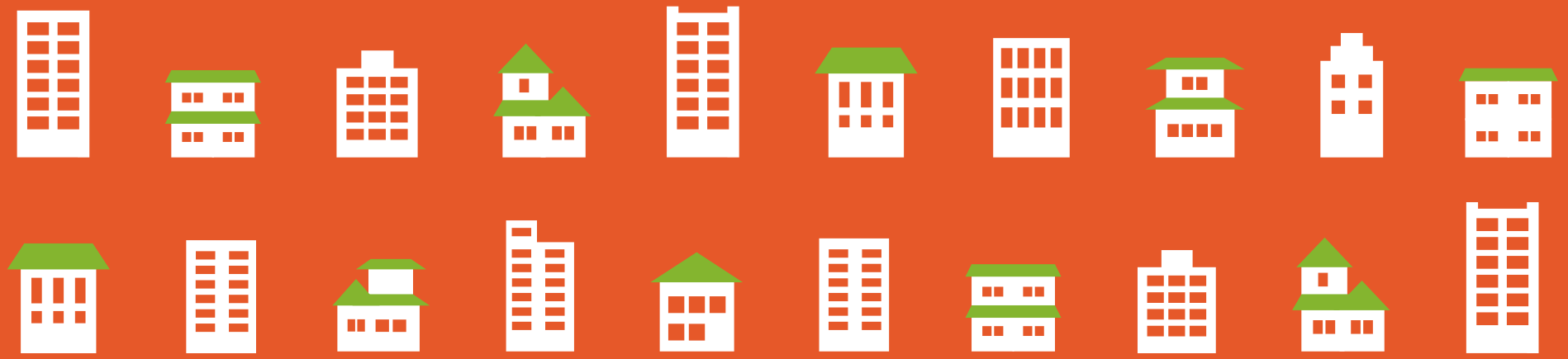
RetrofitHUB

ENERGY EFFICIENT RETROFIT GUIDEBOOK

Recommendations for energy efficiency renovation practices in multi-apartment buildings



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Recommendations for energy efficiency renovation practices in multi-apartment buildings

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About the RetrofitHUB Project

The RetrofitHUB Project, part of the EU's efforts to enhance energy efficiency in buildings, and collaborating with the Croatian, Hungarian, and Polish Green Building Councils, started its implementation in September 2021 and finished in January 2024. It aimed to **educate a variety of stakeholders**, including facility/building managers, condominium representatives, apartment owners and experts, on efficient energy renovations in line with EU policies in order to increase the building sector's scope of retrofits.

The activities carried out included a kick-off meeting, stakeholder engagement through interviews, and national focus groups as well as an **online training course and live on- site workshops, culminating in national document(s) – Energy efficient retrofit guidebooks available in the Croatian, Hungarian and Polish languages** that align with the European Climate Initiative (EUKI) and its climate policy goals. The Retrofit HUB Project also developed an online project platform[1] where project- developed materials can be found and downloaded from. The Platform is available in four languages: Croatian, Hungarian, Polish, and English.

The project initiative facilitated dialogue, shared good practices, and transferred knowledge within the EU. Discussions emphasized educating managers, addressing subsidy challenges, and legalizing renovations, highlighting the need to combat energy poverty and educate experts in sustainable solutions. The Retrofit HUB Project's collaborative effort stands as a vital contribution to advancing energy efficiency in buildings, **supporting broader EU climate objectives, and fostering knowledge exchange among diverse stakeholders**.

Considering the target audience of this Guidebook that focuses on facility managers, condominium representatives, and the general public interested in the topic of energy renovation for multi-apartment buildings, **the Guidebook's objective is to provide enlightening and at the same time pertinent information**. Concentrating on the regulatory framework at both the European Union and national levels, efforts will be directed towards presenting relevant legislative aspects in a professional and accessible manner. Additionally, guidance will be offered for further sources and information for those seeking a deeper understanding of this subject.

The *"Energy Efficient Retrofit Guidebook – Recommendation for energy efficiency renovation practices in multi-apartment buildings"* document is intended to serve as a useful tool for energy renovations by summarizing the most important and internationally relevant information from the three national guidebooks.

[1] RetrofitHUB (n.d.) Retrieved from https://retrofithub.eu/ Last accessed: 18. January 2024.

THE MULTI-APARTMENT BUILDING RETROFIT

Regulatory framework of multi-apartment retrofit

Energy renovation of multi-apartment housing significantly reduces energy consumption and greenhouse gas emissions, which in turn helps to achieve climate goals, improve resident living comfort, and reduce household costs in the long run, as well as yielding an increase in property values.

The EU's regulatory framework for multi-apartment retrofit represents a comprehensive and forward-thinking approach to addressing the challenges of climate change. By combining minimum standards, encouragement for renewable energy use, financial support, and a circular economy perspective, the EU ensures a holistic strategy for achieving sustainable and energy efficient residential buildings.

At the core of the EU's vision for a sustainable future is the **European Green Deal**[2]. This comprehensive strategy aims to make the EU climate neutral by 2050. Aligned with the renovation wave strategy, the European Green Deal reinforces the importance of sustainable and energy efficient buildings. It provides a roadmap for integrating climate considerations into all aspects of policy, thus creating a holistic approach to addressing climate change challenges.

Central to the European Union's regulatory strategy lies the **Energy Performance of Buildings Directive (EPBD)**[3]. Encompassing both new constructions and existing buildings undergoing renovation, the EPBD sets the stage for minimum energy performance standards.

Complementing the EPBD, the **Renewable Energy Directive (RED II)**[4] focuses on integrating renewable energy sources into buildings. Recognizing the role of renewable energy in reducing carbon emissions, it encourages the use of such sources during retrofit projects.

The **Energy Efficiency Directive (EED)**[5] further strengthens the EU's commitment to energy efficiency. By mandating improvements in the energy performance of existing buildings, the EED acts as a catalyst for sustainable renovations. The directive promotes cost effective measures, ensuring that energy efficient upgrades are both environmentally friendly and economically viable.

As technology continues to play a central role in shaping the future, the EU introduced the **Smart Readiness Indicator (SRI)**, an integral part of the EPBD. The SRI assesses the technological readiness of buildings for smart technologies, encouraging the integration of innovative solutions in retrofit projects.

The Energy Performance of Buildings Directive's (EPBD) revision of 2022-2024[6] introduces the concepts of deep renovation, staged deep renovation, and renovation passports. In the trialogue prior to adoption, most stakeholders supported the concept of a renovation passport and staged renovation; they agreed that the passport would provide access to information and reduce costs for consumers, facilitating planning and the multi-stage renovation that would lead to achieving zero emissions.

[2] European Commission (2019) *European Green Deal. Priorities 2019-2024.* https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal_en Last accessed: 17. January 2024.
[3] European Commission (n.d.) *Energy Performance of Buildings Directive* https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/energy-performance-buildings-directive_en Last accessed: 17. January 2024
[4] European Commission (n.d.) *Renewable Energy Directive Recast 2030 (RED II). Joint Research Centre* https://joint-research-centre.ec.europa.eu/welcome-jec-website/reference-regulatory-framework/renewable-energy-recast-2030-red-ii_en Last accessed: 17. January 2024.
[5] European Parliament and of the Council (2023) *Directive (EU) 2023/1791 of the European Parliament and of the Council of 13 September 2023 on energy efficiency and amending Regulation (EU) 2023/955 (recast) (Text with EEA relevance)* https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ%3AJOL_2023_231_R_0001&qid=1695186598766 Last accessed: 17. January 2024.
[6] P9_TA(2023)0068 *Energy performance of buildings (recast) Amendments adopted by the European Parliament on 14 March 2023 on the proposal for a directive of the European Parliament and of the Council on the energy performance of buildings (recast) (COM(2021)0802 – C9-0469/2021 – 2021/0426(COD))* https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex%3A52023AP0068 Last accessed: 17. January 2024.

The majority of the negotiating parties agreed that staged renovation can address the high up-front costs and complexities of single-stage renovations, as well as allow for less disruptive and more cost-effective renovation measures. They warn, however, that staged renovations need to be carefully planned so that no single step of renovation prevents any further necessary steps, and does not cause a "locked-in" situation; i.e., steps that result in a low level of ambition and prevent the building from achieving zero emission by 2050. Renovation passports provide a clear roadmap for staged renovation, helping owners and investors to plan the most optimal timing and scope for interventions. Given that a single-stage deep renovation can be more cost-effective and result in lower carbon emissions, the original proposal has been modified in this regard.

DEFINITIONS ACCORDING TO THE CONSOLIDATED PROPOSAL[7]:

- **renovation passport** means a document that provides a tailored roadmap for the deep renovation of a specific building in a maximum number of steps that will transform the structure into a zero-emission building by 2050 at the latest;

- **deep renovation** means a renovation in line with the energy efficiency first principle and efforts to reduce whole life-cycle greenhouse gas emissions generated during the renovation, which focuses on essential building items, such as wall insulation, roof insulation, low floor insulation, replacement of external joinery, ventilation and heating or heating systems, and treatment of thermal bridges, in order to ensure the occupants' necessary comfort in summer and winter, or a renovation resulting in a reduction of at least 60% primary energy demand for the worst-performing buildings in which it is technically and economically not feasible to achieve a zero-emission building standard, and which transforms a structure or building unit into a nearly zero-energy building before 1 January 2027, and into a zero-emission building from 1 January 2027;

- **staged deep renovation** means a deep renovation carried out in a maximum number of steps, following the path set out in a renovation passport, which may include the use of energy performance contracts;

- **major renovation** means the renovation of a building where – depending on the choice of a Member State – either the total cost of the renovation relating to the building envelope or the technical structural systems rises higher than 25% of the value of the building (excluding the value of the land upon which the building stands); or more than 25% of the surface of the structural envelope undergoing renovation.

The use of the renovation passports remains voluntary but will be a prerequisite for the financial incentives for staged deep renovation.

[7] 7 The Guidebook was written in January 2024. The text and target deadlines may change as a result of final negotiations.

THE RENOVATION PASSPORT MUST MEET THE FOLLOWING REQUIREMENTS:

- it shall be issued by a qualified and certified expert, following an on-site visit (in a digital form suitable for printing);
- it shall comprise a holistic renovation roadmap indicating a maximum number of renovation steps building upon each other in line with the energy efficiency's first principle to achieve a deep renovation in line with the objective to transform the structure into a zero-emission building by 2050 at the latest, outlining how to achieve minimum energy performance standards, and measures to reduce whole life-cycle greenhouse gas emissions in the renovation process;
- it shall indicate the expected benefits in terms of energy savings, savings on energy bills and whole life-cycle greenhouse gas emissions reductions, with an indication of the renovation steps that are to lead to the relevant improvements;
    - it shall contain information about a potential connection to an efficient district heating network, the share of individual or collective generation and self-consumption of renewable energy;
    - it shall contain information on a range of estimated costs for each recommended renovation step, as well as the estimated costs of a one-step deep renovation as a reference scenario;
    - it shall comprise the bill of materials, information on construction product circularity as well as wider benefits related to health, comfort, indoor environmental quality, safety such as fire, electrical, and seismic safety, and the improved adaptive capacity of the building to climate change;
- it shall contain information about potential financial and technical support and updated contact details of the nearest one-stop-shop;
- it shall contain information on any major renovations made to the building, and any retrofitting or replacement of a structural element that forms part of the building envelope and that has a significant impact on the building envelope's energy performance.

Following the adoption of the EPBD, the European Commission will prepare a common European framework for renovation passports to be implemented by Member States. Although not currently available, several European countries have already introduced such provisions to facilitate a staged renovation with a high-level goal.

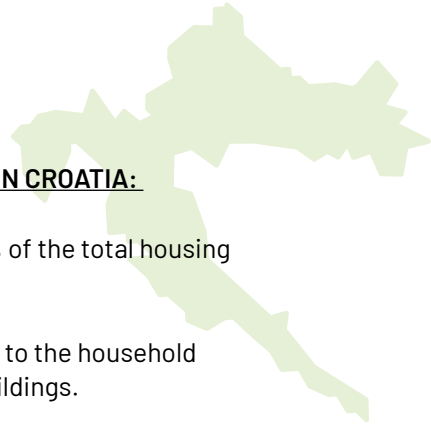
The **renovation flowchart and roadmap** in this document follows the above logic, with the addition of tasks related to decision preparation and decision making. The roadmap prepared with the proposed methodology will be applicable in the future, providing a basis for access to the proposed grants and simplified permission processes.

Regulatory framework: Croatia

In Croatia, several important national documents govern all ambitions to retrofit building stock. They are: *The Energy Development Strategy of the Republic of Croatia by the year 2030*[8], *the Program for the Energy Renovation of Multi-Apartment Buildings by the year 2030*[9], *and the National Recovery and Resilience Plan 2021-2026*[10].

The Energy Development Strategy of the Republic of Croatia by the year 2030 outlines various pathways for the nation's energy transition, reaching towards the year 2050. These scenarios indicate an investment requirement of 31.79 billion euros by 2050 to achieve widespread energy renovation and construct nearly zero-energy buildings.

Recognizing the significance of multi-apartment buildings in this transition, the Croatian government has adopted the **Program for the Energy Renovation of Multi-Apartment Buildings by the year 2030**. This program aims to incentivize and facilitate the energy renovation of multi-apartment buildings, contributing significantly to the reduction of energy consumption, greenhouse gas emissions, and household expenses. **The Republic of Croatia has set a goal of renovating 6.3 million square meters of multi-apartment buildings by 2030**. This would reduce energy consumption and greenhouse gas emissions, and improve the residents' living conditions. The government has adopted a program to incentivize and facilitate this renovation, a development expected **to reduce CO_2 emissions by 74,981.32 tons**.



A FEW SIGNIFICANT FACTS AND TARGETS IN CROATIA:

- Multi-apartment buildings make up 27% of the total housing stock in Croatia.
- About 32% of the total energy delivered to the household sector comes from multi-apartment buildings.
- It is estimated that about 50% of multi-apartment buildings will have to undergo comprehensive renovation that includes measures to increase seismic resistance.
- A total of about 6.3 million square meters of multi-apartment buildings requires renovation by 2030.
- The Long-term strategy for the renovation of the national building stock for 2050[11] states that by 2030, it will be necessary to renovate 25% of the national building stock and achieve an annual building renovation rate of 3%.

[8] *Energy Development Strategy of the Republic of Croatia until 2030, with a view to 2050.* https://narodne-novine.nn.hr/clanci/sluzbeni/2020_03_25_602.html Last accessed: 17 January 2024.
[9] MPGI (2021) *Energy Renovation Program for Multi-Apartment Buildings for the Period Until 2030.*
https://mpgi.gov.hr/UserDocsImages/dokumenti/EnergetskaUcinkovitost/Program_energetske_obnove_VS_zgrada_do_2030.pdf Last accessed: 17 January 2024.
[10] *National Recovery and Resilience Plan 2021 – 2026.* https://planoporavka.gov.hr/UserDocsImages/dokumenti/Plan%20oporavka%20i%20otpornosti%2C%20srpanj%202021..pdf?vel=13435491
Last accessed: 17 January 2024.
[11] MPGI (2020) *Long-Term Strategy for the Renovation of the National Building Stock until the Year 2050*
https://mpgi.gov.hr/UserDocsImages/dokumenti/EnergetskaUcinkovitost/DSO_14.12.2020.pdf Last accessed: 17 January 2024

Regulatory framework: Hungary

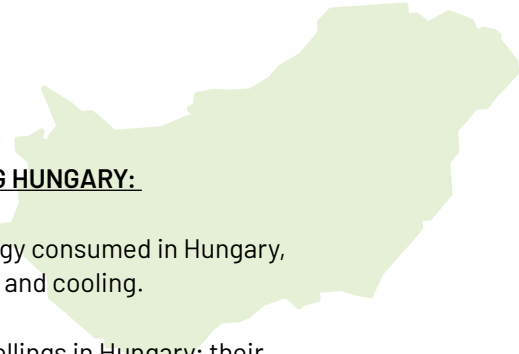
In Hungary, the most important national documents are the **National Energy Strategy** (NES)[12], the updated **National Energy and Climate Plan** (NECP)[13], and the **Long Renovation Strategy** (LTRS)[14]

The Hungarian NES outlines various pathways for the nation's energy transition by the year 2030, reaching towards the year 2050.

