased energy, living and maintenance costs, negatively affect indoor comfort and tenants' health and result in increased CO_2 emissions. Therefore, **energy renovation of MABs is a key instrument for improving energy efficiency, reducing emissions and enhancing indoor living comfort**.

The **residential MAB stock in Medjimurje County** is predominately **privately owned** (approximately 87%). For this pilot area, 6 MABs have been selected as representative examples, whereby they all are under 100% private ownership, which directly affects decision making processes, financing models and stakeholder engagement throughout the renovation process.

The renovation process requires the implementation of a combination of construction, mechanical and, electrotechnical measures to enhance energy performance and overall MAB quality. **Construction measures** involve insulating the building envelope and replacing external carpentry, including windows and doors, to improve thermal efficiency and reduce energy loses. **Mechanical system measures** include the installation of heat pumps, domestic hot water (DHW) collectors and boilers using wood, pellets, or other suitable energy sources, ensuring reliable and energy efficient heating and water solutions. **Electrotechnical measures** cover the replacement of indoor lightning systems with more energy efficient systems and the installation of photovoltaic (PV) systems to generate renewable energy on site. The renovation process also requires the involvement of **qualified and professional technical staff,** including construction specialists, mechanical and electrical engineers and energy efficiency experts to ensure that all interventions are properly planned, executed and compliant with relevant standards. These measures form an integrated set of interventions aimed at improving the MABs energy performance, thermal efficiency and overall functionality for tenants.

To **effectively assess and prioritize which MAB is going through the renovation process** it is essential to consider their key **technical characteristics**.

The following criteria form the basis for informed decision making:

- **Year of construction** which indicates the building's age and likely compliance with outdated construction standards
- **Gross floor area (GFA), number of floors and apartments** which determine the physical scale and scope of potential renovation works
- **Average apartment area** that provides context for space utilization and helps estimate per – unit energy demand
- **Heating system types and energy carriers** that are critical for evaluating the current system's efficiency and identifying suitable modernization options
- **Energy consumption data and efficiency class** that offers a direct metric of current performance and highlights priority areas for improvement
- **History of previous renovations** that identifies which energy saving measures have already been implemented, focusing efforts on buildings with the greatest remaining potential.

Collectively, these technical characteristics form the basis for informed decision making in MAB renovation planning, enabling the identification of structures that would benefit the most from targeted energy efficiency improvements.

The 6 selected **MABs in Medjimurje County**, taken as pilot MABs, have **gross floor areas (GFA)** ranging from approximately **800 to 3.900 m²**, of which about **600 to 2.400 m²,** is used as **housing area (HA)**. The buildings typically have **3 to 4 floors**, including ground floors and basements, with **an average apartment area of 48 m²**. **The heating systems** are mostly individual and natural gas based. **Energy efficiency classes** range from **D to F** (data are available for 5 of the 6 selected MABs). On 5 (out of 6) MABs no significant **renovation activities** have been implemented to date, as these buildings were not previously prioritized for energy efficiency improvements, while on 1 building a partial energy renovation has been carried out in 2025. Nevertheless, this representative selection provides a clear technical basis for prioritizing renovation interventions in Medjimurje County, ensuring that resources are directed towards buildings with the greatest potential for energy savings and improved living conditions.

Table 3: Overview of the general information on 6 selected MABs in Medjimurje County

Selected MABs in Medjimurje County					
MAB	**Year of construction**	**Gross floor area (GFA) (m²)**	**Conditioned area (m²)**	**Number of dwellings**	**Average living area per dwelling (m²)**
Vladimira Nazora 32, Čakovec	1966	2.975,14	2.288,57	45	50,86
Travnik 12, Čakovec	1985	862,39	663,38	10	66,34
Istarska 16, Čakovec	1967	1.573,20	1.194,78	34	35,14
Josipa Jurja Strossmayera 7b, Čakovec	1962	3.849,70	2.381,36	48	49,61
Janka Slogara 4, Čakovec	1959	1.136,06	583,57	12	48,63
Istarska 14, Čakovec	1964	1.680,00	1.014,54	28	36,23

Source: Project CEESEN-BENDER, WP2: T2.1 Analyzing the overall context of the selected buildings in pilot sites, 2026

Within the context of energy renovation, it is necessary to emphasize the importance of **building managers** who play a crucial role in ensuring the proper functioning of MABs and enabling the effective planning and implementation of energy renovation projects. Their involvement is essential for maintaining operational continuity, coordinating stakeholders and protecting the interests of all owners and co – owners throughout the renovation process. Building managers manage the building's joint account, collect the reserves from the tenants and maintain the building. During the renovation process, they closely communicate with the building representative and technical staff, coordinate and supervise all activities and, at the end, pay the involved constructors, financial and supporting organizations. Their role encompasses project management, coordination with the contractors and submission of projects for co – financing under public funding schemes. In addition, building managers also ensure the protection of co – owners' interests in accordance with decisions adopted by the majority, while carrying out regular management tasks and by undertaking extraordinary works only with the consent of the co – owners' or based on the court decision.

In Medjimurje County, there are two official building managers: **Euroland Ltd.**, which is a privately owned company and **GP Stanorad Ltd.**, which is fully owned by the Town of Čakovec. Together, these two companies manage more than **380 residential buildings**

in Medjimurje County and beyond, making them key institutional stakeholders in the management and energy renovation of the local MAB stock.

Beyond technical and managerial considerations, the energy renovation of MABs in Medjimurje County must also address **the vulnerability of tenants at risk of energy poverty**. Vulnerable groups include: *low – income households, elderly tenants, single parent families, individuals with chronic illnesses and the long – term unemployed*, particularly those living in poorly insulated and inefficiently heated/cooled apartments. They are faced with high energy losses, increased utility costs, moisture problems and reduced indoor comfort. These adverse conditions disproportionately affect vulnerable tenants, who often lack the financial capacity to improve their housing conditions independently. Prolonged exposure to energy inefficient housing leads to inadequate thermal comfort, poor indoor air quality and negative effects on health and social well – being. Addressing these challenges requires **social considerations into renovation planning**, including clear communication, targeted support measures and financial incentives for vulnerable households. Adopting such a holistic approach ensures that energy renovation contributes not only to improved building performance, but also to social inclusion and enhanced quality of life for the tenants.

