

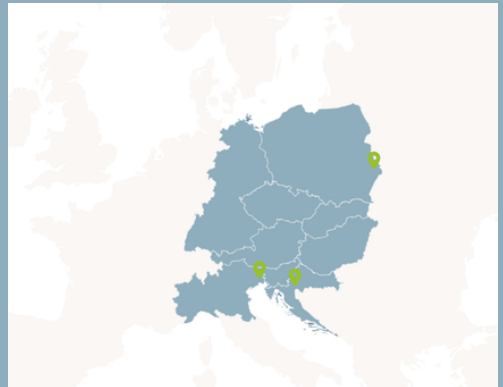
TRANSNATIONAL HANDBOOK ON ZEB4ZEN PILOTS

The transition towards zero-emission neighbourhoods (ZEN) represents a key priority within European climate and energy policies. However, achieving this objective in historic urban areas presents specific challenges due to the need to preserve cultural heritage while improving energy performance.

Within the ZEB4ZEN project, three pilot actions implemented in Zamość, Palmanova, and Karlovac tested innovative solutions for integrating energy efficiency measures, renewable energy systems, and smart technologies in protected historic contexts.

This handbook aims to:

- compile the results of the pilot investments as best practices;
- identify common challenges in historic protected urban areas;
- present innovative processes, methods, and technical solutions;
- provide recommendations for transferability and policy support.



Key challenges in historic areas

Heritage protection constraints

Historic centres are subject to strict conservation regulations that limit physical interventions on buildings and infrastructures. These restrictions often prevent the application of standard solutions such as external insulation systems or rooftop photovoltaic installations, requiring alternative and context-sensitive approaches.

Technical and spatial limitations

Existing buildings frequently present structural and spatial constraints, including:

- lack of space for technical systems (e.g., batteries, HVAC equipment);
- outdated infrastructure;
- architectural limitations.

These factors complicate the integration of modern energy technologies.

Regulatory and administrative complexity

The implementation of pilot actions revealed complex administrative processes, including:

- multiple permitting procedures;
- conservation approvals;
- evolving legal frameworks for innovative technologies.

These elements often resulted in extended timelines and increased coordination efforts.

Market and procurement barriers

Innovative technologies are not always readily available or mature. Public procurement procedures may face:

- lack of suitable bids;
- high costs;
- uncertainty regarding technical Specifications.



Stakeholder engagement and governance

The transition to ZEN requires active participation from local stakeholders. However:

- awareness of innovative models (e.g., energy communities) is limited;
- trust-building and engagement require time and resources.

Innovative approaches and technical solutions

Smart energy systems and mobile storage

The Karlovac pilot focused on integrates smart energy systems, combining:

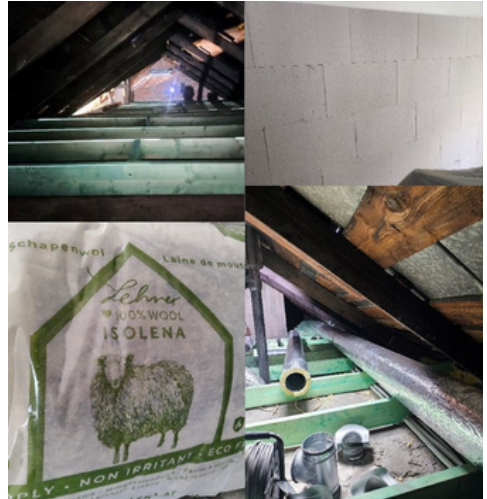
- photovoltaic generation;
- bidirectional electric vehicle charging (V2G);
- mobile energy storage.

This approach addressed spatial limitations by using electric vehicles as flexible storage units.

Renewable Energy Communities

The pilot in Palmanova demonstrates the effectiveness of Renewable Energy Communities (REC) both as a governance and technical model. Key features:

- photovoltaic system installed outside the historic centre;
- virtual energy sharing among community members;
- multi-stakeholder participation (households, SMEs, public bodies).



Energy renovation in historic buildings

The pilot in Zamość implements a research-driven approach to thermal modernization, focusing on internal insulation systems compatible with heritage constraints. Key solutions included:

- internal wall and roof insulation;
- moisture control systems;
- modernization of building services.

Digitalisation and energy management

All pilots highlighted the importance of ICT solutions for:

- real-time monitoring of energy flows;
- optimization of energy consumption;
- improved system efficiency.

Key lessons learned

Adaptability is crucial:

solutions must be tailored to local conditions.

Pilot testing is essential:

real-life experimentation supports innovation uptake.

Stakeholder involvement is key:

governance models influence success.

Integrated approaches are needed:

combining energy efficiency, renewables, and digitalisation yields better results.

Timeframes must be realistic:

historic contexts require longer preparation phases.

Policy recommendations and transferability

Heritage-sensitive policy frameworks

Policies should explicitly address historic areas, enabling energy interventions that respect cultural heritage.

Simplification of administrative procedures

Streamlined permitting processes are needed, especially for innovative technologies.

Financial support and incentives

Dedicated funding schemes should support:

- pilot projects;
- research activities;
- deployment of innovative solutions.

Promotion of REC models

Support for Renewable Energy Communities should include:

- clear legal frameworks;
- access to incentives;
- technical assistance.

Digitalisation of urban energy systems

Policies should encourage the adoption of ICT solutions for energy monitoring and management.

Capacity building and knowledge sharing

Training and exchange of best practices are essential for scaling up solutions across European cities.

Conclusions

The pilot actions implemented within ZEB4ZEN project in Karlovac, Palmanova and Zamość demonstrate that the transition to zero-emission neighbourhoods in historic urban areas is feasible, although complex.

Key success factors include:

- integration of technological and governance solutions;
- flexibility in project design;
- strong institutional cooperation.

Historic areas, while constrained, can act as innovation laboratories for developing and testing solutions that balance sustainability and heritage preservation.

This handbook provides a structured knowledge base to support policymakers, planners, and stakeholders in replicating and scaling up these approaches across Europe.

Who we are

The project ZEB4ZEN *Zero energy buildings for zero energy neighbourhoods* is funded under the Interreg Central Europe Programme.

Zero-energy buildings help regions and cities to save energy and money. But what to do in historic neighbourhoods with rigid architectural protection rules? ZEB4ZEN project develops a transferrable transnational methodology and regional action plans for achieving zero-emission standards, which they also test in pilot actions in historic city neighbourhoods.

<https://www.interreg-central.eu/projects/zeb4zen/>