The LTRS sets the target of a **20% energy saving by 2030**, **40% by 2040** and **60% by 2050** compared to 2018. The GHG emission targets are more ambitious: **20% by 2030**, **60% by 2040** and **90% by 2050** compared to 2018.

The percentage of nearly **zero-energy buildings** is aimed to reach **20% by 2030**, **60% by 2040** and **90% by 2050**. The projections included in the NECP's updated draft indicate that the LTRS objectives cannot be achieved without additional measures.

Hungary aims to promote the uptake of heat pumps as part of the building's renovation as the main action in decentralized heating.



A FEW SIGNIFICANT FACTS REGARDING HUNGARY:

- Our buildings use up 40% of all energy consumed in Hungary, two-thirds of which goes to heating and cooling.
- There are 4.3 million residential dwellings in Hungary; their total floor area: almost 274 million m^2.
- Final energy consumption in residential buildings ranges on average between 205 and 225 kWh/m^2yr, with large differences based on the type, year of construction and the renovations that have taken place since then. The highest energy consumption belongs to the stock of detached houses (1-3 dwellings, 80.5%), followed by the large condominiums (10 or more dwellings, 14.7%), and small condominiums (4-9 dwellings, 4.8%).
- Natural gas is the most widespread energy source, which supplies 76% of the households. The total final energy consumption of residential buildings in 2018 was 205 000 TJ.
- Fully 70% of the Hungarian residential buildings fail to meet modern functional technical and thermal engineering requirements.
- In multi-apartment buildings, the best renewable energy option is the heat pump, followed by solar PVs.

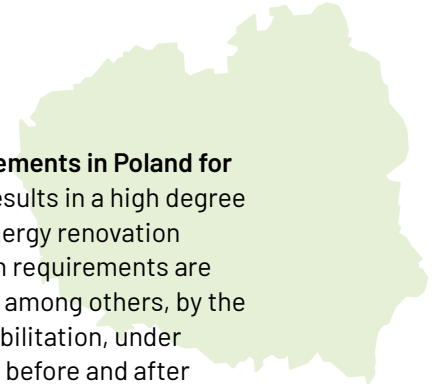
[11] MPGI (2020) Long-Term Strategy for the Renovation of the National Building Stock until the Year 2050 https://mpgi.gov.hr/UserDocsImages/dokumenti/EnergetskaUcinkovitost/DSO_14.12.2020.pdf Last accessed: 17 January 2024.

[12] Ministry of National Development (2012) National Energy Strategy 2030, Ministry of National Development Ministry of National Development https://2010-2014.kormany.hu/download/7/d7/70000/Hungarian%20Energy%20Strategy%202030.pdf Last accessed: 17 January 2024.

[13] Directorate-General for Climate Action (2023) National Energy and Climate Plan (NECP). European Commission https://commission.europa.eu/publications/hungary-draft-updated-necp-2021-2030_en Last accessed: 17 January 2024.

[14] Ministry of Innovation and Technology (2020) Long Renewal Strategy on the basis of Directive (EU) 2018/844 with a view to fulfilling the eligibility conditions for the payment of cohesion funds for the period 2021-2027, Ministry of Innovation and Technology https://energy.ec.europa.eu/system/files/2021-08/hu_2020_ltrs_en_0.pdf Last accessed: 17 January 2024.

Regulatory framework: Poland



The current **Energy Performance of Buildings Directive (EPBD)** has required EU member states to develop **Long-Term Renovation Strategies (LTRS)** to help accelerate the renovation of Europe's building stock. In order to achieve total decarbonization in 2050, it is necessary to **accelerate the rate of renovation of existing buildings to 3% per year**. Poland's LTRS, adopted on February 9, 2022, provides a roadmap for renovating the building stock in both the short and long term. The strategy is designed to "cost-effectively transform the national building stock into nearly zero-energy buildings."

According to the LTRS for Poland, the renovation of buildings should proceed as follows:

- In **2020-2030**, a total of **236,000 buildings** per year are planned to be **energy renovated**,
- In **2030-2040 - 271,000** buildings,
- In **2040-2050 - 244,000** buildings.

According to the strategy, **by 2050 a total of about 7.5 million building energy renovation investments are estimated to be carried out in Poland**, of which 4.7 million are deep renovations, including phased renovations over time.

The strategy assumes an average annual rate of energy renovation of about 3.8%, assuming that by 2050 65% of buildings will achieve a Primary Energy (PE) consumption of no more than 50 kWh/m²yr.

At the moment **there are no legislative requirements in Poland for energy savings in renovated buildings**. This results in a high degree of flexibility in the approach to carrying out energy renovation works (e.g., scope, sequence or method). Such requirements are imposed only by subsidy programs, regulated, among others, by the law on support for energy renovation and rehabilitation, under which it is necessary to prepare energy audits before and after carrying out renovation work, in order to demonstrate specific savings in energy consumption. Housing communities or cooperatives wishing to take advantage of the subsidies are required to meet specific conditions, therefore the renovation works usually follow the path outlined in the energy audit, ensuring that the desired energy effects are achieved. Unfortunately, not all communities take advantage of the available public support, but use their own funds combined with commercial loans, which allows a great deal of freedom in carrying out renovations, without the mandatory audit.

Stakeholders in the renovation works

A multi-apartment building renovation faces difficulties as the process includes a variety of stakeholders.

The most important stakeholders in the process of renovation consist of **APARTMENT OWNERS** who need to jointly bring a decision to start the renovation process. To do so, they need to be well informed in order to bring optimal decisions for their building renovation. For this reason, all kinds of awareness raising activities on a national level are extremely important. Decisions about renovation projects and works are arrived at in collaboration with the **CONDOMINIUM REPRESENTATIVE** and **FACILITY MANAGER** who has an overview of the building's financial status, coordinates building maintenance works, prepares the structural documentation in case of preparing for public or private renovation funding, and collects designs as well as construction companies' bids.

ENERGY SPECIALISTS OR AUDITORS are the most important key experts, especially before the renovation works. They determine the actual state of the building and its energy class before the renovation, and additionally propose suitable measures and provide energy class predictions that will be achieved after implementing the proposed measures.

ARCHITECTS AND ENGINEERS comprise the experts who prepare technical documentation for the renovation of buildings, and **CONSTRUCTION COMPANIES** who do the actual renovation works constitute the other important group of stakeholders. They are well informed of all legal aspects of the renovation and possess the knowledge about materials and environmentally acceptable products that effect a decreased CO_2 impact.

Most of the buildings do not bear enough financial resources to complete deep or even smaller retrofits without bank loans. Therefore, **COMMERCIAL BANKS** play a crucial role in providing custom loans for multi-apartment building renovation works. Also, **NATIONAL AND LOCAL GOVERNMENTS** co-fund renovations by issuing public calls according to foreseeable national or EU energy renovation programs. On the local level (or by a national body), **ONE-STOP-SHOPS** or **INFORMATION SERVICES** provide consulting to applicants (condominium representatives, facility managers) in case of preparing the building for public calls for funding renovation works.

Role of the condominium representative

Condominium representatives play a multifaceted role in overseeing the successful implementation of retrofitting projects in multi-apartment buildings. Acting as advocates for the collective interests of apartment owners, they ensure effective communication, consensus building, and informed decision-making. By serving as intermediaries between individual apartment owners and the facility management, they foster clear and transparent communication channels. Their responsibilities include disseminating information about the retrofitting project, updates, and meeting decisions to maintain transparency among owners. Condominium representatives play a pivotal role in building consensus among apartment owners regarding the necessity, scope, and execution of retrofitting measures. They encourage active participation, address concerns, and gather feedback to ensure a collective decision-making process. During meetings or consultations related to the retrofitting project, they provide crucial support by presenting information, options, and proposals to aid owners in making informed decisions about renovation plans, budget allocation, and the use of reserve funds.

Financial planning is another key aspect of their role. They assist in budget allocation, help owners understand financial obligations, and explore available funding options or subsidies for the retrofitting project. Ensuring that owners remain well-informed about financial aspects and potential impacts on individual budgets is part of their responsibility. Additionally, condominium representatives oversee the implementation of retrofitting measures. They ensure compliance with agreed-upon plans, quality standards, and timelines. Monitoring the project's progress, they liaise between owners and contractors, addressing any concerns or issues that may arise.

Role of the building/facility manager (FM)

The rise in energy costs has heightened public awareness regarding the necessity of energy refurbishments in multi-apartment buildings. The role of building managers, whether legal entities or individuals, is pivotal in this process. They oversee communal areas, conduct inspections, and manage owners' financial commitments per the signed management agreements. Transparency and coordination among managers, owners' representatives, and the owners themselves are crucial for optimal communication. The success of building energy renovations hinges on owners' financial capabilities, banking conditions, and the buildings' creditworthiness. Challenges include a lack of information, irregular public calls for co-financing, as well as the insufficient knowledge of renewable energy sources and energy-saving benefits.

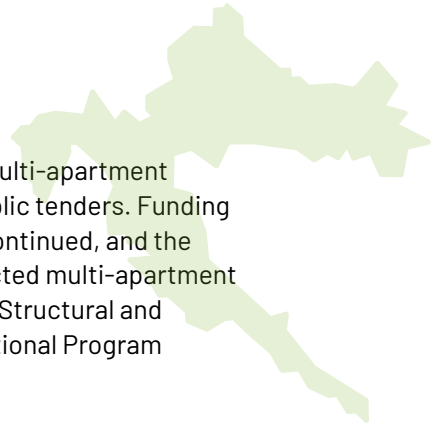
In multi-owned buildings, the FM plays a crucial role in coordinating and overseeing various aspects of the property. This includes managing financial commitments of individual owners as per agreed-upon management agreements, overseeing reserve funds, and ensuring transparency in financial matters. Additionally, the FM stands responsible for overseeing maintenance tasks and inspections of communal areas, ensuring adherence to legal and safety regulations, and promptly addressing any issues. Furthermore, they facilitate transparent communication between owners, their representatives, and relevant stakeholders, ensuring the optimal coordination for efficient operations and renovations. Advocating for and facilitating energy renovation initiatives, educating owners about the importance of energy refurbishments, and exploring funding options or subsidies for such projects are also part of their duties. Finally, the FM assists in decision-making processes regarding renovations, particularly concerning the use of the reserve fund for refurbishments, while ensuring compliance with legal requirements and garnering majority agreement among owners.

When the company manages buildings owned by the municipality, their role extends to broader operational and administrative aspects. This encompasses ensuring the efficient functioning of municipal-owned buildings by overseeing maintenance, repairs, and upgrades to ensure optimal performance and cost-efficiency. Additionally, the FM manages budgets allocated for the maintenance and renovation of municipal buildings, ensuring the proper utilization of funds, and possibly seeking additional financial resources or grants for energy-efficient initiatives. They also ensure compliance with local regulations, safety standards, and sustainability measures for municipal-owned properties. Furthermore, the FM facilitates communication between the municipality, tenants or users of these buildings, and other stakeholders involved in decision-making processes related to building maintenance, upgrades, or energy-related initiatives. Finally, they actively encourage and implement sustainable practices and energy-efficient measures within municipal-owned buildings, aligning with broader municipal sustainability goals and strategies.

Implementation status regarding multi-apartment buildings' energy-efficient renovations

Although targets for improving the building stock and reducing its energy consumption are set in the long term renovation strategies, the rate of building renovations still falls behind the targets. The number of new and renovated nearly zero-energy buildings (nZEB) has become the standard for new buildings in Member States as of the end of 2020. The renovation rate of residential buildings stands highest in Croatia with 10.72%, followed by Poland's 7.55% and Hungary's 4.19% rate[15].

CROATIA



The Environmental Protection and Energy Efficiency Fund (referred to as 'the Fund' in this section) is an institution that collects non-budgetary funds. The collected funds are directed towards environmental protection and energy efficiency projects based on the "polluter pays" principle. A portion of the funds is invested in energy renovations, in accordance with assumed commitments, goals, and programs.

The Fund began co-financing the energy renovation of multi-apartment buildings in 2014. Initially, it co-financed project documentation such as energy certificates, main projects for energy renovation, and other relevant project documentation. Later, it started co-financing the implementation of energy renovation works.

Co-financing for the energy renovation of multi-apartment buildings continued in 2015 through two public tenders. Funding through national means, however, was discontinued, and the Government of the Republic of Croatia directed multi-apartment buildings towards financing from European Structural and Investment Funds (ESIF) through the Operational Program Competitiveness and Cohesion 2014 – 2020.

Since 2016, the Fund has played a dual role in public calls, serving as technical assistance/expert support to applicants and as Implementing Body / Intermediate Body level 2. The COVID-19 pandemic temporarily disrupted the regularity of calls for co-financing energy renovations of multi-apartment buildings. However, co-financing resumed as soon as circumstances allowed, and the last public call was announced and carried out in 2022. The Fund was quickly allocated due to an exceptionally high interest.

[15]Building Stock Observatory (n.d.) Retrieved from https://building-stock-observatory.energy.ec.europa.eu/factsheets/ Last accessed: 17. January 2024.

In 2023, a public call was opened for the energy renovation of multi-apartment buildings damaged in the earthquake, within the National Recovery and Resilience Plan 2021 – 2026. The co-financing of energy renovation measures can reach up to 80%.

In addition to available co-financing sources, past experience of implementing energy renovations in multi-apartment buildings has shown that several prerequisites are necessary to facilitate the preparation and implementation of energy renovations, thus ensuring the quality and sustainability of the measures taken.

The most significant prerequisites for successfully preparing and implementing energy renovations include:

- collaboration among co-owners within co-ownership communities;
- collaboration between co-owners, the condominium representative, and the facility manager;
- preparation of co-owners in advance, even several years before the announcement of the call, by raising the minimum legal reserve to a higher, co-owner-acceptable amount, to enable the accumulation of sufficient funds and facilitate financing their own participation in the renovation with a smaller loan;
- clear definition of renovation steps, required documentation, and project tasks that co-owners are familiar with and agree upon (such as the thickness of thermal insulation layers on balconies/loggias, type of external carpentry, etc.).

TECHNICAL SOLUTIONS FOR ENERGY EFFICIENT BUILDING RENOVATION OF MULTI-APARTMENT BUILDINGS

TECHNICAL SOLUTIONS FOR ENERGY EFFICIENT BUILDING RENOVATION OF MULTI-APARTMENT BUILDINGS

Technical solutions for energy-efficient building renovation of multi-apartment buildings refer to a range of engineering, construction, and technological approaches implemented to enhance the energy performance, sustainability, and overall efficiency of multi-apartment residential structures during renovation or refurbishment.