5.3. Stakeholder involvement in the renovation of MABs

The energy renovation process in Medjimurje County involves a broad range of stakeholders operating at different levels and contributing through distinct roles and forms of engagement. These stakeholders include homeowners and landlords, tenants, building managers, building representatives, technical staff, supporting organizations, financial institutions and national, regional and local authorities. Their coordinated involvement is essential for successful planning, financing and implementation of energy renovation within the Croatian pilot area.

At the **individual level,** homeowners, landlords and tenants are directly affected by energy consumption, living conditions and energy costs. **Homeowners and landlords** represent the most influential stakeholder group, as they participate in key decisions related to renovation and financial contribution. Homeowners who live in the apartments they own are directly affected by energy consumption and utility cost and are, therefore, motivated to engage in energy renovation measures when these results in long – term savings and improved living comfort. Landlords, on the other hand are driven by the prospect of enhancing housing quality and increasing property value. Their engagement is facilitated through structured decision making processes, regular consultations and ongoing communication with building representatives and managers. **Tenants**, although not always directly involved in financial decision making, are significantly impacted by renovation works. Construction can cause temporary inconvenience and disruption to their daily routines, particularly in MABs common in urban areas of Medjimurje County, such as the town of Čakovec. Therefore, their

engagement relies on timely information, transparency and clear communication regarding the planned works and expected benefits.

At the **coordination level**, building representatives and building managers play a key role in ensuring the coordinated execution of the renovation process. **Building representatives** communicate tenants' interests, facilitate decision making and may initiate renovation activities, while **building managers** oversee financial administration, coordinate contractors and supervise the implementation of works in continuous cooperation with tenants, technical staff, financial institutions and public authorities.

Technical staff such as architects and designers, constructors, engineers and material suppliers active within Medjimurje County and surrounding regions contribute professional expertise essential for defining the scope and quality of the renovation measures. Their engagement is based on close collaboration with building level stakeholders, technical consultations and the adaptation of solutions to local building characteristic and local climate.

At the **institutional level**, financial institutions, sectoral and energy agencies and public authorities provide the regulatory, financial and organizational framework in Medjimurje County. **Financial institutions** enable project implementation through loans, grants and public funding schemes, while **national, regional, and local authorities** support MAB renovation through policies, strategic frameworks and educational activities. **Sectoral and energy agencies**, such as *Medjimurje Energy Agency Ltd. (MENEA)*, often act as facilitators, assisting stakeholders during application procedures, coordinating activities and ensuring compliance with technical and regulatory requirements. In cases of energy poor households and vulnerable households, **social welfare institutions in Medjimurje County** *(Social Welfare Centre Čakovec, Community Services Centre Medjimurje, County Department for Health and Social Welfare*) also play and important supportive role. They help to identify vulnerable households that are most in need for renovation, facilitate communication with vulnerable tenants and encourage their participation in renovation activities, thereby contributing to social inclusion and equitable access to improved living conditions across the region.

Across all stakeholder levels in Medjimurje County, engagement is maintained through a combination of information sharing, consultation, collaboration and capacity building activities. This integrated approach supports mutual understanding, reduces barriers to participation and enables effective coordination throughout the MABs renovation process.

5.4. Main drivers of the MAB renovation process

The renovation of MABs is driven by a combination of economic, regulatory, environmental and social factors. Older MABs (primarily built from 1940 until 1960) have inefficient insulation, outdated heating systems and poor ventilation, resulting in high

energy and maintenance costs. Renovation reduces energy consumption, lowers utility and repair expenses and aligns MABs with modern standards, making long – term financial benefits as a key motivator for homeowners, landlords and tenants.

Financial support and regulatory frameworks play a decisive role in facilitating the renovation of MABs. National and EU funding programs such as grants and co – financing mechanisms under the *National Recovery and Resilience Plan (NRRP)*, as well as projects supported through the *Operational Program Competitiveness and Cohesion 2021 – 2027*, significantly reduce upfront investment barriers for homeowners and landlords. By reducing required co – financing and providing access to additional funding instruments, these programs improve the financial feasibility of renovations, especially in privately owned MABs, where decisions rely on the agreement and resources of multiple co – owners. At the local level, the effectiveness of the financial support mechanisms is further demonstrated by ongoing renovation projects (Ivana Mažuranića 9, Vladimira Nazora 8a, Matice hrvatske 1d, etc.) implemented by the building managers (Euroland Ltd., GP Stanorad Ltd.). These ongoing projects combine technical solutions with access to funding schemes, illustrating how regulatory frameworks and financial instruments translate into feasible renovation investments for tenants.

Another key driver of the renovation is the **availability of qualified experts and specialized certified companies** capable of carrying out energy efficient upgrades. Architects, engineers, constructors and material suppliers provide essential technical expertise to design and implement renovation measures that comply with modern energy standards, building codes and local climate conditions. The presence of local certified contractors and energy consultants makes the renovation more feasible and reliable, reducing delays, minimizing construction risks and ensuring high quality outcomes. In Medjimurje County, companies such as Euroland Ltd. and GP Stanorad Ltd. collaborate with regional technical experts to implement renovations efficiently, demonstrating that access to skilled professionals is a significant enabler for successful projects.

Environmental and climate considerations further motivate renovation, as improved buildings' performances reduce CO_2 emissions and allow integration of RES such as PV installations and solar thermal collectors. **Indoor comfort and health improvements**, including adequate indoor temperature, better air quality and lower risk of mold, enhance tenants' wellbeing, particularly for vulnerable groups, such as the elderly, families with children or people with chronic illnesses.

