# CEESEN-BENDER

# Building intErventions in vulNerable Districts against Energy poveRty

## Deliverable 5.3

## Report on building – level renovation roadmaps in 5 pilot regions

## Renovation roadmaps and investment strategies for buildings in the pilot region Alba Iulia (Romania)

# - Summary -

Dissemination Level: Public

WP5 Creating roadmaps and support services for building energy renovations for vulnerable districts

Alba Iulia, July 2026

Co-funded by the European Union

CENTRAL & EASTERN EUROPEAN SUSTAINABLE ENERGY NETWORK
CEESEN-BENDER

# Building – level renovation roadmaps and investment strategies for pilot multiapartment buildings in Alba Iulia (Romania)

The residential building stock in Alba Iulia municipality, as across the rest of Romania, is heavily dominated by multi-apartment buildings (MABs) constructed during the communist era, primarily between 1960 and 1980, using precast reinforced concrete panels or structural brick masonry. These buildings exhibit severe systemic technical deficiencies, including an acute absence of thermal insulation on external walls, uninsulated basements and roofs, single-glazed wooden windows with deteriorated frames, and obsolete space heating and hot water distribution systems. Consequently, the majority of targeted MABs fall into energy performance classes C or D, presenting massive heat losses and specific annual space heating consumption levels ranging between 171.74 and 292.17 kWh/m² per year. Executing deep energy renovations on these structures holds massive potential, as comprehensive interventions can decrease space heating energy demand by 40% to 60% per building, contributing directly to climate neutrality targets and enhanced living standards.

Field evaluations and home visits conducted under the CEESEN-BENDER project in pilot areas across Alba Iulia, including Cloșca, Alexandru Ioan Cuza, Livezii, Transilvaniei, and Gheorghe Șincai streets, revealed severe indoor living condition challenges in unrenovated apartments. Ground-floor residents endure major heat losses through uninsulated basement ceilings, leaving indoor ambient temperatures in bathrooms well below comfort thresholds during winter. Conversely, uninsulated upper-floor and south-facing apartments suffer from severe summer overheating, reaching temperatures around 30°C and drastically reducing living quality without air conditioning. The lack of facade insulation, combined with balcony thermal bridges and poor ventilation, frequently causes condensation and mold growth on external walls during winter. Furthermore, 12-month continuous indoor air quality monitoring using ALEA HomeMonitor devices demonstrated that carbon dioxide ($CO_2$) concentrations rise alarmingly at night in unventilated bedrooms, reaching peaks between 2,000 ppm and 5,000 ppm when windows remain closed. This proves that simple facade insulation and window replacements are insufficient, making the integration of mechanical ventilation systems with heat recovery (MVHR) indispensable for maintaining healthy indoor air quality and preventing mold.

Energy poverty represents a major structural challenge in Alba Iulia, where data collected at the level of homeowners' associations indicates that between 30% and 60% of residents in target buildings are vulnerable or at high risk of energy poverty. This population is predominantly composed of low-income households, elderly retirees, single-person households, and citizens with chronic illnesses or disabilities. Average net monthly household incomes for vulnerable families range between 300 and 500 EUR, while utility costs consume between 20% and 40% of this income. Under this unbearable financial pressure, many residents resort to intentional self-disconnection by turning off

heating during winter, a survival mechanism that damages building structures through mold growth and severely deteriorates public health. Sociological surveys from the project demonstrate that while renovation drastically reduces structural defects and improves perceived thermal comfort, it does not automatically resolve financial payment difficulties, as utility bill arrears occasionally persist post-renovation due to broader macroeconomic factors, energy prices, and user behaviors. Furthermore, resident concerns post-renovation shift from the building envelope toward common area infrastructure, such as elevators, drainage, and stairwell maintenance.

The deep energy renovation of communist-era MABs involves a complex network of stakeholders across national, regional, and local levels whose coordination determines project success. At the national level, the Ministry of Development, Public Works and Administration (MDLPA) establishes construction and energy efficiency policies and supervises national building renovation programs. Concurrently, the Ministry of Investments and European Projects (MIPE) serves as the managing authority for the National Recovery and Resilience Plan (PNRR), administering essential grant funding for MAB renovations. At the regional level, the Agency for Regional Development Center (ADR Centru) manages structural funds allocated through the European Regional Development Fund (ERDF), specifically the Regional Program Center (PRC) 2021-2027 Action 3.1, allocating non-reimbursable funds and monitoring territorial implementation. At the local operational level, the Municipality of Alba Iulia acts as project applicant and coordinator, managing public procurement, building permits, and site supervision, while the Alba Local Energy Agency (ALEA) provides technical advisory services, baseline energy data, air quality monitoring, and home visits. Finally, homeowners associations (HOAs) and individual apartment owners represent the demand side; because 100% of apartments in Romanian MABs are privately owned, securing a legal majority or two-thirds consensus among residents is mandatory to initiate renovation works.