These technical solutions encompass various measures, methodologies, and systems aimed at improving the energy efficiency of buildings while considering factors such as insulation, heating and cooling systems, ventilation, lighting, renewable energy integration, and smart technologies. This involves utilizing advanced building materials, modern heating and cooling equipment, insulation upgrades, installing energy-efficient windows and doors, implementing renewable energy sources such as solar panels or heat pumps, and adopting smart building management systems.

The objective is to reduce energy consumption, minimize heat loss, optimize thermal comfort for occupants, lower the environmental impact, and potentially decrease overall operational costs for the building while adhering to modern energy efficiency standards and regulations. These technical solutions are tailored to suit the specific requirements, structural aspects, and complexities of multi-apartment buildings, aiming to achieve a sustainable and improved living environment for residents.

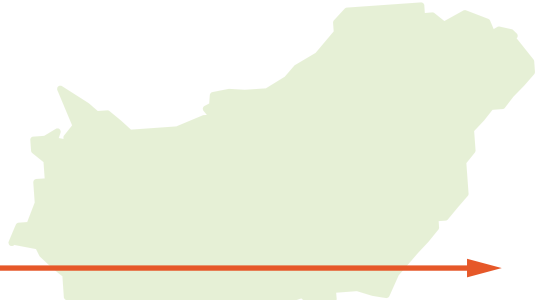
Types of renovation works

BUILDING TYPES

EPBD[16] (Article 2a.1a) and EED[17] (Article 4a) prescribe that the National Long Term Renovation Strategies (LTRS) [18] should include an overview of the national building stock, as the sound knowledge of the existing building stock is a prerequisite for developing an effective building renovation strategy. Most European countries provide detailed descriptions of their building stock. Typology includes single-family and multifamily buildings, distinguished increasingly by size (small or large number of apartments), material (traditional, industrialized) and the year they were built. Also, some countries include historic features or other specific (e.g., climatic, territorial, seismic) criteria.

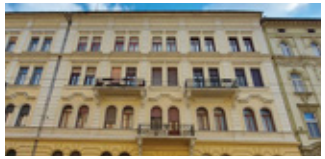
[16] COM(2021) 802 final
[17] Directive (EU) 2023/1791
[18] Long-term renovation strategies (n.d.) Retrieved from: https://energy.ec.europa.eu/topics/energy-efficiency/energy-efficient-buildings/long-term-renovation-strategies_en Last accessed: 17. January 2024.

Typical scenarios: Hungary



THE GENERAL TECHNICAL ISSUES OF ENERGY-EFFICIENT BUILDING RENOVATION INCLUDE A DESCRIPTION OF THE RESIDENTIAL BUILDING STOCK ACCORDING TO THESE THREE TYPES.

1945



Residential buildings built before 1945 consist of over 213 thousand single-family detached or terraced houses (1-3 apartments) with 15.8 million m² inhabited floor area. Small condominiums (4-9 apartments) represent 72 thousand apartments with 3.9 million m² area, while large condominiums (10 or more apartments) constitute 179 thousand apartments with 10.4 million m² inhabited floor area (2020 data). The first type is the least energy-efficient: it has an average 412 kWh/m²yr total primary energy consumption (excluding lighting and household appliances) compared to 328 kWh/m²yr and 259 kWh/m²yr respectively.

TYPICAL BUILDING STRUCTURES:

- External wall: brick masonry plastered on both sides: U ~ 0.9 W/m²K
- Window: double glazing with double glazing having staple glazing bars: U ~ 2.5 W/m²K
- Attic slab: wooden beam with slag filling: U ~ 1.0 W/m²K
- Basement slab: brick porous glass vault: U ~ 0.9 W/m²K

Residential buildings built after 1945 with traditional structures consist of over 1.58 million single-family detached or terraced houses (1-3 apartments) with almost 150 million m² inhabited floor area. Small condominiums (4-9 apartments) represent 166 thousand apartments with 9.9 million m² area, while large condominiums (10 or more apartments) constitute 664 thousand apartments with 33 million m² inhabited floor area (2020 data). The first type is the least energy-efficient: it ranges from 160 kWh/m²yr in the younger to 420 kWh/m²yr total primary energy consumption (excluding lighting and household appliances) in the older building stock. The smaller multi-family buildings range from 182 to 272 kWh/m²yr and the larger ones from 111 to 227 kWh/m²yr respectively.

TYPICAL BUILDING STRUCTURES:

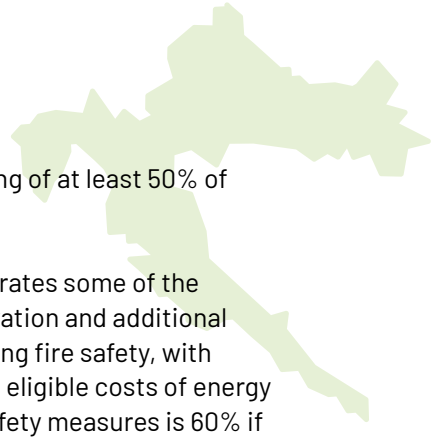
- Exterior wall: brick masonry plastered on both sides: U = 1.1 W/m²K
- Window: double glazing with double glazing units: U = 2.5 W/m²K
- Attic slab: reinforced concrete slab: U =3.0 W/m²K
- Basement slab: reinforced concrete slab: U =2.0 W/m²K

Industrialized technology buildings built after 1945 consist of almost 15 thousand units in medium or large block, cast concrete with 785 thousand m² inhabited floor area. Panel buildings built before 1979 represent 177 thousand apartments with 9 million m² area, while panel buildings built from 1980 to 1989 represent 120 thousand apartments with 6.4 million m² inhabited floor area (2020 data). The first type is the least energy-efficient: it has an average 217 kWh/m²yr total primary energy consumption (excluding lighting and household appliances) compared to 175 kWh/m²yr and 168 kWh/m²yr respectively.

TYPICAL BUILDING STRUCTURES

- External wall: U = 1.8 W/m²K
- Window: single sash, 2x glazing: U = 2.5 W/m²K

Typical scenarios: Croatia



Since many multi-apartment buildings often wait for co-funding public calls, their renovation measures are defined by the National Renovation Programs.

The Multi-Apartment Building Energy Renovation Program for Croatia until 2030[19] categorizes energy renovation for condominiums into three types: integral energy renovation, deep renovation, and comprehensive renovation.

Integral energy renovation involves a combination of multiple energy renovation measures and requires at least one building envelope measure, which results in a savings of at least 50% of the required thermal energy for heating (QH,nd) compared to the pre-renovation state. In some cases, a single building envelope measure that achieves a 50% reduction in QH,nd is sufficient. Applicants for this level of energy renovation can obtain a co-financing rate of up to 60% of eligible costs.

Deep renovation requires achieving savings of at least 50% of the annual required thermal energy for heating (QH,nd) and primary energy (Eprim) on an annual basis. To meet these conditions, it is necessary to implement measures on the building envelope and measures related to technical systems. The co-financing rate for deep renovation is up to 80% of eligible costs, including measures for a comprehensive renovation that achieve a saving of at least 50% of the required thermal energy for heating and measures on technical systems in order to achieve a saving of at least 50% of primary energy annually.

Comprehensive building renovation incorporates some of the previously mentioned levels of energy renovation and additional measures. These measures include increasing fire safety, with eligible costs not exceeding 15% of the total eligible costs of energy renovation. The co-financing rate for fire safety measures is 60% if implemented alongside comprehensive energy renovation, and 80% if implemented alongside deep renovation. Measures to improve the mechanical resistance and stability of the structure to enhance earthquake resistance are also eligible if they increase the building's seismic resistance by at least 10% above the existing level, and are mandatory for the renovation to be considered comprehensive. These measures can achieve an 80% co-financing rate.

Lastly, measures to ensure healthy indoor climate conditions are eligible for co-financing should integral energy renovation or deep renovation be planned. The co-financing rate for these measures equals the rate for integral or deep renovation.

[19] Ministry of Physical Planning, Construction and State Assets (2021)

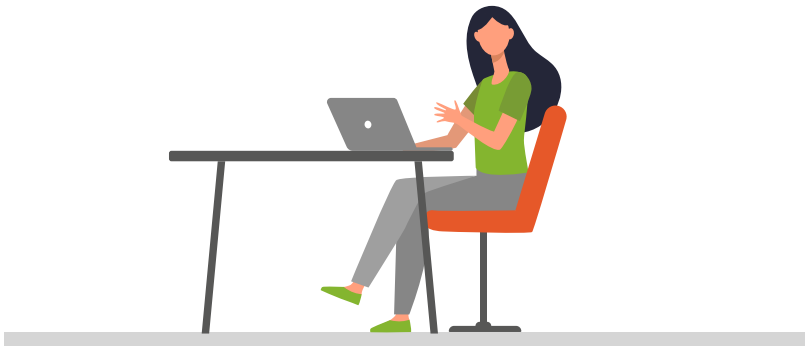
The order of the retrofit actions: Energy Efficiency First Principle

The European Commission formulated their Energy Efficiency First Principle in 2015 as one of the guiding principles of the EU energy policy to ensure a secure, sustainable, competitive and affordable energy supply. Since then, it has been reflected in a number of resolutions, proposals and directives. Energy Efficiency First serves not only as an overarching principle taken into account in the energy sector, but also across all end-use fields as well. While taking full account of supply security and market integration, it aims to ensure that only the energy really needed is produced, the investments in stranded assets are avoided, and the demand for energy becomes reduced and managed in a cost-effective way.

> **The cheapest and most environmentally friendly energy is the energy we do not use!**

For buildings, this principle implies the right order of measures to be applied in renovations. First, the structure's energy demand should be minimized. Only then should the technical systems (e.g. heating) be modernized followed by the use of renewable energy sources.

To achieve the best results, complex thinking is important. Renovation initiatives in multi-apartment buildings encompass a broad spectrum of enhancements that target energy efficiency, functionality, and sustainability. These efforts are critical for improving the overall quality of life for residents while reducing their buildings' environmental impact. The renovation process often commences with fundamental enhancements, such as improving the roof structure and insulation, always a crucial step aimed at preventing heat loss and enhancing thermal comfort while significantly reducing overall energy consumption. Additionally, renovation endeavors extend to encompassing a comprehensive scope of works. This includes the replacement of existing windows with more energy-efficient models, insulation upgrades in various elements such as the external envelope, roof, and basement ceiling, as well as the integration of passive heat protection measures like shading. Upgrading heating, ventilation, and air conditioning systems also remains essential for improved efficiency, involving renovations in the heating, hot water, and ventilation systems, along with the integration of cooling systems as needed.



Several challenges persist in this process, however, including financial disparities among co-owners, the necessity for consensus on renovation decisions, and a scarcity of specialists for documentation and execution. These challenges might lead to increased prices and demand during public calls for energy renovation, creating hurdles in achieving widespread renovations. To encourage a comprehensive approach to renovation, one that focuses on energy efficiency, safety, and overall building well-being, stands as a vital step towards sustainable upgrades in multi-apartment buildings. Collaboration among stakeholders, effective planning, and addressing financial barriers are crucial to ensure successful and widespread implementation of renovation initiatives.

Initiating the renovation process typically involves conducting a comprehensive energy audit to accurately assess the building's current state. Various tests, including air permeability and thermography, may be effectively conducted to evaluate the building's performance. Following the completion of detailed project documentation, renovation efforts commence, aiming at improved energy efficiency, heightened safety standards, and enhanced structural stability. Renovation projects are often executed comprehensively across entire buildings or neighborhoods to address diverse needs simultaneously. Throughout this renovation journey, condominium representatives and building managers play a pivotal role, providing essential support, coordinating project preparation and execution, and exploring critical financing options necessary for successful renovations.

The building's preservation tasks (building structure, infiltration, mould, etc.) form the basis for every energy renovation. The energy-efficient renovation process then involves THREE MAIN PARTS:

1

THE FIRST STEP IS RENOVATING THE EXTERNAL ENVELOPE TO REDUCE THE ENERGY DEMAND FOR HEATING AND COOLING.
This includes the thermal insulation of external walls, floors, roofs and attics as well as the replacement or modernization of doors and windows. It can also involve shading, eliminating thermal bridging and ensuring air-tightness (preventing heat loss through openings and gaps), and guaranteeing vapor transmission as well as winter-summer thermal comfort.

While modernizing the building's structure, it is recommended that the heating system be controllable, otherwise the building will become overheated. Only propose modernizing the building's structure if an automatic temperature control is already in place. If automatic temperature control has not been provided, it is recommended to install a central weather-dependent control mechanism at the heat generator, as well as a thermostatic valve on the radiators.

2

THE SECOND STEP INVOLVES THE RENOVATION OF TECHNICAL SYSTEMS SUCH AS HEATING, DOMESTIC HOT WATER, COOLING AND VENTILATION SYSTEMS, AND BUILT-IN LIGHTING.
Modernizing the technical equipment proceeds together with the renovation works of the building's structure. This means that boilers with a lower output and smaller heat transfer appliances could be sufficient, thus no oversizing occurs and the investment costs are lower.

The renovation works could involve implementing smart building management systems to efficiently monitor and control energy usage. Smart systems and building automation can optimize energy use, controlled based on demand. Managing these items ensures a healthy environment, good indoor air quality, a pathogen-free environment and occupant comfort in summer and winter, with low energy consumption.

Upgrading the lighting system is another essential aspect, focusing on improving energy efficiency and overall building functionality. It can generally be done independently of other works at any time, but it is advisable to coordinate improvements to the solar energy system and the lighting system.

3

THE THIRD STEP IS PRODUCING ENERGY FROM RENEWABLE SOURCES TO FULFIL A SIGNIFICANT PORTION OF THE BUILDING'S ENERGY NEEDS.
In all cases, it is important to explore renewable energy options. In multi-apartment buildings the most commonly considered options are the solar PV installations and heat pump systems.

Solar photovoltaic (PV) systems can offer several benefits in multi-apartment buildings, both for individual residents and the overall community, including environmental impact, cost savings, a degree of energy independence by generating electricity on-site, increased property value. It's important to note that the applicability of PV systems depends on many factors, such as available sunlight, local regulations, financial incentives, the specific energy needs of the building, or the availability of rooftop areas. As technology advances and costs decrease, the range of applications for solar PV continues to expand.

Heat pump systems are energy efficient at low heating temperature scales (e.g., 45/40°C or 40/35°C) and are therefore recommended for surface heating (floor, wall, ceiling) or fan-coil systems. For deep renovations, retrofitting the surface heating/cooling or resizing the heat transfer system to a low temperature scale is recommended.

Elements of deep energy renovation

Different countries define deep energy renovation of a building in different ways. It is associated with significant energy savings compared to the initial energy consumption measured before renovation. Due to the fact that deep renovation is associated with a large scope of measures, and thus high financial expenditures, it is often carried out in several stages, and an energy audit, on the basis of which the renovation project should be drawn up, will help to determine the sequence and course of the work.