An important social driver of renovation in Medjimurje County is the **active participation and supportive attitude** of homeowners, landlords and tenants. When they understand the long – term economic, environmental and comfort related benefits of energy renovation and engage in decision making, the process becomes more efficient, transparent and collaborative. **Positive perspectives and attitudes** among co – owners

and tenants promote joint decision making on financing, scheduling and technical solutions, reducing delays, conflicts and misunderstandings.

Homeowners, landlords and tenants who witness successful renovations in neighboring MABs often act as advocates, sharing their experiences and encouraging others to undertake similar projects. In addition, **engaged building managers** play a crucial role in mediating discussions, coordinating stakeholders and ensuring that renovation works align with tenants' needs and regulatory requirements. This combination of **social support, community trust and active involvement** has been shown to significantly increase participation rates and the overall success of renovation projects.

5.5. Main difficulties of the MAB renovation process

Despite many economic, environmental and social benefits of the energy renovation, such as energy savings, lower costs, decreased emissions, improved living conditions and increased property value, the renovation process faces numerous obstacles and difficulties, which often hinder its implementation.

The **limited availability of financial instruments** represents the most significant barrier. Energy renovation requires substantial upfront investment, while financial returns are achieved only in the long term. Many homeowners and tenants in Medjimurje County are reluctant to take on debt. Limited availability of grants, low co – financing rates, and restricted national funding further slow renovation efforts. When public funding is available, application procedures are often complex and **administratively demanding**, requiring extensive documentation and compliance with strict deadlines.

Administrative complexity and short implementation deadlines are closely linked to the **limited availability of qualified experts and certified contractors** at the local level. High demand for experienced technical professionals, designers, energy auditors and construction companies frequently leads to delays or the engagement of less qualified service providers, increasing the implementation risk and reduced renovation quality.

Older MABs, which are prevalent in Medjimurje County, face significant **technical challenges**. They are particularly evident in poorly maintained buildings, especially those housing energy poor households. Such buildings frequently require comprehensive structural renovation in addition to energy upgrades, significantly increasing costs and technical complexity.

Ownership structures of MABs and **decision making processes** also pose challenges. MABs are typically characterized by fragmented ownership, requiring consensus among multiple co – owners to proceed with renovation. Divergent financial capacities, priorities and expectations among homeowners and landlords often complicate facilitating consensus. **Emotional and social factors**, such as fear of financial burden, distrust of authorities and contractors, uncertainty about the outcomes and concern over construction disturbances, strongly influence decision making. Energy

renovation is therefore frequently perceived as an expensive, administratively demanding investment and is often viewed as a responsibility of building managers and public authorities, rather than co – owners themselves.

Finally, **insufficient access to clear and reliable information** on renovation procedures, available financing mechanisms, and long – term benefits further complicate the renovation process. This often leads to uncertainty, misconceptions and lack of trust among homeowners and tenants, ultimately reducing their willingness to actively participate or support renovation initiatives.

5.6. MABs in need for renovation works

The project CEESEN-BENDER combines various theoretical, practical and analytical tasks, which require detailed input from the 5 Central and Eastern European countries and corresponding pilot areas. One of the selected pilot areas is Medjimurje County in Croatia, where a total of 32 MABs was selected to analyze their current states and estimate needs for renovation using the digital tool to prioritise buildings for renovation, whereby the first 3 ranked buildings are estimated to be in the greatest need for energy renovation.

The prioritization process consisted of 3 steps and began with, as mentioned, the preselection of 32 MABs (either unrenovated or partially renovated) located in the town of Čakovec. The second step included an overall analysis of the following buildings' characteristics:

- **Socioeconomic data** (number of dwellings with an X number of tenants, tenants' structure (number, distribution of age, owners and tenants (in percentage (%)), average living area (per dwelling and person (in m^2)), average gross salary per dwelling (in EUR), dwellings with tenants receiving social assistance (in percentage (%))
- **Constructive characteristics** (gross floor area (in m^2), conditioned area (in m^2), year of construction, year of renovation)
- **Consumption details** (electricity (in MWh), natural gas (in MWh)
- **Heating costs** (in EUR).

As certain data was not publicly available, the same was estimated and filled taking into account the size, year of construction and number of dwellings in the MABs.

The third step included the ranking of the selected MABs using the digital tool to prioritise buildings for renovation created within the project CEESEN-BENDER, where the ranking was performed through coding and programming in the program R. At the end of the process, results generated a ranking of the 32 selected MABs based on the, previously mentioned, provided data estimating, thereby, the ones in the greatest need for energy renovation.

According to the digital tool to prioritise buildings for renovation, the results and raking of the MABs were generated as follows in Table 4.

Table 4: MABs prioritized for energy renovation in Medjimurje County according to the D4.1 Digital tool to prioritise buildings for renovation

Rank	Address	Year of construction	Year of renovation
1	Vukovarska 11, Čakovec	1973	Unrenovated
2	Ivana Zajca 11, Čakovec	1977	Unrenovated
3	Vukovarska 13, Čakovec	1977	Unrenovated
4	Jakova Gotovca 1, Čakovec	1975	Unrenovated
5	Jakova Gotovca 1/b, Čakovec	1975	Unrenovated
6	Otokara Keršovanija 6, Čakovec	1967	Unrenovated
7	Kolodvorska 4, Čakovec	1984	Unrenovated
8	Vukovarska 5, Čakovec	1977	Unrenovated
9	Vukovarska 9, Čakovec	1977	Unrenovated
10	Vukovarska 7, Čakovec	1969	Unrenovated
11	Otokara Keršovanija 4, Čakovec	1968	Unrenovated
12	Miroslava Magdalenića 1/b, Čakovec	1975	Unrenovated
13	Preloška 68, Čakovec	1962	Unrenovated
14	Miroslava Magdalenića 1, Čakovec	1975	Unrenovated
15	Katarine Zrinski 4, Čakovec	before 1968	Unrenovated
16	Janka Slogara 4, Čakovec	1959	Unrenovated
17	Travnik 12, Čakovec	1985	Unrenovated
18	Valenta Morandinija 17, Čakovec	1963	Unrenovated
19	Istarska 14, Čakovec	1964	Unrenovated
20	Jakova Gotovca 1/a, Čakovec	1975	Unrenovated
21	Kolodvorska 1, Čakovec	1910	Unrenovated
22	Vladimira Nazora 26a, Čakovec	1957	Unrenovated
23	Tome Masaryka 13, Čakovec	1962	Unrenovated