Classification table of stakeholders involved in the renovation of multiapartment buildings in Alba Iuila (Romania):

| STK Name/ Group | Main role(s) in MAB renovation | Main barrier(s) in MAB renovation in pilot area | Recommended action(s) for barrier(s) overcoming |
|---|---|---|---|
| Alba Iulia Municipality | Applicant / facilitator | Insufficient public funds for MAB energy renovation, limited knowledge / capacity on MABs energy renovation, high bureaucracy of MABs renovation projects / | Increase the use of private funds / set-up a municipal company dedicated to MABs energy renovation / improve staff capacity / support reduced bureaucracy of local MABs energy renovation projects / tender books optimised for |

| | | | |
|---|---|---|---|
| | | long public procurement process | efficient delivery of MAB energy renovation works |
| Regional Developme nt Agency | Financier and funds / grants provider | Insufficient ERDF funds for MAB energy renovation | Launching new regional financing instruments based on private sources or a mix (ERDF + private) for MABs energy renovation |
| Homeowner associations in MABs | Facilitator / beneficiary | Low cohesion of members (apartment owners) / low self-financing capacity of energy renovation works / equipment on MABs | Changes in national regulations / legislation, establishment of dedicated financing support mechanisms for MABs energy renovation |
| The Ministry of Developme nt | Facilitator/gr ants provider | Insufficient funds available for MABs renovation | Increase the level of funding dedicated to MABs energy renovation, identify / implement hybrid financing schemes (including ESCO, PPP, etc.) |
| Ministry of EU Funds | Facilitator | Insufficient EU grants dedicated to MABs renovation | Identify ways to use available grants more efficiently (including combining EU grants with private financing) to support more MABs energy renovations |
| Alba Local Energy Agency | Facilitator | Lack of data on MABs constructive status and living conditions at local/regional level, difficult access to EU projects supporting MABs renovation | Implementing more projects dedicated to research/capacity building on MABs energy renovation, supporting municipalities in MABs data collection process, publish new methodologies technologies, best practices on MABs renovation |
| Apartment owners / residents | Final beneficiaries | Lack of knowledge and active involvement on: MABs energy renovation projects | MABs facilitators to increase the local meetings / home visits / workshops frequency and participation of apartment |

| | | | |
|---|---|---|---|
| | | elaboration / implementation / financing options / available technologies | owners on the topic of MABs energy renovation |

Energy renovation of MABs in Romania relies almost entirely on public grant funding, as commercial financial instruments like low-interest green loans or ESCO energy service contracts remain virtually non-existent for residential MABs. The primary national funding mechanism is PNRR Component 5 ("Renovation Wave"), which manages a 23.8 billion EUR budget and provides grants between 100,000 EUR and 5 million EUR per project, covering up to 100% of eligible costs. Regionally, the Regional Program Center (PRC) 2021-2027 managed by ADR Centru allocates 1.38 billion EUR, with Action 3.1 specifically targeting residential energy efficiency. At the local level, a crucial best practice established by the Municipality of Alba Iulia is the full absorption of the mandatory 2% local co-financing rate required under regional schemes, along with all non-eligible technical expenses. By lifting this direct financial burden from homeowners associations and low-income residents, the municipality eliminates the primary economic barrier to deep renovation. In 2025, the local administration submitted funding applications for several unrenovated MABs in pilot areas, absorbing total renovation costs that often exceed 1 million EUR per building.

Formulating the local investment plan requires transitioning from ad-hoc building selection to a transparent, data-driven methodology. Under the CEESEN-BENDER project, a digital building prioritization tool was created in R Studio, ranking 30 candidate MABs in Alba Iulia based on a multi-criteria matrix integrating construction age, vacant housing rates, unemployment, social assistance reliance, proportion of minors, average income, and space heating costs. Furthermore, technical intervention packages have been standardized with estimated unit costs per square meter of usable apartment area, including building envelope insulation and roof refurbishment (~210 EUR/m²), staircase-integrated mechanical ventilation with heat recovery and air quality sensors (~100 EUR/m²), photovoltaic solar systems (~40 EUR/m²), facade shading systems (~100 EUR/m²), exterior elevators and emergency evacuation stairs (~60 EUR/m²), urban heat island mitigation measures (~100 EUR/m²), window and balcony awnings (~10 EUR/m²), and attached structural balcony extensions (~100 EUR/m²). Financial simulations using the project's simplified ROI Calculator reveal that deep renovation yields a long-term amortization period of around 23 to 33 years across pilot buildings, underscoring the absolute necessity of public grant support.