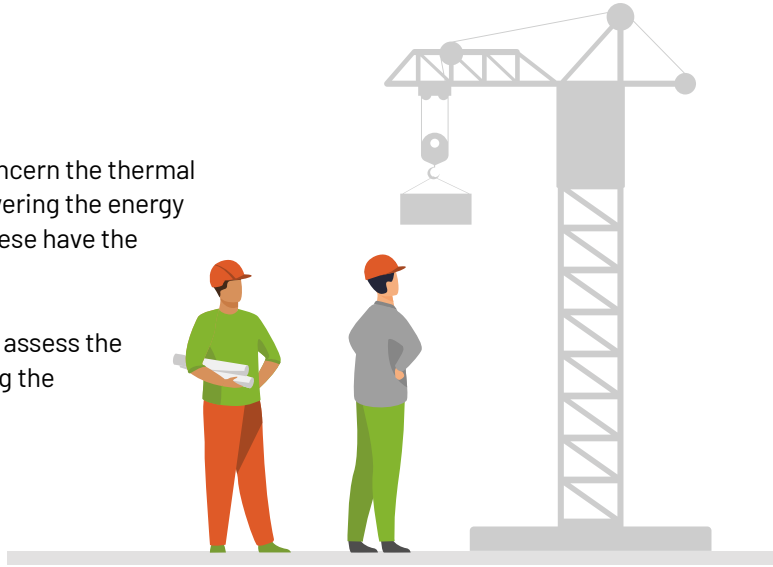
MANY FACTORS AFFECT A BUILDING'S ENERGY CONSUMPTION:

- insufficient insulation of the structure's exterior walls;
- insufficient insulation of the ceiling above the basement or the floor on the ground;
- insufficient ceiling insulation over the last heated floor;
- leakage of old window frames;
- a building's poor ventilation and low efficiency of its heating system;
- excessive losses in networks and installations;
- inability to regulate heat consumption.

It is therefore necessary for building managers, at the planning stage of energy renovation, to familiarize themselves with the national regulations and guidelines in order to choose the most optimal path of implementing renovation measures.

This chapter discusses the key elements that are subject to renovation in buildings, which have the greatest impact on energy savings.

Building envelope



Energy renovation decisions made by owners or facility managers of residential buildings predominantly concern the thermal insulation of the structure's envelope, eliminating or significantly reducing heat losses in the edifice and lowering the energy demand for heating. The most common partitions selected for renovation are the exterior walls, because these have the largest share of the entire building envelope's surface area.

Before deciding on the scope of the energy renovation works affecting external walls, it is first necessary to assess the technical condition of the wall to be insulated. The issues that should be taken into account when diagnosing the technical condition of an exterior wall are of an architectural, structural, and physical nature.

Insulating external walls improves the thermal insulation of the walls themselves as well as the entire building, including:

- Reducing heat losses resulting from heat transfer through external walls during periods of reduced external air temperature.
- Improving the microclimate of heated rooms – limiting heat loss in rooms by conduction, limiting the problem of cooling internal surfaces of insulated external walls (the impact of the partition on users by radiation).
- In the case of insulating walls from the outside – reducing the risk of surface and interlayer condensation.
- Increasing the thermal stability of the building, related to the thermal accumulation capacity of the insulated wall.
- Reducing the phenomenon of wall overheating during periods of increased outdoor air temperature.
- Reducing the heating expenses due to the building's reduced energy demand resulting from heat loss reduction.
- Improving the building's air tightness – it is necessary to remember the need to ensure the supply of outside air to the rooms in the presence of natural ventilation (e.g., installing ventilators in the windows, installing supply air vents in the walls). As a result of implementing works adjusting the ventilation system in connection with the insulation works (in compliance with legal and normative regulation requirements), ultimately the ventilation in the building should be verified taking into account the completed construction works.
- The possibility of reconstructing the heating system in the direction of replacing the existing heat source and devices transferring heat energy in heated rooms (such as radiators) with new ones of lower power.
- The need to perform warranty inspections of the insulation performed.
- Increased thermal accumulation capacity (if insulated from the outside).
- Shorter time to warm up rooms in winter (in the case of insulation from the inside).
- Improved wall aesthetics.
- Improved wall durability.

In most cases, external wall insulation is associated with the need to carry out accompanying works – such as the reconstruction of the rainwater drainage system (gutters, downpipes) and flashings (external windowsills, gutter belts, flashings over the edges of cornices, flashings of attic walls, etc.).

It should also be borne in mind that when, as a result of insulation, the demand for heating, hot water preparation or cooling is significantly reduced, the operation of heating (and other) systems should also be adjusted to meet the reduced needs. It is not beneficial when, after energy renovation, a building is still left with a twice oversized heating source, heat substation and pumps or an un-hydraulically adjusted heating system. Therefore, practically every time energy renovation measures are undertaken, a parallel effort should be made to adjust the operation of heating systems to the reduced heating needs.

In parallel with measures to reduce energy consumption, interventions should be implemented that make it possible to measure the achieved effects with the help of measuring devices.

When insulating exterior walls, it is important to remember to select the appropriate side of the insulation (from the outside or inside), as well as the method of insulation, including the appropriate materials used to perform the work; i.e.:

- The light-wet insulation method (also known as the ETICS from External Thermal Insulation Composite Systems), in which adhesive and adhesive-mortar mortars are responsible for the firm bonding of both the individual elements and the firm bonding of the thermal insulation layer to the substrate.
- The heavy-wet method, which has been superseded by the light-wet method, involves the use of heavy cement-lime plaster, 1.5-2.5 cm thick, and a steel reinforcing mesh made of rebar 4.5 mm, which is suspended from steel pins.
- The light-dry method is a technique in which no glue, mortar, and therefore no water, are used for the installation of insulation and finishing of building walls. All layers are mechanically fastened using screws, nails, or staples. The main thermal insulation material used in this method consists of mineral wool, but Styrofoam is also used.
- The "in-situ" insulation method involves forming the insulation layer at the construction site by blowing loose material into the insulated space or onto the insulated substrate, or spraying the material forming the insulation layer.

Although the insulation of exterior walls is the most common priority renovation measure, insulating the ceiling in the basement should also be remembered – if the building under renovation has one – or the foundations, as well as the roof or ceiling above the top floor.

Another important measure in the context of insulating the building envelope is to replace window and door frames with those that meet national requirements for the heat transfer factor (UC), taking into account the application of layered mounting, and not just foam sealing.

The finalization of external walls' insulation should be accompanied by a thermal imaging examination, in order to verify the quality and effects of the work performed, ideally at a time when the introduction of possible corrective measures after identifying thermal bridges will still be possible.

Building services

HEATING

Correctly chosen and designed heating systems improve thermal comfort, protect the building from damage, and reduce energy consumption. The heating system warms the space and prepares hot water, consisting of a heat generator (boiler, water heater, heat pump, district heating) and a piping system for heat transfer, along with heat transfer equipment (radiators, fan convectors, panel systems such as underfloor heating). Heat generators can be categorized based on energy efficiency, with the most efficient being ground source heat pumps, air source heat pumps, district heating, gas boilers with heat pumps/solar collectors, biomass boilers, heat substations, condensing boilers, solid fuel boilers, and non-condensing gas boilers. To further reduce the building's negative impact on the environment, it is essential to choose solutions offering lower PM10 particle emissions and without generating solid waste (an issue with using burned wood). The replacement of an existing atmospheric gas boiler with a heat pump is becoming increasingly popular, as the heat pump can be considered a renewable energy source (depending on its efficiency).

COOLING

As global temperatures rise and urbanization intensifies, the demand for effective cooling systems has become increasingly crucial. Cooling systems play a pivotal role in maintaining thermal comfort, especially in warmer regions, by removing excess heat from buildings and creating a more habitable environment. Beyond providing thermal comfort, cooling systems also safeguard buildings from the detrimental effects of heat and humidity. Excessive heat can lead to structural damage, material degradation, and the growth of mold and mildew. Efficient cooling systems help regulate indoor temperature and humidity levels, thereby protecting building integrity and extending its lifespan. Cooling systems are major energy consumers in buildings, accounting for a significant portion of overall energy consumption. Implementing energy-efficient cooling strategies can substantially reduce energy costs and lessen the environmental impact of buildings. This involves selecting energy-efficient cooling generators, optimizing system design, and adopting energy-saving practices such as proper thermostat settings and regular maintenance. A growing trend in retrofitting involves replacing traditional cooling systems with more sustainable alternatives, such as heat pumps. Heat pumps utilize a refrigeration cycle to transfer heat from a cooler source (air or ground) to a warmer source (indoor space), providing both heating and cooling capabilities. Their efficiency and potential classification as renewable energy sources make them an attractive option for sustainable building practices.

VENTILATION

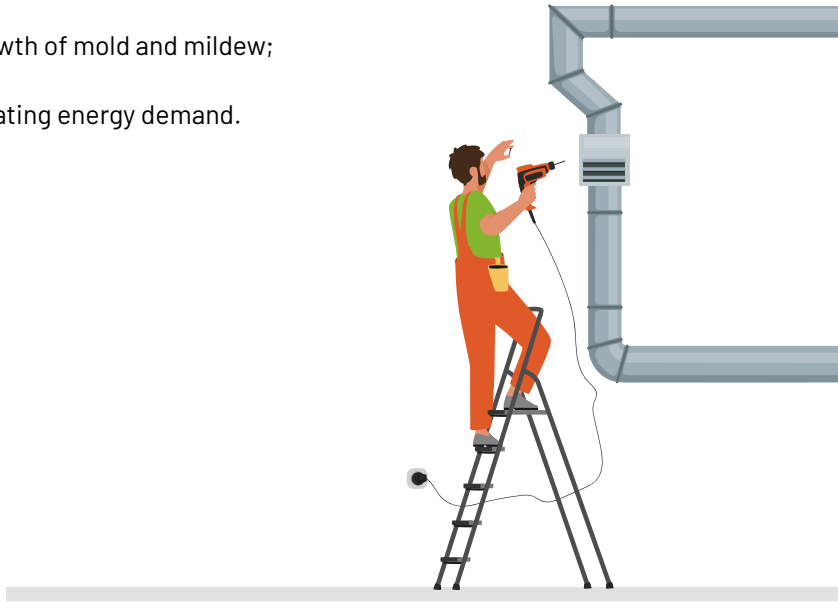
Residential buildings are equipped with natural or mechanical ventilation systems. Carrying out comprehensive energy renovation measures, which significantly improve the insulation of the envelope and a building's airtightness, directly affects the structure of the heat balance where the main contributor to the balance of heat losses are precisely the losses incurred from heating of the ventilation air by any heating system. A common situation, however, is the lack of adequate airflow in the rooms as a result of the exchange for airtight window frames not equipped with properly selected ventilators. Consequently, occupants stay in poorly ventilated rooms without ensuring adequate air quality, exposing themselves to negative health effects often referred to as the Sick Building Syndrome (SBS).

In order to ensure adequate comfort for users, effective ventilation remains essential, especially in rooms where people spend a lot of time – that is: also in houses and apartments. Properly selected for the given needs, the ventilation system not only provides a constant supply of fresh air, but also removes excessive moisture from the rooms, resulting from breathing, cooking, or bathing. Effective ventilation must guarantee fresh air regardless of weather conditions or season, and cover all rooms within the apartment.

At this point it should be emphasized that the requirements to be met by the ventilation system (e.g., the flow of ventilation air, or the size of vents) in the building are specified in national norms and regulations, so it is necessary to familiarize oneself with them, so as not to miss this extremely important aspect of ventilation in the course of the building's renovation.

A PROPER VENTILATION SYSTEM FOR APARTMENTS SHOULD:

- ✔ provide continuously adequate microclimate and good air quality;
- ✔ have an adjustable capacity; that is, the ability to increase or decrease the air flow according to current demand;
- ✔ prevent drafts;
- ✔ remove harmful substances and unpleasant odours from the rooms;
- ✔ inhibit the growth of mold and mildew;
- ✔ reduce the heating energy demand.



With this in mind, it is necessary to design and then implement an appropriate ventilation system. The basic types of ventilation used in multi-apartment housing are described below.

NATURAL VENTILATION

This is the most basic system of air exchange in apartments. The idea of this solution is based on the flow of air, forced by the active pressure in the ventilation channel, which depends on the difference in density between external and internal (heated) air and the height of the ventilation channel (from the position of the ventilation grille in the room to the top of the ventilation channel). Air movement is determined by the pressure difference caused by the action of wind on the building.

In order to maintain pressure balance, fresh outside air enters the building through leaks in doors or windows (called infiltration), as well as through window ventilators and wall grilles located under the windows. Radiators or underfloor heating warms up the air, which then circulates through the room.

The intensity of air exchange also depends on the strength of the wind (chimney caps are often used to reduce its impact or use it to assist ventilation) and on the height of the ventilation channels – the higher they are, the more efficiently the ventilation works. Heat losses are often higher than intended, based on nominal air flows.

Importantly, in the case of natural ventilation, we observe the lack of stable air exchange over time and the inability to influence its intensity, adjusted to current needs. At the same time, energy is wasted by removing heated ventilation air through ventilation channels.

MECHANICAL VENTILATION

In mechanical (also called forced) ventilation, the air exchange is due to the supply and/or exhaust ventilators, which gives building users the ability to control and steer the system. Mechanical ventilation is a much more effective system than natural ventilation but remains rarely used by builders. It consists of a channel ventilator, channels, exhaust vents located in rooms that require ventilation (bathrooms, kitchens, rooms without windows) and the exhaust vents of used air to the outside of the building, which are located in the exterior wall or roof (exhaust tile). It can exhibit different variations, depending on the method of air exchange, the direction of air movement in relation to the ventilated room, and the pressure difference between inside and outside the room.

There is a basic division of mechanical ventilation into:

- supply ventilation (the fan provides fresh air to the room);
- exhaust ventilation (the fan removes pollutants from the room and fresh air flows in naturally); and
- supply and exhaust ventilation (the system of supply and exhaust fans provides air flow in the room).

In modern multi-apartment buildings central mechanical ventilation is often used, with a central duct to which rooms from multiple apartments are connected. Such a solution is beneficial due to the small area occupied by the ventilation system. The proper functioning of the system, and the proper acoustic protection, as well as the elimination of odor transmission, requires continuous operation. As a result, in central installations using conventional roof or duct fans, a large amount of heated ventilation air is discharged to the outside, resulting in large energy losses. The disadvantages of this system are the difficulty to regulate the installation, low resistance to unauthorized interference by users during the operating period, and noise inside and outside the building.

The advantage of mechanical ventilation is a constant and efficient exchange of air; however, it is more expensive than natural ventilation.

MIXED-MODE VENTILATION

Using the advantages of both systems, more and more often a hybrid ventilation system is used in newly constructed residential buildings.

It is a hybrid solution that provides alternate system operation in both mechanical and natural ways. If the pressure stands too low due to atmospheric conditions, an exhaust ventilation system is switched on to improve the air flow. Special chimney caps (low-pressure fans) are mounted on the chimney, where the ventilation duct ends, and are connected to the control system. Mixed-mode ventilation ensures effective and required air exchange but generates heat losses due to the ejection of heated air to the outside, regardless of the momentary operation of the natural or mechanical system.

HYGRO-CONTROLLED VENTILATION

A more advanced solution – increasingly used in multi-apartment buildings – is the hygro-controlled ventilation system.

This system can be used in new as well as older buildings. It is based on adjusting the amount of fresh air to the apartment's current needs, and the indicator that determines the size of the supply and exhaust air flow is the relative humidity of the air in the rooms.

The system consists primarily of hygro-controlled diffusers located in the rooms, which allow the supply of outside air, and hygro-controlled exhaust or exhaust vents, mounted in the humid rooms (kitchen, bathroom and toilet), applied to regulate the amount of air removed.