24	Kralja Tomislava 3, Čakovec	1900	Unrenovated
25	J.J. Strossmayera 5, Čakovec	1890	Unrenovated
26	Josipa Jurja Strossmayera 7b, Čakovec	1962	Unrenovated
27	Istarska 16, Čakovec	1967	Unrenovated
28	Kralja Tomislava 29, Čakovec	1911	Unrenovated
29	Vladimira Nazora 32, Čakovec	1966	Partially renovated (in 2025)
30	Vladimira Nazora 8a, Čakovec	1952	Partially renovated (in 2025)
31	J.J. Strossmayera 1, Čakovec	1870	Unrenovated
32	Dr. Ivana Novaka 6, Čakovec	1928	Unrenovated

Source: Project CEESEN-BENDER, WP4: T4.1 Design and testing of a digital tool to prioritize buildings for renovation, 2026

As evident from the Table 4, the year of construction of the analyzed MABs varies from 1870 until 1985, whereby only 2 buildings have been partially renovated in 2025, with improved insulation of the envelope (walls, ceilings, external carpentry (partial or complete) and replaced indoor lighting as the main implemented measures. Furthermore, the heating systems of the 2 MABs remained gas based, measures for installation of PV plants have not been undertaken, automatic ventilation systems with heath recovery have not been installed and both buildings are still in the need of complete insulation of the walls, roofs, floors and ceilings, as well as replacement of all remaining external carpentry. Because of the energy renovation being carried out only partially and the need for additional work to be fully modernized, both MABs have been considered during the prioritization of buildings for renovation in Medjimurje County.

Although energy renovation, either deep or partial, is required for all 32 ranked MABs, within this document only the first 3 buildings were selected for further financial analysis. Therefore, the MABs in the greatest need for energy renovation with estimated financial resources need for implementation of works and calculated return on investment (ROI) are shown in the Table 5.

Table 5: Estimated financial resources and ROI for the first 3 prioritized MABs

Rank	Address	Gross Floor Area (GFA) (m^2)	Financial resources (EUR)	Return on investment (ROI)
1	Vukovarska 11, Čakovec	3.685,15	1.370.000,00	7,67% (13 years)

2	Ivana Zajca 11, Čakovec	4.002,00	1.450.000,00	5,08% (19 years)
3	Vukovarska 13, Čakovec	3.861,00	1.420.000,00	5,14% (19 years)

Source: Project CEESEN-BENDER, WP4: T4.1 Design and testing of a digital tool to prioritize buildings for renovation, T4.2 Desing and testing of a digital tool for the calculation of the return on investment (ROI), 2026

The estimated financial resources indicated in Table 5 were calculated using the buildings' gross floor area (GFA) in m^2 and the available energy renovation price per m^2 for a MAB of approximately the same size (measured by the gross floor area (GFA)), which is currently under renovation. Under the assumption that the renovation needs for all 3 ranked MABs are the same as in the case of the MAB in renovation, the calculated amounts present rough estimations of the potentially needed financial resources for each building. These amounts present the current market values of the required works and starting points for a future energy renovation of the first 3 ranked MABs.

As for the return on investment (ROI), the values were calculated using the D4.2 Digital tool for the calculation of the return of the investment, whereby the data which were entered considered 4 aspects of each building:

- **Building information and energy profile** (address, total building conditioned area, specific energy consumption before and after renovation, green electricity production using RES)
- **Costs savings related to energy savings and RES** (specific cost of energy/fuel used for heating and electricity, equipment operation and maintenance cost)
- **Renovation project costs** (total renovation project costs)
- **Contribution to the real estate market value increase** (specific market value before and after renovation, estimated renovation project lifespan).

After entering the required data for each of the 3 MABs, the estimated return on investment (ROI) was calculated as a percentage per year and a total number of years required to pay back the renovation costs. As in the case of the financial resources, the calculated return on investment (ROI) is an approximate value based on the currently available and, for some parts, estimated data on the market.

Furthermore, the projected return on investment (ROI) for these prioritized buildings is calculated based on long – term energy cost savings. It is important to note that these financial returns are intrinsically linked to significant reductions in CO_2 emissions, as improved energy efficiency directly lowers fossil fuel consumption. Therefore, the return on investment (ROI) should be understood not only as an economic metric, but also as an indicator of environmental and climate benefits, contributing to both household savings and national decarbonization targets.

Finally, the exact renovation costs of the 3 MABs depend highly on the geographical location, construction characteristics and technical conditions of the buildings, scope and type of works required, targeted energy performance level, market prices of project designs, materials, labor and supervision, as well as the current inflation rate. Therefore, the actual financial value of the energy renovation can only be determined once the process actually begins.

5.7. MAB renovation role in achieving national targets

MAB renovation plays a key role in supporting national energy efficiency and sustainability targets. By improving building envelopes, upgrading insulation and introducing modern, energy efficient systems, renovation helps to significantly reduce energy consumption and CO_2 emissions. These improvements contribute directly to national goals related to climate change mitigation, reduced energy dependency and improved living standards.

Furthermore, large scale renovation programs stimulate the construction sector, create jobs and encourage the use of innovative materials and technologies. Through strategic planning and implementation, energy renovation not only modernizes the existing building stock, but also ensures long – term economic and environmental benefits. As a result, it represents an essential tool in achieving national targets for energy performance, carbon neutrality and sustainable urban development.

The Croatian national strategic, legal and legislative framework includes various strategic, planning and guiding documents, which prescribe overall national climate targets aligned with the legislative framework on EU level. As already mentioned in chapter 4, energy renovation in Croatia is regulated through legal acts, strategies, climate plans and programs, which set the national climate targets until 2030 and 2050, including reduction of energy consumption and CO_2 emissions, as well as prescribe the increases in energy renovation of private and public buildings.