**Energy performance synthesis**

The energy performance indicators for the Romanian pilots in Alba Iulia target six unrenovated communist-era multi-apartment buildings (MABs) constructed primarily between 1960 and 1980. Characterised by precast reinforced concrete panels, structural brick masonry, and obsolete space heating systems, these legacy blocks exhibit severe systemic energy deficiencies, falling into baseline Energy Performance

Certificate (EPC) classes C or D with space heating demands ranging between 171.74 and 292.17 kWh/m² per year. Collectively, the six targeted buildings represent an annual baseline final energy consumption of 6.541 GWh/year. The proposed deep renovation roadmaps aim to achieve a substantial average heating demand reduction of 40.44% across the portfolio. This comprehensive thermal upgrade is projected to deliver 2.697 GWh/year in final energy savings and 3.506 GWh/year in primary energy savings, translating into an average EPC improvement of 1.3 class steps and direct greenhouse gas mitigations of 555 $tCO_2$/year. Furthermore, the roadmaps map out a substantial solar renewable energy potential of 0.900 GWh/year to be generated via standardized rooftop and balcony solar photovoltaic installations to support local energy self-consumption

| **For all MABs included in your roadmap** | **Unit** | **Romania** |
|---|---|---|
| *Number of MABs included in the roadmap (to be renovated)* | - | 6 |
| Baseline final energy consumption before renovation | *GWh/yr* | 6,541 |
| Final energy savings after renovation | *GWh/yr* | 2,697 |
| Primary energy savings after renovation | *GWh/yr* | 3,506 |
| Estimated $CO_2$ reduction after renovation | *$tCO_2$/yr* | 555 |
| Energy Performance Certificate class improvement (average) | *class diff.* | 1.3 |
| Renewable energy potential | *GWh/yr* | 0.900 |
| Expected reduction of heating demand (average) | *%* | 40,440 |

The roadmap details comprehensive technical, energetic, indoor air quality, and financial evaluations for six representative pilot MABs in Alba Iulia. Pilot Building BL. G5-G6, located at Str. Alexandru Ioan Cuza Nr. 16, was built in 1975 and comprises 40 apartments with a total heated area of 2,272 m². Moving from energy class C (253.08 kWh/m²/yr) to model class B (152.72 kWh/m²/yr) achieves estimated annual gas energy savings of 228 MWh (€13,283/yr) and $CO_2$ emission reductions of 49 tonnes/yr, alongside an estimated rooftop and balcony PV output of 89 MWh/yr (€8,641/yr). With a total primary renovation CapEx of €795,200 (€19,880/apartment) and an overall ROI of 31 years, the renovation increases property market value by +€300/m² (€17,040 net equity gain per apartment). Pilot Building BL. 2 CDEF, located at Str. Cloșca Nr. 10, was built in 1983 and contains 38 large apartments with a heated area of 3,875 m². Transitioning from class D (309.23 kWh/m²/yr) to class B (200.93 kWh/m²/yr) yields energy savings of

420 MWh/yr (€24,446/yr) and $CO_2$ reductions of 86 tonnes/yr, complemented by a PV potential of 156 MWh/yr (€15,146/yr). Total primary renovation CapEx is €1,356,250 (€35,691/apartment) with an overall ROI of 29 years, boosting apartment market value by +€300/m² (€30,592 net gain per unit).

Pilot Building BL. 26-27, situated on Bulevardul Transilvaniei, was constructed in 1971 and houses 59 apartments across a heated area of 4,080 m², with approximately 30% of residents facing energy poverty. Upgrading from energy class C (287.99 kWh/m²/yr) to class B (147.41 kWh/m²/yr) delivers annual energy savings of 574 MWh (€33,412/yr) and $CO_2$ reductions of 118 tonnes/yr, alongside a total PV generation potential of 170 MWh/yr (€16,505/yr). Total primary renovation CapEx stands at €1,428,000 (€24,203/apartment) with an overall ROI of 25 years, enhancing unit market values by +€300/m² (€20,746 net gain per unit). Pilot Building BL. 71-72-73, located at Bulevardul Gheorghe Șincai Nr. 27-31, is a 1986 Soviet T770 diaphragm structure containing 53 apartments and a heated area of 3,931 m², where 40% of residents are energy vulnerable. Improving performance from class C (221.79 kWh/m²/yr) to class B (148 kWh/m²/yr) results in energy savings of 290 MWh/yr (€16,897/yr) and $CO_2$ reductions of 59 tonnes/yr, paired with a PV potential of 182 MWh/yr (€17,670/yr). Total primary renovation CapEx is €1,375,850 (€25,959/apartment) with an overall ROI of 33 years, resulting in a market value uplift of +€300/m² (€22,251 net gain per unit).