Each element of this system reacts automatically and determines the air flow depending on the room's current needs, which is achieved by equipping the supply and exhaust elements with sensors consisting of a bundle of tapes made of polyamide. Under the influence of a change in humidity, the tape lengthens or shortens, then by means of a mechanical system this is translated into a movement that opens or closes the dampers, thus causing the flow of incoming air to enlarge or throttle. The minimum number of ventilators is one ventilator in each room and kitchen.

Hygro-regulated vents, placed into bathrooms, kitchens, and toilets, regulate the flow of exhausted air through their opening degree, on a similar basis as hygro-regulated diffusers in each of the mentioned rooms.

In summary, the solution characterized above works more effectively than natural or mechanical ventilation systems, thanks to the possibility of adjusting the air flow, and thus adapting it to current needs while minimizing heat loss.

SUPPLY AND EXHAUST VENTILATION WITH HEAT RECOVERY

The mechanical ventilation system with heat recovery provides the technical solution to controlling the airflow. Today it serves as the best, most effective and efficient system in terms of environment and economy, which provides better comfort for users compared to other ventilation systems.

It is a system successfully used in office or industrial structures, while still rare in multi-apartment buildings (although becoming more common in single-family homes).

The operation is similar to the mechanical ventilation system, expanded by a recuperator (heat exchanger) responsible for recovering heat from the air exhausted from the apartment. This ventilation allows a controlled flow of air: A recuperator removes used air and supplies fresh air. It uses the heat of the exhaust air to warm the outside air, which provides energy savings.

From the point of view of energy savings, a ventilation system with heat recovery reduces the heat loss from warming ventilation air by up to 50%, which translates into total energy savings of about 25% from heating and ventilation.

Renewable energy

The transition from fossil fuels to renewable and zero carbon alternatives in heating and cooling has been slower than in electricity generation. Currently, renewables contribute only 23% to the overall energy consumption in the heating and cooling sector according to Eurostat[20].

In the decarbonization of the construction sector, it is crucial to move away from fossil fuels. In this context, renewable energy sources (RES), which have gained great popularity in single-family residential buildings in recent years, serve an important function. Although RES solutions are not yet as popular in multi-apartment buildings, a number of solutions, both legislative and technological, are emerging that enable housing communities and cooperatives to take advantage of RES.

This chapter discusses the two most recommended and usable RES solutions in multi-apartment housing: photovoltaic systems (PV) and heat pumps.

[20] Eurostat (2021) Heating and cooling. Heating and cooling constitute around half of the EU energy consumption, European Commission https://energy.ec.europa.eu/topics/energy-efficiency/heating-and-cooling_en Last accessed: 17. January 2024.

PHOTOVOLTAIC INSTALLATIONS

Photovoltaic installations are devices that generate electricity from solar light, using the photoelectric phenomenon in semiconducting materials. Currently, the development of photovoltaics is very dynamic. The sun serves as the third largest source of renewable energy in the world; thus, solar energy can be used to power small portable devices, household appliances, lighting, traffic signals, as well as for space heating and water heating in residential buildings.

THE INSTALLATION CONSISTS OF SEVERAL COMPONENTS:

- PV panels connected to each other, located on a proper construction,
- inverter,
- cables,
- energy storage (optional) [21].

A photovoltaic installation can be mounted in various locations, such as on the roof of a building, on a facade, or on the ground, depending on the possibilities. However, it remains necessary to take into account its location relative to the sun and the angle of inclination. The crucial thing is to properly choose the power of the installation, so that it is not oversized.

As for the installation's operation, the interconnected PV panels produce direct current (DC), which the inverter converts into an alternating current (AC), the same as flows in the electrical outlet – which is used to power the building (in the first place) and to charge the energy storage (if any). The system should be tested on a quarter-hourly basis.

According to national regulations surplus energy produced can be returned to the electricity grid. Often energy suppliers are obliged to repurchase surplus energy, however the feed-in tariff might be unfavorable (only the energy price is reimbursed, not the system usage fee). It is worthwhile to learn about the possibilities in this regard in our own country. When designing a solar energy system, the annual production of the household-size solar power plant should be sized in such a way that the majority of its production is consumed.

It's also worth taking advantage of available national subsidy programs for photovoltaic installations.

Photovoltaic systems bring multiple benefits: financial savings (acquisition of electricity from a freely available natural source), as well as independence from rising energy prices, not to mention the benefits for the environment.

When deciding to install a photovoltaic system, it is important to remember to comply with safety requirements, including the load-bearing structure of the roof (if PV panels are mounted on it), or fire safety, as well as to perform periodic inspections of the electrical system, including the PV panels.

[21] Buderus (n.d.) Pompa ciepła: rodzaje [Heat pump: types]
https://www.buderus.com/pl/pl/informacje/pompy-ciepla/pompa-ciepla-rodzaje/ Last accessed: 18. January 2024

HEAT PUMPS

Heat pumps, while not as popular as PVs, are an excellent alternative to fossil fuel-powered heat sources. With the transition away from oil-, coal- and gas-fired heating appliances, they will provide – together with photovoltaic installations – a key service in the decarbonization of building resources. Heat pumps can be used for heating or for domestic hot water preparation.

Heat pumps use approximately 75% renewable energy from the air, water or ground for heating purposes. Types of heat pumps can be categorized by heat source. Energy for heating is obtained from:

GROUND: Used in cold and moderate climates, obtaining energy from collectors placed in the ground, characterized by high stability and efficiency.

AIR: Obtains energy from the air, without the need to install a bottom source, suitable for warmer climates where temperatures do not fall below 0°C.

WATER-BASED: The least frequently used, as it requires the construction of a well, or locating the investment near existing water reservoirs.

Types of heat pumps by temperature of the heating system:

LOW TEMPERATURE: Designed for surface heating installation (underfloor heating).

HIGH TEMPERATURE: Intended for buildings with existing heating installation in the form of traditional radiators[22].

Heat pumps are gaining popularity in modern single-family homes, however, their use in multi-apartment buildings is also possible. Annex 50. Heat Pumps in Multi-Family Buildings for Space Heating and Domestic Hot Water[23], developed by the Technology Collaboration Program on Heat Pumping Technologies (HPT TCP) outlines systemic solutions involving heat pumps in multi-apartment buildings, sorted by the level of system centralization. The publication is currently being supplemented with case studies from various countries, which are collected in Annex 62 Heat pumps for multi-family residential buildings in cities[24].

[22] Budaeus Polska (n.d.) Rodzaje pomp ciepła - warto je znać! [Types of heat pumps - it's worth knowing!] Buderus Polska Retrived from https://www.buderus.com/pl/pl/informacje/pompy-ciepla/pompa-ciepla-rodzaje/ Last accessed: 18. January 2024.
[23] IEA Heat Pumping Technologies (n.d.) Heat Pumps in Multi-Family Buildings for Space Heating and Domestic Hot Water (DHW) https://heatpumpingtechnologies.org/annex50/ Last accessed: 18. January 2024.
[24] IEA Heat Pumping Technologies (n.d.) Heat Pumps for Multi-Family Residential Buildings in Cities https://heatpumpingtechnologies.org/annex62/ Last accessed: 18. January 2024.

Energy certification and energy audit

ENERGY PERFORMANCE CERTIFICATION (EPC)

Determining and certifying the energy performance of buildings according to the legislation in force is a crucial step. The certificate consists of a validated certification form and the supporting energy calculation. The energy certification provides an idea of the building's expected energy level that proper operation can achieve, which also serves as the starting point for cost savings. The energy rating of the building is based on its current condition, which might be a legal obligation in many cases (e.g., when selling or renting a property) and a prerequisite for applying for funds.

In many countries a mandatory element of the certificate is a modernization proposal describing the measures to be taken to meet the requirements for major renovation or nZEB. However, this is only an element of a more elaborate consideration – the many tasks of design – that should cover safety, heritage, nature conservation, conservation, acoustics, fire protection and other design aspects. Also, it is recommended that a deeper assessment be conducted, which consists of the energy audit.

ENERGY AUDIT

Improving a building's energy efficiency requires a thorough analysis of the facility, a search for possible energy renovation improvements, and the evaluation and selection of proposed changes aimed at reducing energy consumption and operating costs. It is therefore necessary to carry out calculations for energy-economic optimization. A building energy audit is a study that covers all these activities - one necessary for the energy-efficient and economically viable energy renovation of a building.

National regulations contain requirements for handling heat protection issues in buildings; these requirements can vary significantly from country to country. Therefore, it is necessary to familiarize oneself with the applicable national regulations.

The basic requirements for a building's energy efficiency are the maximum values of the index of annual demand for non-renewable primary energy (PE index, expressed in kWh/m^{2}yr), and the heat transfer coefficients of the building envelope (UC, expressed in W/m^{2}K).

The analysis of energy and economic viability in the energy audit of a multifamily building is carried out on the basis of the building's calculated thermal needs. It takes into account both the annual demand for heating (for usable and final energy), as well as the heating power required in the building under so-called design conditions.

An energy audit serves as a useful tool, indicating which renovation measures should be carried out and in what order.

Energy renovation measures, resulting in savings in energy consumption and thus in energy related costs, can be divided into low-cost (sometimes practically no-cost) and high-cost measures.

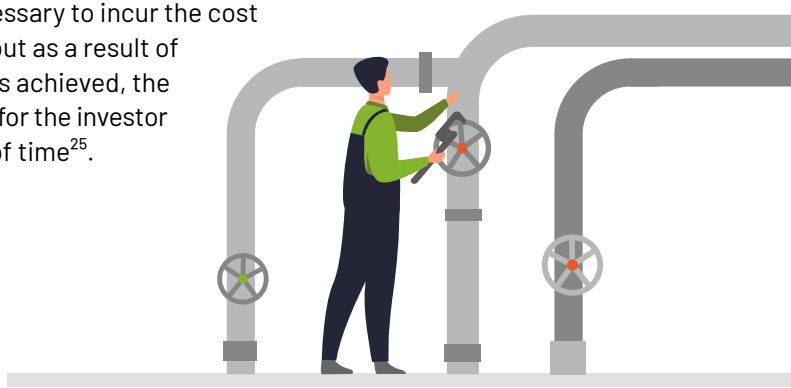
Low-cost measures carried out as part of inspections and the ongoing maintenance of the building and installations include:

- inspecting the building's technical condition in order to prevent excessive heat losses (prevention of moisture in the partitions, maintaining the air tightness of the partitions - roof, windows and doors);
- ongoing service and maintenance for components of technical equipment systems to ensure the proper functioning of elements responsible for heat loss and energy consumption (maintaining the proper quality of operation or replacing control and measurement components, control regarding the correct functioning of algorithms that regulate the operation of installations, eliminating leaks in internal installations, replacing or supplementing thermal insulation for pipelines and fittings of central heating and hot water installations);
- ongoing removal of faults and failures;
- installing automatic control equipment to optimize system operation ;
- installing equipment that makes it possible to calculate heating costs according to individual consumption in the apartments (i.e., heat meters or heat cost allocators),
- implementing the principles of energy-efficient use for apartments by educating residents and developing the habit for behaving in accordance with the principles of energy efficiency.

High-investment energy renovation measures, which require larger financial outlays – often made possible thanks to various types of loans and subsidies – should be carried out, since they garner much greater savings in energy consumption. High-investment measures include insulating the building's envelope, replacing windows and doors, modernizing central heating, hot water and ventilation systems, replacing the heat source, utilizing heat recovery, etc. The implementation of such measures requires an energy-economic analysis; i.e., performing an energy audit.

When carrying out high-cost energy renovation measures, it is important to make sure that the measures are ordered from the most to the least economically beneficial.

An energy audit, which the auditor performs, employs their technical and economic expertise on the use of energy in the building. It presents proposals for energy renovation measures that are expected to reduce the structure's energy consumption in an optimal way, and associated with it is also a reduction in energy costs. It is necessary to incur the cost of energy renovation, but as a result of the energy cost savings achieved, the investment will pay off for the investor after a certain period of time[25].



[25] "Jak skutecznie modernizować budynki wielorodzinne. Poradnik dla zarządców nieruchomości" pod red. PLGBC (s.37-68)

Building diagnostics

The fundamental component of building diagnostics is the energy audit discussed widely in the previous chapter. Other elements of building diagnostics, however, might also bear a significant impact on the quality of retrofit work performed.

Inspecting and assessing a building's technical condition[26]

Before any major building's renovation, it is extremely important to perform an assessment of the structure 's technical condition. Such an inspection will allow the detection of defects and an appropriate response in the form of remedial actions, including in establishing priority measures for renovation.

Building diagnostics is the testing of building structures, building services, and building electrical systems. Diagnostics of an existing structure should be carried out when its stability seems uncertain (cracks) or when a renovation is planned. The work starts with a preliminary site inspection in which the client explains what work he wants to carry out (e.g., adding a roof space, adding a full floor, building an extension, etc.). With this information, the expert will then explain the tests required and which of these are non-destructive and which involve damage. Building diagnostic tests may include strength tests (mechanical tests of load-bearing structures, windows and doors), building physics tests (effects on the interior and exterior spaces), and durability tests for corrosion, material, etc. (i.e., damage to the materials of the structures due to building physics).

In Poland, an opinion or expertise regarding the building's technical condition is required should the desire exist to interfere with the construction of the building (e.g., reconstructing a part of it). In addition, the legislation in Poland requires owners of all buildings to conduct periodic inspections of the technical condition every five years. These types of regulations may vary in different countries, so becoming familiar with the current legislation in the context of building regulations is extremely important.
Such inspections may include:

BUILDING ELEMENTS AND INSTALLATIONS EXPOSED TO HARMFUL ATMOSPHERIC INFLUENCES, SUCH AS:

- external layers of the building envelope (texture layer), external wall elements (attics, pillars, cornices), balustrades, loggias and balconies;
- equipment attached to the building's walls and roof;
- building drainage elements and flashings;
- roof coverings;
- central heating and hot water installations;
- devices that constitute the structure's fire protection;
- elements of the sewage system draining waste water from the building;
- passages of installation connections through the building's walls.

[26] https://www.gunb.gov.pl/strona/kontrole-stanu-technicznego-obiektow

Inspecting installations and equipment designed to protect the environment; e.g., installations and equipment that counteract the building's negative impact on the state of the environment and on humans' health: in particular, in terms of the introduction of gases or dust into the air, the introduction of sewage into the water or into the ground, causing noise, the generation of electromagnetic fields.

INSPECTING GAS INSTALLATIONS AND CHIMNEY FLUES, SUCH AS VERIFYING:

- the implementation of recommendations arising from the previous periodic inspection;
- changes to ducts and flue pipes that have been made with the consent of the building owner or manager in the period since the previous inspection;
- air permeability of the chimney ducts;
- the strength of the chimney draught, determined with an approved measuring device to ensure proper operation for the connected smoke, flue, ventilation devices;
- the presence of damage to the ducts along their entire length: ducts, flue pipes, flues, manholes, chimney benches, chimney cowls, etc.;
- the operation of well-functioning ventilation equipment, including supply and exhaust in rooms where heating appliances are installed (e.g., stoves, instantaneous water stoves, central heating boilers, etc.);
- frequency of periodic cleaning of chimney flues;
- convenient access to cleaning and carrying out periodic inspections of chimney flues and chimney-related equipment;
- the existence of other irregularities found during the inspection that may cause a threat to the safety of people or property.