The most significant guiding documents with elaborated national climate and renovation targets are presented below.

Table 6: EU and national climate targets in Croatia

Integrated National Energy and Climate Plan of the Republic of Croatia for the period from 2021 to 2030 (NECP)	Low – Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050
Energy efficiency/consumption until 2030: Primary energy consumption: 336,9 PJ Final energy consumption: 246,2 PJ **CO_2 emissions until 2030:** • -40% (for EU) • -310,000 kt CO_2eq (for EU) • -16.7% (for Croatia)	**Energy efficiency/consumption until 2030:** Primary energy consumption: NU1: 344,4 PJ ; NU2: 328,7 PJ Final energy consumption: NU1: 286,9PJ ; NU2: 272,5 PJ **Energy efficiency/consumption until 2050:** Primary energy consumption:

• -5.527kt CO_2eq (for Croatia) **Energy renovation until 2030:** Total renovated buildings: 30.838.830 Residential buildings: 20.171.751 Annual renewal rate: 2% **Energy renovation until 2050:** Total renovated buildings: 32.099.102 Residential buildings: 21.117.537 Annual renewal rate: 4%	NU1: 287,4 PJ ; NU2: 251,0 PJ Final energy consumption: NU1: 225,6 PJ ; NU2: 189,6 PJ **CO_2 emissions until 2030:** • -18,5% to -21,7% (for EU) • - 7% (for Croatia) **CO_2 emissions until 2050:** • -50,6 do -64,0 (for EU) • not yet defined for Croatia **Energy renovation until 2030:** Annual renewal rate: 3% **Energy renovation until 2050:** Annual renewal rate: 4%

Source: Ministry of Environmental Protection and Green Transition of the Republic of Croatia, Integrated National Energy and Climate Plan of the Republic of Croatia for the period from 2021 to 2030 (NECP), 2026 (https://mzozt.gov.hr/azurirani-integrirani-nacionalni-energetski-i-klimatski-plan-republike-hrvatske-za-razdoblje-od-2021-2030-necp/9220), Ministry of Environmental Protection and Green Transition of the Republic of Croatia, Low – Carbon Development Strategy of the Republic of Croatia until 2030 with a view to 2050, 2026 (https://mzozt.gov.hr/o-ministarstvu-1065/djelokrug/uprava-za-klimatsku-tranziciju-1879/strategije-planovi-i-programi-1915/strategija-niskougljicnog-razvoja-hrvatske/1930)

Further 2 documents, which set the national climate targets for the energy renovation of MABs in Croatia are the Long – term Strategy for the Renovation of the National Building Stock until 2050 and the Program for the Energy Renovation of Multiapartment Buildings until 2030. The aims of both documents strongly rely on the targets set within the NECP and the Low – Carbon Development Strategy, with an addition of fostering deep renovation as a primarily goal for all private and public buildings in Croatia.

It is evident that the main goal is to increase the renovation rate of MABs from 2% to 3% until 2030 and 4% until 2050, whereby this goal is harder to achieve in certain parts of Croatia where energy efficiency is still not a priority. As for Medjimurje County, energy renovation increases every year, with more MABs being applied and renovated through national funds and subsidies. The current aim is to increase the energy efficiency of the MABs through insulation of the buildings' envelopes (walls, roofs, floors, ceilings) and replacement of external carpentry (doors and windows), as well as small technical improvements such as replacement of the indoor lighting. To achieve the nationally set climate targets, the energy renovation in Medjimurje County would have to raise to a higher level, with the replacement of the current technical, fossil fuel based systems with RES based ones (PV plants, heat pump, biomass boilers, etc.) being the first and most recommended step. But, to achieve the maximum efficiency of such systems in the future, first the buildings are in need of a strong, resistant and impermeable outer shell.

Consequently, investing in the energy renovation of MABs generates a dual return on investment (ROI): direct financial savings for the tenants through reduced energy bills and a strategic environmental return for the region and country through achieved CO_2

reductions, aligning with the binding targets of the NECP and the Low – Carbon Development Strategy.

5.8. Financial solutions

Funding of energy renovation in Croatia in general is very concise, whereby the main sources are strictly transnational, meaning provided by diverse EU funds and through either transnational programs and calls or national programs and plans based on transnational mechanisms such as the Mechanism for Recovery and Resilience. In line with the national situation, funding sources available in Medjimurje County for energy renovation of buildings are, also, based on transnational programs and, in some, cases, regional financial support for a specific kind of projects.

Table 7 presents the most used financing instruments for renovation of buildings, specifically MABs, in Medjimurje County with their main characteristics and conditions.

Table 7: Financing instruments for energy renovation of MABs available in Medjimurje County

Financing instrument	Call	Energy renovation measures	Co – financing rate
National Recovery and Resilience Plan 2021 – 2026 (Mechanism for Recovery and Resilience)	Energy renovation of multiapartment buildings	• Project documentation (energy audits, reports and certificates, main and other project documentation) • Energy renovation measures (building's envelope, technical systems, res systems, automation and management systems, green infrastructure elements, safety measures, mobility and accessibility for people with disabilities) • Supervision and safety coordination • Project administration and management • Promotion	• 85% – 100% for the creation of the project documentation • 60% – 80% for the energy renovation (measures, supervision and safety coordination) • 85% – 100% for project administration and management • 85% for promotion and visibility of the project
Operational Program Competitiveness and Cohesion 2014 – 2020 (European Regional Development Fund (ERDF) and Cohesion Fund (CF))	Energy renovation of multiapartment buildings	• Project documentation (energy audits, reports and certificates, main and other project documentation) • Energy renovation measures (building's envelope, technical systems, res systems,	The call has been postponed several times and no further information is available

		automation and management systems and accessibility for people with disabilities) • Supervision and safety coordination • Project administration and management • Promotion	
Bank/Green loans and subsidies	No specific call, funds are accessible to everyone who meets the eligibility criteria	• Adaptation, maintenance, installation, extension and reconstruction of the common parts of the building • Project documentation (energy audits, reports and certificates, main and other project documentation, legal documentation) • Co – financing of the energy renovation works and improvements financed from EU funds • Procurement of equipment and devices • (Post) Earthquake renovation measures	No co – financing rates, funds are allocated according to the conditions set by the respective bank
Transnational and Programs – Interreg (European Regional Development Fund (ERDF))	Periodic calls within the Interreg Central Europe and Danube Region Programs	• Increase of energy efficiency and use of RES in combination with storage and charging systems for e – mobility • Improving energy performance of buildings • Fostering behavioral changes • Reducing energy consumption • Testing innovative technologies and solutions for RES and energy efficiency • Energy planning at regional and local levels	• 80% of the total eligible costs