Pilot Building BL. B1-B5, located at Str. Orizontului Nr. 8-16, was built in 1983 and represents a large 5-entry MAB containing 93 apartments across 5,073 m² of heated area. Upgrading from energy class D (371.32 kWh/m²/yr) to model class C (205.97 kWh/m²/yr) generates substantial energy savings of 839 MWh/yr (€48,863/yr) and $CO_2$ reductions of 172 tonnes/yr, complemented by a PV generation potential of 205 MWh/yr (€19,903/yr). Total primary renovation CapEx is €1,775,550 (€19,092/apartment) with an overall ROI of 23 years, driving a market value appreciation of +€300/m² (€16,365 net gain per unit). Pilot Building BL. 46 CĂMIN, situated at Str. Livezii Nr. 46, was constructed in 1979 as a studio hostel block containing 92 small 27 m² studios across 2,467 m² of heated area. Upgrading from energy class D (339.70 kWh/m²/yr) to class B (199.22 kWh/m²/yr) yields energy savings of 347 MWh/yr (€20,188/yr) and $CO_2$ reductions of 71 tonnes/yr, alongside a PV potential of 98 MWh/yr (€9,515/yr). Total primary renovation CapEx is €863,450 (€9,385/studio) with an overall ROI of 25 years, boosting unit market value by +€300/m² (€8,045 net gain per studio). Additionally, BL. 46 CĂMIN offers a specialized option for apartment recompartmentation, where two or more small 27 m² studios can be merged into 50–80 m² family apartments through municipal or developer buyouts to drastically improve living quality.

Practical implementation of renovation works in Alba Iulia requires a structured sequence of next steps grounded in empirical field data. The local administration must update energy audits, prepare detailed engineering documentation (DALI and Feasibility Studies), and utilize the R Studio prioritization tool to establish transparent investment queues across all remaining unrenovated MABs. Technically, future projects must mandate the inclusion of staircase-integrated MVHR systems to ensure healthy

indoor air and prevent mold, while installing rooftop and balcony PV systems to support energy self-consumption. Local authorities and ALEA will facilitate the creation of Renewable Energy Communities among homeowners associations to enable collective prosumer energy sharing. Crucially, social engagement and direct citizen support must be maintained through home visits, thermal camera inspections, energy bill counseling, advocacy workshops, and demonstration building visits to build community trust, lower social resistance, and secure mandatory legal voting majorities within HOAs.

The roadmaps highlight critical policy improvements needed at national, regional, and local levels. Nationally, Romania must establish a clear legal definition and standardized indicators for energy poverty, replacing "first-come, first-served" grant allocations with mandatory socio-economic vulnerability criteria. National frameworks should also enforce regional fund distribution equity, strengthen legal provisions for building-level Energy Communities, and develop alternative commercial financial tools like ESCO energy performance contracts and state-guaranteed loans. Regionally and locally, authorities should maintain a centralized digital MAB inventory tracking structural degradations and resident demographics, streamline communication between ADR Centru and HOAs, and operationalize a permanent integrated Energy Poverty Advisory Center (One-Stop-Shop) in Alba Iulia.

The building-level roadmaps create direct synergies and add substantial strategic value to Alba Iulia's broader planning tools. They directly operationalize the targets of Alba Iulia's Sustainable Energy and Climate Action Plan (SECAP/PAEDC), which aims to rehabilitate 2,147 apartments across 30 MABs, and reinforce the Integrated Urban Development Strategy (SIDU) by transforming general emission reduction goals into detailed, bankable building-level investment plans. Furthermore, the roadmaps align with other EU-funded initiatives in Alba Iulia, including DOITSMARTER (Innovation Norway social assistance mapping), the Energy Poverty Advisory Hub (EPAH), CEESEU-DIGIT, MESTRI-CE, and the Building Efficiency Accelerator (BEA). The CEESEN-BENDER project delivers tangible added value through open-source tools—such as the simplified ROI Calculator, R Studio Prioritization Tool, and MAB PV Output Calculator—combined with 12-month indoor air quality datasets and field counselling protocols, establishing a highly replicable model for equitable urban energy transition across Central and Eastern Europe.

Co-funded by the European Union

*The CEESEN-BENDER project has received funding from the European Union's Programme for the Environment and Climate Action (LIFE 2021-2027) under grant agreement no LIFE 101120994. The information and views set out in this material are those of the author(s) and do not necessarily reflect the official opinion of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.*