It should be emphasized that there are also other building elements that should be inspected periodically, such as:

- building elements, structures and installations exposed to harmful atmospheric and other destructive agents occurring during the use of the object;
- a building's and its surroundings' aesthetics;
- installations and devices for environmental protection;
- gas installations and chimney flues;
- electrical and lightning protection installations.

If defects or irregularities are found, the property manager is required to implement appropriate measures.

With regard to the experts authorized to carry out periodic inspections, it is necessary to familiarize with the applicable national regulations which should define the qualifications and credentials that experts hired to perform inspections should have.

Thermal imaging tests[27]

Thermal imaging provides an effective tool for detecting hidden heat losses in a building. Thermal images of the whole building and of the structure's individual parts disclose energy problems. By providing accurate measurements, thermal imaging can also reveal insulation problems and the exact location of possible water and heating pipe leaks in walls/floors.

Thermography is a research method that involves visualizing, recording, and interpreting the temperature distributions of an object's surface. The temperature on the surface of the object is measured indirectly; that is, the thermograph measures the radiation that falls on the detector, and the detector converts the radiation into electrical signals proportional to its power. These signals are converted into an image on the thermal imaging camera screen. Then it can be viewed in real time but also saved as a graphic for further analysis.

Thermal imaging tests have a wide range of applications in the construction industry. First of all, they allow the verification of a building's quality and tightness. Thermal imaging of the thermal insulation of a structure's walls generally uses a qualitative approach, locating only the places with increased temperature and thus with excessive heat loss, without aiming to determine their exact temperature value. In the construction industry, thermal imaging tests are also used to determine whether window frames are seated correctly, to detect defects in underfloor heating, heating system obstructions and similar defects.

For the test to be reliable and feasible to carry out, the temperature difference between outside and inside the building should be at least 15°C. Low sunlight is also an important factor, so the best time to conduct the survey is during the autumn and winter months. The survey can be performed in two ways – from the building's outside and from its inside. The survey performed from the outside is quicker to carry out, does not require access to the interior of the structure and allows one to obtain an image of the building's entire facade on one or a few images, yet this method is characterized by much lower accuracy or sometimes complete inefficiency. On the other hand, measurements made from the inside of the building are much more accurate and effective, although they require much more effort, and therefore greater financial outlay.

Carrying out thermal imaging tests before a renovation makes it possible to accurately identify the places in the envelope with the highest heat transfer, thus facilitating the identification of the renovation measures to be prioritized. Carrying out thermal imaging during the renovation (e.g., after laying an insulating layer on the walls, but before finishing it with an external coating; during the installation of doors and windows) will allow the verification of the quality of the work performed and the possible implementation of corrective measures.

Low cost thermal imaging can greatly assist the decision making process for renovations, as it provides a very clear picture of the causes that are not visible. However, it is not a substitute for an energy calculation; it only provides additional information.

[27] https://www.rynekinstalacyjny.pl/artykul/projektowanie-c-o/35243,praktyczne-aspekty-stosowania-termografii-do-oceny-budynkow-i-instalacji-budowlanych

FINANCIAL ASPECTS OF ENERGY-EFFICIENT RENOVATION OF MULTI-APARTMENT BUILDINGS

Return-on-investment and other benefits

The high investment costs of energy renovations often raise the question regarding how long it will take to recoup the project's cost. Below, we would like to provide some considerations to complement the simple payback calculations.

Simple payback calculations often only take into account the investment value and the reduction in overheads. For example, solar panels typically have a lifespan of 25 years and a payback period of 5-8 years. On the other hand, the lifespan of thermal insulation can be up to 50 years, but the payback period is 35 years. However, it is worth considering that energy renovations also bring a number of benefits that are difficult to monetize, such as comfort, aesthetics, health and safety. The property's value may also increase, although this is rarely included in the payback period.

It is important to note that simple payback calculations are not always objective, as they do not take into account the lifespan and maintenance costs of individual renovation measures. The "energy efficiency first" principle emphasizes the need to reduce the heat demand of the building before modernizing heating or using renewable energy sources.

Continued reinforcements of energy performance requirements for buildings are expected. Waiting to comply with the requirements is not a profitable strategy, as it can easily make renovation costs even more expensive. A deep retrofit (i.e., renovation involving at least 25% of the total surface area of the bordering structures), also requires work items that might not have been planned in advance. These must be considered, however, and implemented when fulfilling certain requirements (for example in case of loans, tenders, or sale).

Own resources

RESERVE FUND, CROATIA

The Reserve Fund, as dedicated communal resources (as part of the property) among owners, plays a significant role in maintaining shared building components. Decisions to finance renovations from the Fund occur when the accumulated amount becomes substantial, or when residents opt not to await the next public call. This allows the autonomous initiation of refurbishment, complying with legal regulations and incorporating other measures. Owners agree upon the Reserve Fund's amount based on financial capabilities and communal area maintenance needs. A decision on the reserve per square meter of the net floor area is made by a majority of over half of all owners, and such a decision is binding for all owners. Therefore, it is recommended to start preparing for the renovation several years in advance in order to accumulate funds, and if needed, appropriately raise the monthly reserve.

RENOVATION FUND, HUNGARY

The Renovation Fund is an optional solution laid down in the Condominium Act. Although it is not mandatory, setting up a Renovation Fund has several advantages.

Most importantly, it is easier to save gradually than to pay the contribution to the investment all at once. Also, without the Renovation Fund, not all tenants would have the willingness to save. To ensure the Fund's stability, it is important to consider saving opportunities. The recommended amount varies by national investment costs. In Hungary, it is estimated that a 250-400 HUF/m² reserve is enough to start energy-efficiency improvements.

The Fund is usually a requirement for commercial loans (12 HUF/m²/year in Hungary in January 2024) and is very often required for grants and non-refundable resources. It also gives advantages at certain loans: when a Fund is existing beyond two years, the condominium can be entitled to a 70% interest subsidy for five years, 35% for six to ten subsequent years.

For a lump-sum payment, condominium owners in some countries are eligible to buy discount treasury bills. Also, to invest the monthly savings of a condominium, European banks offer building savings schemes.

Private financing, commercial loans

Financial aspects of energy-efficient renovation in multi-apartment buildings often serve a significant function in enabling and facilitating energy-efficient renovations, offering financial resources for building upgrades aimed at enhancing energy performance and sustainability. The initiative typically arises from owners, often triggered by available commercial loans or state co-financing, indicating a collaborative effort between owners, financial institutions, and/or government-supported programs to improve building conditions. Crucial criteria for decision-making include fund availability, low energy efficiency, and poor technical and energy states of buildings. Obtaining consensus among all owners, however, remains the greatest challenge, with unequal financial capabilities among owners and intergenerational gaps posing significant issues.

Elderly owners, in particular, struggle with substantial reserve fund increases for renovations, exacerbating their vulnerability to energy poverty. In this context, private financing options become crucial. Equity financing and debt financing from private sources provide essential funding avenues. Owners can opt for financing through private loans from banks. Commercial loans from financial institutions, ranging from term loans to lines of credit, provide upfront capital or flexible access to funds for renovation projects.

Challenges such as unexpected public calls with short deadlines causing temporary material price hikes, documentation costs, and execution expenses can hinder the renovation process. To mitigate these challenges, continuous calls, increased financial allocations, sustainable financial models with co-financed interest rates, and revenues from trading CO_2 emission units can be viable solutions. Encouraging condominium renovations by apartment owners, coupled with systematic energy consumption monitoring, ensures that renovations align with actual needs, thereby maximizing the effectiveness of the financial resources allocated to the renovation projects. Aligning public call conditions with relevant legislative acts is vital to foster a conducive environment for owners and institutional support, ensuring efficient implementation without market price disruptions.

EU, national, and local government financial mechanisms

To increase the rate and depth of energy renovation, and achieve the building stock's decarbonization by 2050, the financing aspects assume a key function. Through the Renovation Wave, including the Recovery and Resilience Facility, Cohesion Policy Funds and European Energy Efficiency Funds, all Member States are required (EPBD Article 2a.3) to actively facilitate access to financial mechanisms in order to support the mobilization of investments through using public funds to leverage private investments.

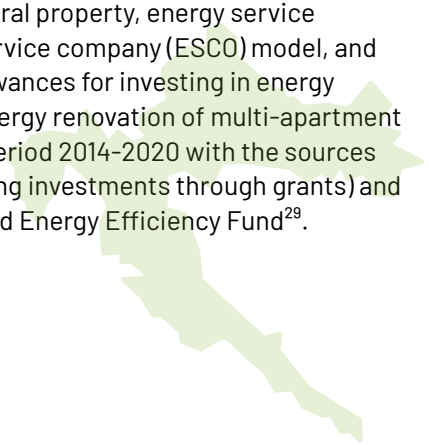
The most common types are non-refundable grants and subsidies, preferential loans, tax incentives, and energy taxation.

In Hungary, governmental non-refundable tenders targeted different types of buildings and segments, and the applicants had to have a share in accordance with the requirements of the relevant tender for the energy investment. Their own contribution was between 40% and 80%, depending, where applicable, on the total investment costs. Between 2014 and 2019, the public tender subsidies concerned approximately 315,000 apartments, representing almost 7% to 8% of the total number of dwellings.

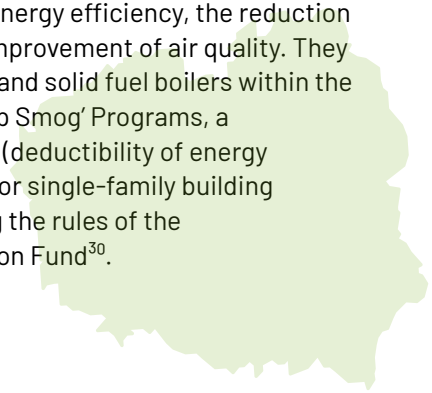
A loan program was also launched in 2017 to provide the necessary resources for the residential sector's energy investments in buildings with a view to increasing the energy efficiency and using renewable energy sources in residential buildings. The loan could also be -borne by a private person, a condominium or a housing association. Between 2017 and 2019, the preferential loan reached 10,630 homes and 60 multi-family apartments. Municipal grants also are available in many cities. Tenders are locally different and depend on the municipality's budget conditions. In general, cities commit in their Sustainable Energy and Climate Action Plans (SECAP) to help the renovation of the residential buildings as they represent the main source of CO_2 emissions. Where funding is available, typically 50-60% grants or interest-free loans are provided. Funds are allocated in the annual budgets, and are available until exhausted[28].

[28] 28 LTRS HU (2021)

Croatia's model of financing renovation relies on establishing financial instruments. The financing mechanisms include renovation funds for energy renovation projects implemented through European Structural and Investment Funds (ESIF) and development banks, long-term and sustainable loans and guarantees for public and private sector beneficiaries, implementing national energy renovation programs for buildings, a special support scheme to co-finance building energy renovation of buildings with the status of cultural property, energy service contracting under the energy service company (ESCO) model, and establishing a system of tax allowances for investing in energy renovation. A program for the energy renovation of multi-apartment buildings was launched for the period 2014-2020 with the sources of ESIF (ERDF) funds (co-financing investments through grants) and the Environmental Protection and Energy Efficiency Fund[29].



Poland is delivering comprehensive measures to support building renovation, which comprise legislative, planning, and organizational tools, as well as EU and domestic financial support. Bank Gospodarstwa Krajowego (with its Thermomodernization and Renovation Fund) and the National Fund for Environmental Protection and Water Management (and its 'Clean Air' Program) are the key financial mechanisms supporting building stock renovation efforts. In 2017-2020, a number of actions were initiated for the long term improvement of building energy efficiency, the reduction of greenhouse gas emissions, and improvement of air quality. They include requirements for solid fuels and solid fuel boilers within the framework of the 'Clean Air' and 'Stop Smog' Programs, a thermomodernization tax allowance (deductibility of energy renovation costs from the tax base for single-family building owners) and efforts towards revising the rules of the Thermomodernization and Renovation Fund[30].

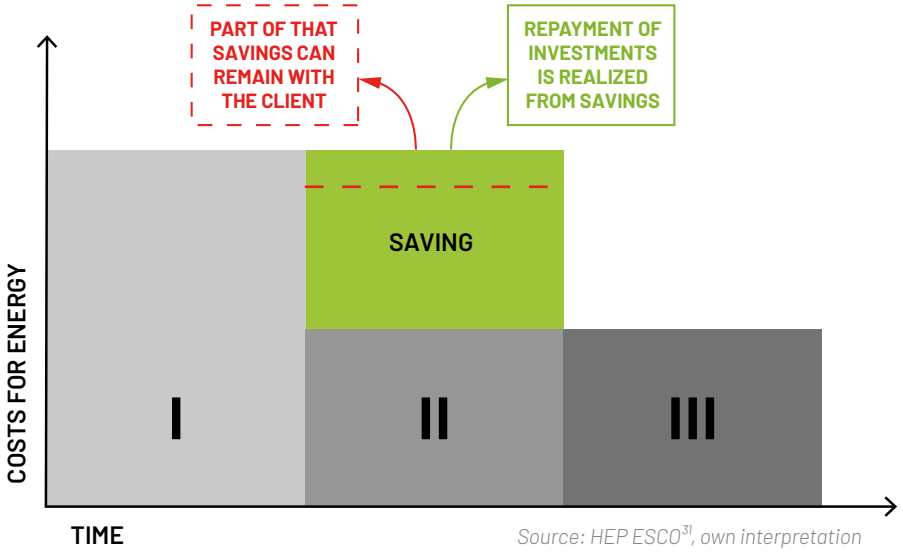


[29] Long-Term Strategy for National Building Stock Renovation by 2050, Republic of Croatia, Ministry of Physical Planning, Construction and State Assets, 2020.
[30] Long-Term Building Renovation Strategy – Supporting renovation of the national building stock, Annex to Cabinet Resolution No 23/2022 of 9 February 2022.

Innovative financing schemes

In addition to grants and loans, other innovative financing options exist. These typically involve private market actors – third parties – to finance part or all of the initial costs of energy efficiency improvement projects.

One type is the Energy Performance Contracting (EPC), where an energy service company (ESCO) carries out energy upgrades under a contract with guaranteed energy savings. Another market-based mechanism is the Energy Efficiency Obligation Scheme (EEO), where energy service providers and traders are required to achieve a prescribed amount of energy savings per year for the end-user. In some European countries – including Hungary – energy-efficiency results of building energy renovation works can be included in EEO. Although their application is limited at present, they could play a greater role in the future, especially in larger projects.



Source: HEP ESCO[31], own interpretation

Energy Service Company (ESCO)

The Energy Service Company (ESCO) model is implemented by companies that provide energy services. In this model, the service involves developing an energy renovation project, managing the project, and financing it on a "turnkey" basis. The ESCO company invests funds in the project and recovers its investment through monthly/annual savings achieved in the building due to reduced energy consumption. This means the savings that are realized repay the investment.

During the repayment of the investment for energy efficiency measures and renewable energy sources, the client pays an amount equal to what was previously allocated for energy costs. However, after the implementation of the measures, this amount is divided between the energy cost and the investment repayment cost (the saved amount). After the repayment, the savings obtained from reduced energy costs remain with the client.