		• Financing schemes and capacity building • Energy poverty	
Programs of the European Union (European Commission)	LIFE, HORIZON	• Development of business models for large scale deep renovation projects • Innovative technologies and tools for constructions and renovations • Installation of heat pumps and solar energy systems • Development of One – Stop – Shops (OSS) • Capacity building • Renovation of MABs with energy poor tenants • Construction approaches and solutions for zero emission buildings • Improvement of indoor environment and air quality	• 95% of the total eligible costs (LIFE) • 100% of the total eligible costs (HORIZON)

Source: Project CEESEN-BENDER, WP2: T2.1 Analysing the overall context of the selected buildings in pilot sites, 2025, Ministry of Physical Planning, Construction and State Assets of the Republic of Croatia, Call "Energy efficiency of multiapartment buildings", 2024 (https://mpgi.gov.hr/energetska-obnova-visestambenih-zgrada-14464/14464), Zgradonačelnik.hr, Loans from all banks for multiapartment buildings, 2026 (https://www.zgradonacelnik.hr/kreditiranje/krediti-svih-banaka-za-visestambene-zgrade/2044)

Apart from the mentioned funding sources with transnational and national reach, on regional level there are, currently, no available financing instruments for the energy renovation of MABs. Starting from 2023, Medjimurje County launches a call for co – financing of RES in family houses, but for MABs this type of subsidy still does not exist. When observing more locally, the town of Čakovec follows the same pattern as Medjimurje County and does not grant financial support for energy renovation of MABs.

An exception of the mentioned are social MABs owned by the town itself intended for individuals and families with low incomes or in difficult social situations. In these cases, the town finances maintenance and minor repairs on the roofs and technical systems, while major reconstruction works and energy renovation need to be financed from the financing instruments mentioned above. These buildings also fall under the category of energy poor MABs, for which no exclusive national, regional or local funding sources are allocated for energy renovation. In the cases of generally energy poor MABs or energy poor households within the non – social MABs, the renovation is financed through one of the nationally available instruments, with the National Recovery and Resilience Plan 2021 – 2026 being the most extensive and used one.

6. Best practice cases

Energy renovation of the MAB at Uska 1, Čakovec

The first building that is a noteworthy example of a successful energy renovation in Medjimurje County is the energy upgrade of the MAB at **Uska 1**, **Čakovec.** The building was constructed in 1969, underwent a comprehensive energy renovation completed in 2019, supported by **the European Regional Development Fund (ERDF)** under the **Operational Program Competitiveness and Cohesion 2014 – 2020** within the call *Energy renovation of multiapartment buildings.* This project demonstrates how strategic public financing, coordinated planning and stakeholder engagement can enable effective energy upgrades in privately owned MABs.

The building has a **gross floor area (GFA) of 4.134,49 m²**, comprising a **ground floor and 4 additional floors**, with **56 apartments and 5 entrances** and an **average apartment size of 47 m².** The renovation project was carried out between **April 2016 and December 2018** and was led by the **building's co – owners**, with the building representative as the lead of the process.

The renovation cost was **763.925,82 EUR** with **co – financing of 52% through public funding**, while the remaining costs were covered by **a bank loan** taken by the building owners. A key factor in the project's success was the role of the **building manager**, GP Stanorad Ltd., who acted as the project manager. The building manager submitted the building to the public tender for co – financing, coordinated the whole renovation process and contracted the works. Additional stakeholders included **architects and designers,** which were responsible for creating the project documentation and proposing technical solutions. Throughout the whole renovation process, there were **continuous communication and regular meetings** with the building representative, ensuring that the co – owners were informed, consulted and actively involved in decision making at every stage of the renovation.

Renovation measures focused primarily on improving the building's envelope and technical systems. These included **thermal insulation of exterior walls, insulation of floors and ceilings, replacement od exterior windows and doors and replacement of indoor lightning.** Together, these measures significantly improved both the building's energy performance and the living conditions for tenants.

As a result of the renovation, the MAB at Uska 1, Čakovec, achieved an **energy class B** based on **specific annual heating demand** ($QH_{,nd}$ = 46 kWh/m²), improving from class F prior to renovation. The **specific annual primary energy consumption** reached **energy class C** (E_{prim} = 131 kWh/m²). These results reflect substantial energy savings, reduced heating costs and improved long – term financial benefits for homeowners, landlords and tenants.

Unfortunately, there is **no systematic data available on the number or share of vulnerable tenants, including energy poor households**. Such households are difficult to identify due to the absence of clearly defined national criteria for assessing energy poverty. As a result, there is currently no structured monitoring mechanism for identifying energy poverty at the building level.

Overall, the energy renovation of the MAB at Uska 1, Čakovec represents a strong example of good practices for the energy renovation of MABs in the Croatian pilot area, Medjimurje County. The project represents how public co – financing, effective building management and the active involvement of relevant stakeholders (co – owners, technical staff, building managers, etc.) can be successfully combined to deliver energy upgrades and long – term benefits for the tenants. Beyond the building itself, the project has significant importance for the town of Čakovec, but also Medjimurje County as a whole, serving as a **replicable model for improving energy efficiency, promoting sustainable building practices and encouraging further investments in energy renovation** across the local residential building stock.

Figure 3: Multiapartment building at Uska 1, Čakovec (before and after renovation)

Source: GP Stanorad Ltd.