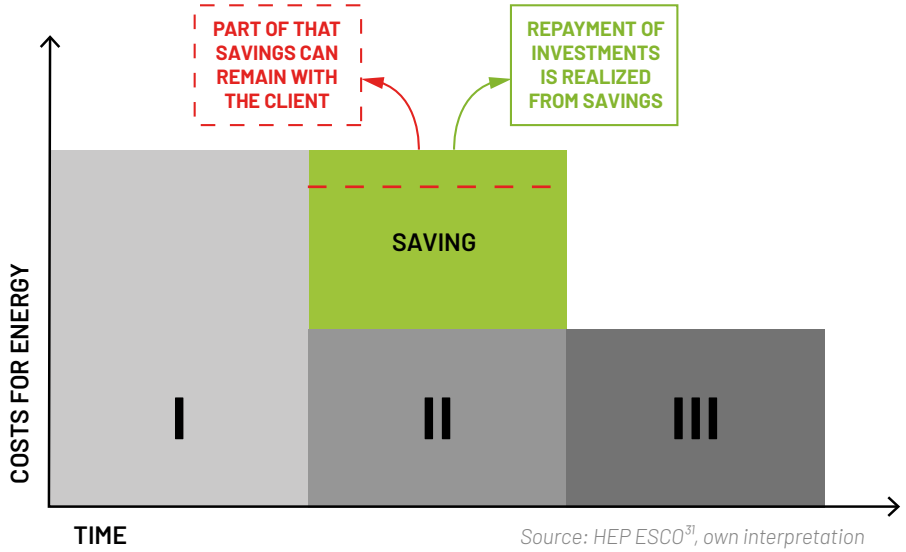
[31] HEP ESCO (n.d.) Deployment of energy efficient services Retrieved from https://www.hep.hr/esco/esco-model/1395 Last accessed: 18. January 2024.

CROATIA

At present, ESCO firms face several obstacles and risks, and the ESCO market in the multi-apartment building sector in Croatia remains underdeveloped, which means that this financing model is not available for building co-owners. However, the Ministry of Physical Planning, Construction, and State Property (MPGI) and the Croatian State Agency for Housing Loans (APN) are working on developing a specific model that will cater to multi-apartment buildings. The challenges include an extended return on investment (over 15 years) and a more complex combination of non-refundable EU funds and the ESCO financing model to ensure that projects have a shorter investment payback period and are appealing to ESCO firms.

HUNGARY

Currently, high interest rates and unpredictable energy prices result in very few cases under ESCO schemes; especially, deep renovations are rare. Heating modernizations, however, become more often financed under this scheme. In this measure, the new heating equipment remains the property of the ESCO provider for the payback time, which model cannot be applied to building envelope projects.



Source: HEP ESCO[31], own interpretation

[31] HEP ESCO (n.d.) Deployment of energy efficient services Retrieved from https://www.hep.hr/esco/en/ Last accessed: 18. January 2024.

Energy efficiency obligation scheme: Hungary

The Energy Efficiency Obligation Scheme (EEO) is a stable, long-term option for raising funds for energy-efficient multi-apartment building renovations. The EEO is a market-based mechanism that obliges designated energy market stakeholders to achieve a certain level of energy savings for end-users in proportion to their energy sales. Under the EEO scheme, a private loan usually finances the investment and the proceeds of the EEO financing are used to prepay the loan.

Introduced in Hungary in 2021, experience from projects implemented since then shows that most of the savings have been achieved by obligated parties in the corporate/industrial sector, with residential building renovation projects generating less than 1%savings. The main reason is that industrial projects are larger in size, single ownership, and involve less administration in terms of savings achieved. The energy savings must be verified by an energy auditor before and after the retrofit. According to the data from energy auditors, savings of 10-15 GJ/apartment can be achieved for a condominium, which is negligible compared to the savings generated by industrial projects. However, a larger condominium with 100-200 apartments – like post-war prefabricated housing – provides a type for attracting funds through EEO.

The Hungarian Energy and Utility Regulatory Office (MEKH) records energy savings. A catalogue sheet for condominium renovations has been developed to facilitate the accounting of savings from condominium renovations. According to the catalogue, the thermal envelope must be renovated first (insulation + replacement of windows and doors), followed by heating modernization.

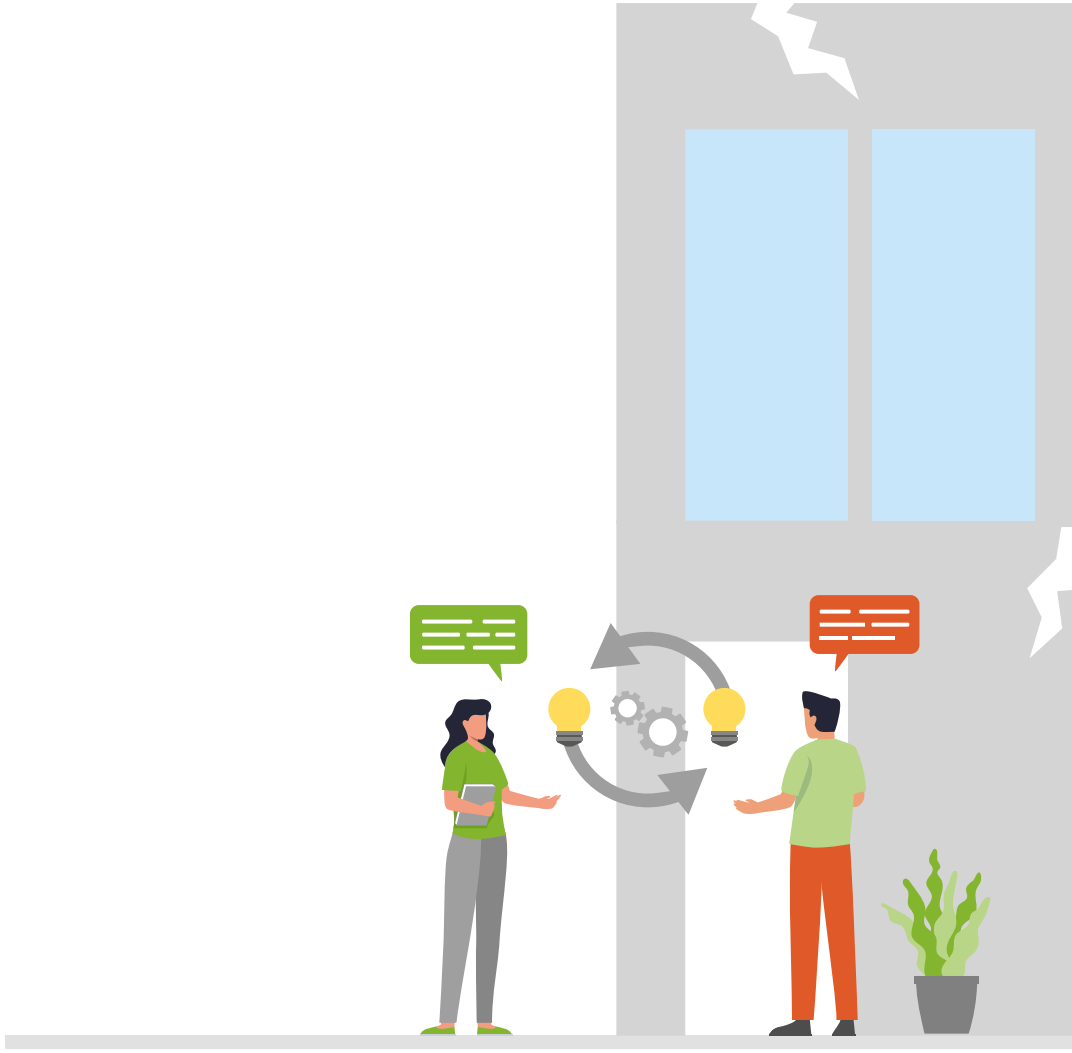
At present, the condominium renovations with the mobilization of resources through the EEO are sporadic. There are many uncertainties about the new system and a general lack of information. Generally, projects well prepared by the largest general contractors are able to access such funding because they are in contact with auditors who undertake energy auditing for condominiums.

PLANNING FOR ENERGY-EFFICIENT RETROFIT – THE DECISION-MAKING PROCESS

The renovation process

The planning for energy-efficient retrofit constitutes a multifaceted process that involves continuous assessment, adaptation to changing conditions, collaboration among stakeholders, and ongoing optimization. It goes beyond a singular task, requiring a holistic and iterative approach to address the complexities associated with retrofitting existing buildings.

The methodological recommendations outline long-term, step-by-step renovation tasks for implementing a deep renovation of a multi-apartment building. It addresses the complexity of the renovation works and ensures coordination of individual and community decisions and subtasks as well as the different stages of their implementation.



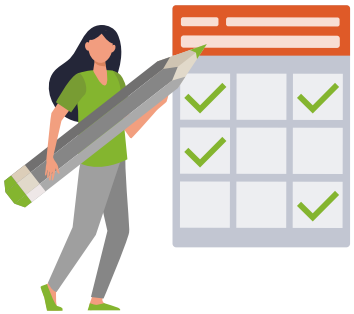
Flowchart: Croatia

To successfully renovate a multi-apartment building for energy efficiency, proper preparation is necessary. The RetrofitHUB project has identified the need for a flowchart of activities to achieve the desired results. This flowchart aims to provide co-owners, property managers, and other stakeholders with a clear idea about the steps required to carry out the energy renovation of the multi-apartment building.

THE RENOVATION FLOWCHART INVOLVES THE FOLLOWING STEPS:

1 A condominium representative should contact the facility manager for information about the measures and prerequisites for implementing the energy renovation interventions and assess the possible costs and available public calls for renovation co-financing and loan options.

2 The condominium representative should organize a meeting with the building co-owners to inform them about the building's energy renovation. They should initiate the creation of a project task including energy renovation measures that co-owners can/want to implement.



3 The condominium representative, together with the facility manager, should draft a decision to initiate energy renovation and collect the co-owners' consent by gathering signatures.

4 Based on the co-owners' decision, the condominium representative should initiate the process of engaging and preparing the project documentation required for the execution of works and potential application for co-financing models.

5 After preparing project documentation, it is advisable to present technical solutions covered by the documentation to all co-owners, as well as other necessary segments of documentation, to avoid delays in works on individual co-owner shares.

6 Application for one of the co-financing models.

7 Ensure the co-owner's own participation (if additional insurance beyond already accumulated common reserve funds is insufficient to cover the co-owners' own participation) and open a separate building account for the project's co-financing needs.

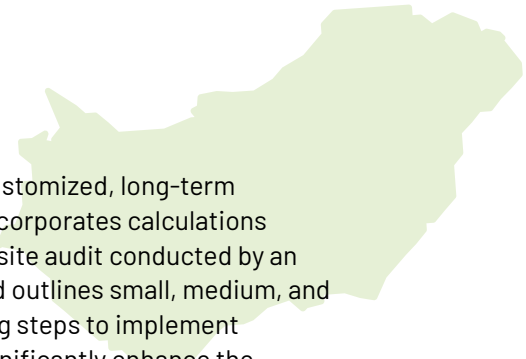
8 Selection of contractors and a supervising engineer.

9 Execution of works.

10 Maintenance of the effects produced by the completed energy renovation.

It is recommended to form a group within the co-ownership community that oversees the entire energy renovation process, considering that the process and works represent extraordinary, demanding, and responsible activities yielding long-term effects.

Building renovation roadmap: Hungary



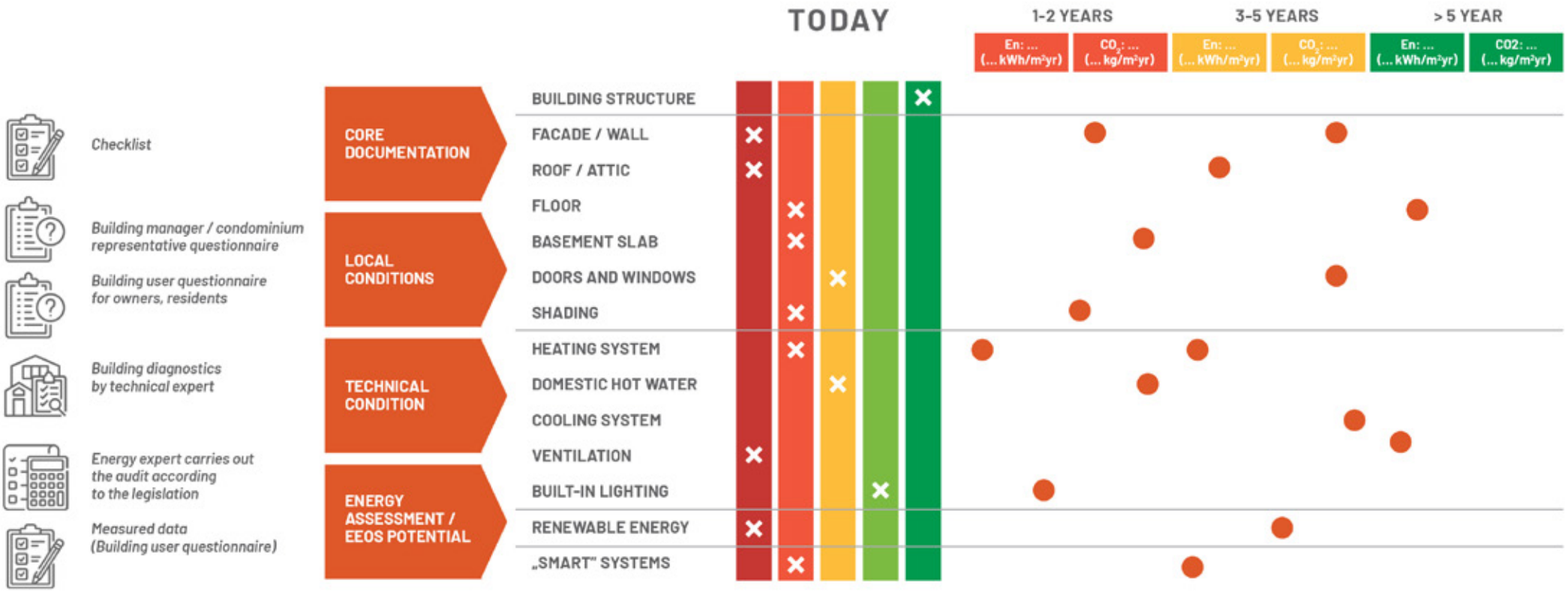
The building renovation roadmap is a methodological recommendation for the deep renovation process. It outlines a long-term, step-by-step renovation plan for the deep renovation implementation of a condominium. It addresses the complexity of the renovation works and ensures coordination regarding individual and community decisions, subtasks and the different stages of their implementation.

The building renovation roadmap provides the condominium owners with a long-term, tailor-made renovation schedule. It includes calculations based on available data and/or an on-site audit by an energy expert. The tool identifies and outlines small, medium, and deep renovation scenarios. It includes steps to implement energy saving measures that can improve the building's energy performance to significantly higher levels over a defined period of time. The roadmap also explores the links between common and individual renovation elements. A longer-term decision or agreement to renovate the whole building will prioritize other types of modernization tasks in the near future.

Providing the condominium with a customized, long-term renovation schedule, the roadmap incorporates calculations derived from available data or an on-site audit conducted by an energy expert. The tool identifies and outlines small, medium, and deep renovation scenarios, proposing steps to implement energy-saving measures that can significantly enhance the building's energy performance over a defined period.