Energy renovation of the MAB at Vladimira Nazora 24a, Čakovec

Another example of a successful energy renovation in Medjimurje County is the energy upgrade of the 100% privately owned MAB at **Vladimira Nazora 24a**, **Čakovec.** This MAB, built in 1961, completed an energy renovation in 2023, with support from the **Recovery and Resilience Facility (RRF)** as part of the **National Recovery and Resilience Plan 2021 – 2026** under the call *Energy renovation of multiapartment buildings.* The project highlights the importance of coordinated planning, stakeholder involvement and public co – financing in implementing energy renovation works. As a result, the MAB achieved higher energy efficiency, lower CO_2 emissions and improved living conditions, providing a strong example for future renovation projects in Medjimurje County.

The building has a **gross floor area (GFA) of 594,68 m²**, including a basement, ground floor, first floor and loft, and comprises **6 apartments**. The average apartment size is approximately **47,20 m².** The energy renovation, completed in 2023, amounted **146.451,47 EUR** with **co – financing of 46% through public funding**, while the remaining costs were covered by **a bank loan** taken by the building owners. The **renovation measures** included **thermal insulation of walls, floors, ceilings and the loft, replacement of windows and doors and upgrades to heating systems and indoor lightning**, enhancing energy performance and comfort for tenants. As a result of the renovation, the MAB achieved an **energy class C** based on **specific annual heating demand.**

The success of the renovation was strongly supported by the **active involvement of professional technical staff**, including architects, designers and engineers, who played a central role in coordinating the technical aspects of the project. Their expertise ensured that all renovation measures were designed and implemented in full compliance with energy efficiency standards and optimized for long – term performance. Meanwhile, the **building manager**, GP Stanorad Ltd., provided comprehensive oversight of the entire process, coordinating the contractors, managing timelines and ensuring that all the works progressed efficiently and according to the plan.

Equally significant was the **collaborative approach and positive engagement of the homeowners and landlords**, who demonstrated a strong commitment to the project by financing the majority of the investment themselves (54%). Their proactive participation, combined with **continuous and structured communication** with the building representative through regular meetings, ensured co – owner consensus, cohesive decision making and a shared focus on achieving high quality results. This combination of technical professionalism, effective project management and active co – owners' engagement was crucial in delivering successful energy renovation, which met both performance targets and tenants' expectations.

Similar to the MAB at Uska 1, Čakovec, **no comprehensive data exists on the vulnerable or energy poor households** in this building. Identification of such households is only possible indirectly, for example through eligibility for social welfare benefits, which provides an incomplete representation of energy poverty at the building level.

The renovation of the MAB at Vladimira Nazora 24a, Čakovec demonstrates a best practice approach for MABs in Medjimurje County, showcasing how specialized technical expertise, professional project management, active stakeholder motivation and public co – financing can be combined to deliver high quality energy upgrades in fully privately owned MABs. Alongside improvements of the energy performance, CO_2 emission and quality of living, the building serves as a replicable model for similar residential MABs in Medjimurje County, demonstrating how **carefully planned and coordinated energy renovation can deliver both technical improvements and social value**.

Figure 4: Multiapartment building at Vladimira Nazora 24a, Čakovec (before and after renovation)

Source: GP Stanorad Ltd.

7. Renovation priority areas and actions in the pilot area

The energy renovation of MABs in Medjimurje County is still in its first step, where the energy efficiency is being increased, mainly, through improvements on the buildings' envelopes, while technical systems do not present a priority at this point. Additional barriers are visible in the unwillingness of the tenants to start the renovation due to lack of information, quality technical and professional staff and high administrative and financial burdens the process brings. Therefore, to increase the overall interest and promote the positive effects of the energy renovation, 4 priority areas with corresponding actions have been identified, whereby special focus has been set on mitigating energy poverty.

Related to the mentioned, the 4 priority areas for ensuring an effective and long – term energy renovation of MABs are:

Priority area 1: Increasing energy efficiency in MABs

Action 1.1: Engagement of qualified technical staff in the preparation of the technical documentation needed for the energy renovation

Qualified technical staff ensures that renovation plans are accurate, comply with regulations and are designed to maximize energy efficiency. Their expertise reduces technical risks and ensures smooth project implementation.

Action 1.2: Use of high quality and certified materials during the implementation of renovation works on the buildings' envelopes

High quality and certified materials improve thermal performance, durability and safety of the buildings' envelopes. They also ensure long – term energy savings and reduce maintenance needs.

Action 1.3: Engagement of highly recommended contractors and professional supervision during the implementation of renovation works

Experienced contractors, supported by professional supervision, ensure that renovation works are executed efficiently and to a high standard. This results in better quality outcomes and reliable project delivery.

Action 1.4: Fostering deep instead of partial renovation of MABs

Deep renovation addresses the building as a whole, achieving greater energy savings, improved comfort and long – term sustainability. Partial measures alone often fail to deliver significant energy or cost reductions.

Action 1.5: Education of the tenants after the energy renovation, with focus on the installed improvements

Educating tenants on the correct use of new systems helps maximize energy savings and prevents misuse or unnecessary wear. Knowledgeable tenants can contribute significantly to the building's overall energy efficiency.

Action 1.6: Use of energy efficient household appliances to decrease energy consumption

Energy efficient appliances reduce electricity consumption, lower energy bills and support environmental sustainability. Their use complements the energy savings achieved through building renovations.

Priority area 2: Fostering the use of RES based technical systems

Action 2.1: Awareness raising about the benefits of RES based technical systems in daily life

Raising awareness helps tenants understand how RES based systems can reduce energy costs, lower CO_2 emissions and contribute to environmental sustainability. Increased knowledge encourages the adoption of RES based systems in everyday life.

Action 2.2: Integration of smart energy management systems to optimize the use of RES and improve overall system efficiency

Smart systems enable real – time monitoring and control of energy flows, maximizing the use of renewable energy while reducing waste. This integration improves energy efficiency and lowers operating costs for buildings.

Action 2.3: Capacity building activities and training programs for technical staff to ensure proper design, installation and maintenance of RES based systems

Providing targeted training ensures that technical staff has the skills needed to correctly implement and maintain renewable energy solutions. This reduces errors, improves system performance and extends the lifespan of the installed technologies.

Action 2.4: Establishment of One – Stop – Shops (OSS) for timely and comprehensive information sharing

OSS serve as centralized hubs where building managers, contractors and tenants can access guidance on RES options, newly developed technologies and technical support. This approach streamlines decision making and promotes wider adoption of renewable energy solutions.

Priority area 3: Mitigating the effects of energy poverty in the regional building stock

Action 3.1: Establishment of a regional register of energy poor households

Creating a regional register helps authorities identify households most in need of support and track the effectiveness of energy assistance programs. It provides a reliable basis for targeted interventions and resource allocation.

Action 3.2: Empowering management authorities to support and communicate with energy poor households

Strengthening the capacity of authorities ensures that they can provide timely guidance, financial support and advice on energy efficiency measures to the most vulnerable households. Effective communication fosters trust and encourages energy poor households to participate in energy saving programs.

Action 3.3: Awareness raising for energy poor households on energy management and savings

Educational campaigns and practical guidance help energy poor households adopt energy efficient behavior, reduce energy bills and improve the living comfort. Knowledge sharing empowers households to make informed decisions about energy use and fosters increased energy savings.

Action 3.4: Periodic visits to energy poor households and distribution of energy packages

Regular household visits allow authorities to monitor energy usage, provide personalized advice and distribute energy saving packages and products. These actions directly support energy poor households in managing energy consumption and costs, as well as ensure a long – term support to their energy needs.

Action 3.5: Leverage project survey data on wellbeing for advocacy and tailored communication

Systematically use the validated findings from the CEESEN-BENDER cross – country survey to develop targeted communication materials for different stakeholder groups. Evidence on improved health, comfort, and satisfaction is a powerful motivator that complements financial arguments. Sharing these results can build trust, reduce apprehension, and demonstrate the holistic value of renovation, especially among vulnerable groups.

Priority area 4: Increase the accessibility of financial instruments for energy renovation for different types of buildings and households

Action 4.1: Establishment of One – Stop – Shops (OSS) providing information on available financial opportunities for MAB renovation

OSS serve as centralized hubs where the tenants can access guidance on funding options, grants and loans for energy renovations. This simplifies the process and encourages wider participation in energy efficiency programs.

Action 4.2: Encouraging regional and local financial support schemes for energy renovation

Targeted financial support from regional and local authorities helps reduce upfront costs for energy renovations and eases the financial burden for the tenants. This increases affordability and accelerates the adoption of energy efficient measures.

Action 4.3: Introduction of tailored financial instruments for energy poor buildings and energy poor households

Customized financial instruments, such as low interest loans or grants, ensure that energy poor households can afford necessary energy renovations. Tailored support addresses both technical needs and financial constraints.

Action 4.4: Introduction of protection mechanisms for energy poor households

Safeguards such as capped contributions, extended repayment periods or social clauses prevent rent increases or financial strain after renovation. These measures ensure that energy improvements do not inadvertently burden energy poor households.

8. Conclusion

Achieving high levels of energy efficiency, expanding the use of RES and addressing energy poverty are among the most critical climate objectives for every country. To accomplish these goals, comprehensive energy renovation of buildings is essential, as the building sector remains one of the largest contributors to pollution. Effective energy renovation depends on the availability of skilled technical personnel, high quality materials, significant financial resources and timely coordination and cooperation among all stakeholders.

Energy renovation processes are typically coordinated by building managers, who maintain internal records on construction dates, energy consumption and renovation needs of the MABs. These records allow the building managers to prioritize buildings with the greatest need for energy renovation. Related to the mentioned, this roadmap serves as a general guidance document for management authorities and building representatives, offering recommendations on how to effectively plan and implement renovation processes, taking into account the energy consumption, stakeholders, funding opportunities and technical requirements of the MABs.

To provide the most suitable renovation solutions, this roadmap integrates multiple tasks and results from the project CEESEN-BENDER. Using on site data from Medjimurje County, the document summarizes technical analyses (including construction characteristics and energy consumption), stakeholder responsibilities (primarily management authorities, building representatives and technical staff) and available funding sources for energy renovation. This provides a comprehensive overview of regional renovation needs, whereby it is important to note that all analyses were conducted on 32 selected MABs, out of which 2 have been partially renovated. As such, the document offers a partial guidance framework, with the selected MABs serving as examples for renovation practices.

Following the assessment of the current situation in Medjimurje County and using a digital tool for building prioritization, all 32 MABs were ranked based on the available data, whereby the first 3 buildings were chosen for further financial and investment assessments. Based on these selections, 4 priority areas were identified as key to achieving EU and national climate targets, while also fostering a more sustainable and inclusive region. These priority areas circle around enhancing energy efficiency, promoting the use of RES based systems, addressing energy poverty and increasing access to diverse funding sources for various target groups.

Furthermore, this document lays the basis for developing tailored, building level roadmaps, which will guide specific measures for 6 preselected MABs, enabling a more focused and effective approach to energy renovation in the region. However, due to limited data and the small sample size, this document should be considered as a

general recommendation. More detailed assessments and extensive data processing are required to determine specific needs and measures for each individual building.

Additionally, the document is grounded not only in technical and financial analyses, but also in unique empirical evidence on the social impacts of renovation gathered through the project's comparative survey. This human – centric data reinforces the imperative to design renovation policies and programs that explicitly target improvements in health, comfort and social cohesion, ensuring that the energy transition is both effective and equitable.

Beyond serving as a technical guide, this roadmap is designed also as a strategic advocacy tool. By providing a data driven analysis of the needs and priorities, it aims to inform and influence regional and local planning, thereby supporting a more effective and targeted allocation of public and EU renovation funding to the buildings and households that need it most.

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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 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 multiapartment 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 analyze 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 multiapartment 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.

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