Moreover, the roadmap delves into the interconnectedness of shared and individual renovation elements. In the event of a longer-term decision or consensus to renovate the entire building, the roadmap prioritizes other types of modernization tasks in the near future. This approach ensures a holistic approach to building renovation, considering both immediate and future needs in a coordinated manner.

BUILDING RENOVATION ROADMAP: HUNGARY



PRELIMINARY DOCUMENTATION, LOCAL CONDITIONS, TECHNICAL AND ENERGY ASSESSMENT

STATUS QUO ASSESSMENT TECHNICAL AND ENERGY AUDIT

What level do we want to get to with each element contributing to energy efficiency?
What are the financial means and possibilities to achieve it?
What decisions are needed to achieve it?
Which stakeholders are needed to be involved (e.g. experts, contractors, technical inspectors, etc.) beyond the owners and condominium community?
How the differences of ownership interests can be managed?

While the aim is to achieve a deep renovation by 2050, in most cases no financial budget is available to carry out heat insulation, door and window replacement, and heating modernization at the same time. It is important that the contractors carry out the implementation of the individual elements in a planned way, following successive steps. This is ideally included in an energy efficiency renovation roadmap developed in consultation with an expert (energy auditor).

In the roadmap, the condominium owners can evaluate customized proposals for renovation options, speeding up the path towards deep renovation. Steps:

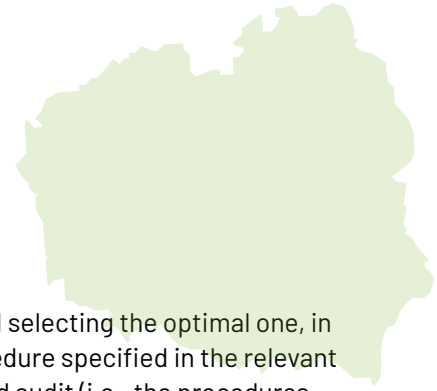
- Where are we now? (Situation assessment)
- What is a zero emission building? (Long-term outcome, status)
- How do we get to implementation?
  - What are the owners' motivations?
  - The order of technical content?
  - What must be implemented collectively and what can be done individually?
  - What are the costs and benefits of the renovation steps? What are our financing options?
- Decision-preparation documentation / Decision

Energy audit as a roadmap: Poland

The energy audit can be considered as a roadmap based on which the project of building energy renovation is developed; it should be emphasized that an audit is not a technical documentation for implemented construction works.

THE ENERGY AUDIT SHOULD PROVIDE ANSWERS TO THE FOLLOWING QUESTIONS:

- What improvements should be made to achieve financial and energy-related benefits?
- How to perform the improvements – indication of possible technical solutions, types of materials and equipment, and determining the implementation sequence of individual actions?
- What will be the cost of energy renovation and the amount of economic effects (payback time, cost-effectiveness of energy renovation), energy effects (percentage reduction in energy consumption, the building's energy consumption indicators) and environmental effects (reduction in the amount of pollutants introduced into the environment)?
- How to finance energy renovation, what is the profitability of using the various loans and subsidies available?



IT IS POSSIBLE TO DISTINGUISH SEVERAL SUCCESSIVE STAGES OF A PROPERLY CONDUCTED ENERGY AUDIT:

1. Defining the purpose for which the audit is performed (most often the purpose involves reducing energy consumption and obtaining financing for energy renovation in accordance with the law or a support program).
2. Collecting data about the facility (this is a very important stage of the audit involving the analysis of the existing documentation of the building and installations, as well as a field visit to the facility to confirm the validity regarding the existing project documentation and collect missing data).
3. Analyzing and evaluating the existing condition (based on the collected information about the facility, ' the condition of the existing building and its technical equipment systems is evaluated).
4. Searching for and formulating possible alternative solutions (based on analyzing the existing state, selecting individual energy renovation measures carried out and formulating energy renovation scenarios consisting of the improvement sets is carried out; the scenarios must take into account any technical possibilities in the existing building and all possible limitations).
5. Evaluating alternative solutions and selecting the optimal one, in accordance with the required procedure specified in the relevant regulations related to the performed audit (i.e., the procedures specify the manner of formulating variants and the profitability criteria used, as well as other guidelines, such as those for calculating emissions of harmful substances into the environment).
6. Developing the audit, or report, in accordance with the guidelines of the given support program.
7. The next step involves handing over the audit to the investor. It is important that the auditor also provides information on the order of proceeding with the implementation of energy renovation, as well as on the types of projects that the investor must commission – taking into account the guidelines given in the audit.
8. After the energy renovation is completed, it would be very useful for the auditor's experience to evaluate the effects recommended in the audit improvements 's implementation one year after the energy renovation's execution, or even in the following years. However, auditors do not often practice such activities, as they are not legally required.[32]

[32] "Jak skutecznie modernizować budynki wielorodzinne. Poradnik dla zarządców nieruchomości" pod red. PLGBC (s.37-68)

Owners as a community, as a forum for decision-making

Condominiums and housing associations can be considered as communities wherein the common issues arising within the owners' sphere of interest are generally in line with the interests of the common ownership. The preparation, as well as the rational and meaningful making of joint decisions, can only be addressed once these common interests have been identified. The conflicts and disinterest that residents experience are largely the result of repeated conflicts of interest. This chapter aims to ensure that the results of collective decisions are progressive both on the level of individual residents and the community.

COMMUNITY PLANNING METHODOLOGY

One of the most common explanations given for the lack of real social dialogue cites the disinterest of the public who can be characterized as passive and disillusioned. Another one is that the decision-makers perceive resident involvement as another effort and risk.

However, another, seemingly obvious argument exists, according to which the 21st century citizen does not really want to identify with anything (hereinafter referred to with the often-used word, 'involved'), and does not wish to be consulted. Rather, they empower the "decision-maker" to make a decision for them.

As such, three types of condominium governance can be distinguished: participatory, representative, and expert-based.

In participatory governance, citizens are regularly involved in decision-making, while in representative governance, the members of the housing association delegate this power and remain in the background.

WHY IS IT WORTHWHILE TO MOBILIZE THE COMMUNITY?

According to Putnam, community cooperation and its forms (such as community planning) are based on the recognition by participants that their short-term altruism can serve their long-term self-interests[33]. We can be sure that participation signals or at least suggests a desire to have a direct input.
But what can be done to achieve a more satisfying harmony in everyday circumstances? Do we have the means for the community or communities and the individuals they are composed of to engage in forward-thinking activity through balanced engagement?
Community involvement and group thinking within a thematic framework requires resources. It requires self-organization and patience from residents, but it also leads to more effective decisions (i.e., identifying with decisions, insight, and ownership). The benefits are definitely greater than the dedicated energy.

HOW DOES PLANNING BECOME COMMUNITY PLANNING?

Taking responsibility, expressing oneself, openly revealing one's interests to others in a specific place and under specific circumstances offer no guarantee that a common outcome will emerge. In order to turn this into the proper direction, formal conditions are needed. This is where a trusted facilitator has a significant role to play, who can be a resident with skills, a residents' representative, or even a trained facilitator.

If common goals and priorities are identified as part of the community planning process, the experience and knowledge of the community members are usually put to good use.

[33] Putnam, R. D. (1995) Bowling Alone: America's Declining Social Capital, Journal of Democracy 6(1), 65-78. https://doi.org/10.1353/jod.1995.0002 Last accessed: 18. January 2024.

Should the preparation, implementation and aftermath of the projects create continuity, then a chain of interlinked projects can be created with this approach.

Participatory design involves a complex, multi-stakeholder process. When done well, the project and the stakeholders involved can benefit from it in many ways.

At the beginning of a planning process, it is usual to face that the ideal conditions for participatory planning are not present (e.g., not enough time, unclear objectives, not all stakeholders want to address local society in the same way, etc.). In fact, there is almost never an ideal situation. Therefore, the realistic prospects for engagement and collaboration in a given specific situation should be assessed by looking for the potential success factors. It is very important to communicate honestly about this, as excessive expectations lead to disappointment, whereas cooperation can only be sustained through success[34].

The way one is invited has a huge impact on the outcome of the assembly. On the one hand, it determines how many people will come, but it also has an impact on who shall attend the event, as well as the expectations and attitudes they bring.

PRINCIPLES OF COMMUNITY MEDIATION[35]:

- Participants are in partnership throughout the project.
- Everyone's opinion counts: the mediator maintains a balance of power and encourages the expression of opinions during discussions (methodological tools are discussed later).
- The principle of "I have the right to speak my mind and I have the right to be heard" is applied, there are no right or wrong questions or comments.
- Mutual respect as part of the ground rules.
- Commitment to the participants, to the work, to the topic and to the common goals.

If you want to have a large number of participants exhibiting a positive and constructive attitude, the invitation must be designed accordingly. The following points may help you to prepare your invitation:

- Various marketing tools (design, logos, project identity, etc.) have a big influence on the target group we are able to reach. It is therefore important that the appearance remains in line with the forum's theme. To reach a more informal, family-oriented target audience, the invitation can also be more playful, colorful, and creative.
- It is good if the invitation draws attention to itself with a short, slogan-like title, but also makes clear what it is about.
- It is important that the community to be invited feels addressed. Use the imperative form therefore in communicating; i.e.: "Get to know the latest plans! Give us your opinion!"
- The invitation should indicate the web address where detailed information is available.

[34] Sain M. (2017) Az Urban Agenda és a magyar városok szükségletei [The Urban Agenda and the needs of Hungarian cities], URBACT III. Program Nemzeti Tájékoztatási Pont Magyarország [URBACT III Programme National Information Point Hungary]

[35] Ferik, T. (2014) Konfliktuskezelési, mediációs módszerek alkalmazása a településfejlesztésben [Application of conflict management and mediation methods in settlement development], Völgyzugoly Műhely. http://vzm.hu/letoltes/konfliktuskezeles_mediacio_a_telepulesfejlesztesben.pdf Last accessed: 17. January 2024.

A printed paper invitation posted to the right place is still an effective way of inviting people, but it is also worth using electronic platforms and communication channels (especially social networking sites). However, given the different internet skills of residents and the way social networking sites are being used, we cannot rely on having posted the event on Facebook.

Concerning invitations, a personal invitation remains particularly effective and provides a very personal experience for both the inviter and the invitees. It is obviously time-consuming, but having the residents' representative or "active residents" contact the people on the phone list can be an effective way to address key people.

Community planning tools

There are many types of tools available, but the common features of the most effective tools for condominiums are:

- publicity, which includes not only information but also means of communication that require reciprocal responses;
- organization, mainly organizational, governance and regulatory framework issues;
- integrating the community will into the process of conceptualization by involvement in the different stages of design (project idea, project goal, planning, design);
- community action, dissolving homogeneity, which may have been perceived on a larger scale or incorrectly in the initial phase, in order to create a community, activate and strengthen it;
- social programmes: meetings that respond to emerging issues in a complex way and provide more of a community experience.

If you want to organize the residents' meeting or general assembly as a forum-type discussion, you can create a constructive atmosphere right from the preparation stage. Preparing for a community meeting involves fixing the right date and venue, setting up the room and planning the programme. All of these factors can have a significant impact on the effectiveness of the meeting and all need to be tailored to the objectives and target groups of the meeting.

The main criterion for choosing the time is, of course, which period serves as the most appropriate for the target group to be involved. Most people are usually available after working hours on weekdays. In such cases, the forum (residents' meeting, general assembly) can last around one and a half to two hours, possibly leaving room for further discussion after the formal closure.

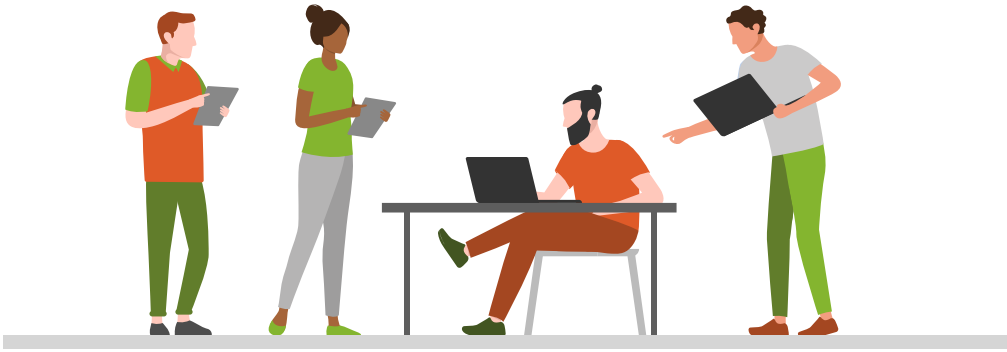
Several factors exist when considering choosing a room. It is important that the size accommodates the expected or estimated number of attendees. It is also important that it remains easily accessible to the target group.

If possible, choose a room that is comfortable for as many people as possible, and where people feel at home. This can have a big impact on the atmosphere, the relaxedness, and the openness of the participants. The ceremonial hall of the local government is more associated with solemnity or the image of an official hierarchy, while the hall of the community center, for example, is associated with social experiences and informal encounters.

You can also make a big difference to the atmosphere of the forum by the way you set up the room. While a frontally arranged table with white tablecloths on a lectern creates an atmosphere of revelation and announcement, the chairs arranged in a circle encourage equal conversation between peers (see: Circle Way).

It is highly recommended to create opportunities for public note-taking, for example by using a flipchart or a projected screen.

A blank sheet of paper on the flipchart or a paper with a matching question serve also as a kind of symbolic invitation for participants to share their suggestions.



BRAINSTORMING AND ITS VARIANTS

This is the most basic tool for community planning; it can be used to gather as many ideas as possible in a group as quickly as possible, and with the active participation of all group members. It is often used as a first step in a meeting, where we can then continue working together using other methods.

Essentially, the two ways of doing the brainstorming are card deck and mind mapping.

The card deck (ideas written on post-it notes) is one of the most effective and widely used workshop methods, as many ideas can be quickly collected and organized to help interpretation.

Mind mapping aims to collect and organize information quickly with a minimum of tools. It's a good way to ensure that all aspects of a complex situation are considered, while allowing for creativity alongside linear thinking.

THE WORLD-CAFÉ METHOD

For larger meetings (with 20-50 people), we cannot use the brainstorming methods unless we form several small groups working in parallel. However, this requires a much greater facilitation capacity and, in addition, the participants will only partially find out about each other's positions.

The World Café method was invented for events with a larger number of people. The technique is to organize parallel discussion groups at several tables around different topics related to the table, but the people at the tables rotate at set intervals.

CIRCLE WAY

The Circle Way method is all about presence, participation, empowerment, self-control, quality conversation and effective leadership. The circle as a supporting wall holds the conversation together. Participants become peers, attuned to each other, listening to each other, thinking together.

The method is generally applicable when and where relationships or processes between individuals need to be made more collaborative, serious, and creative (e.g., in the case of change, consensual decision-making).

The circular format ensures equal eye- level and everyone is equally responsible for the conversation and the results. The minimum number of participants is five persons; max. runs between 30–40 persons.

THE FOLLOWING ASPECTS CAN CONTRIBUTE TO THESE METHODOLOGIES' EFFECTIVENESS:

- Formulating a goal; to make efficient progress, The community's near unanimous decision will be needed, this importantly serves not only for legal compliance but also for strengthening community cooperation.
- The partnership of community-empowered condominium managers remains perhaps one of the most difficult issues to address in the methodology, because most of them do not possess the necessary facilitation or conflict management skills.
- Extensive and good preparation, achieved through elaborating general information (sensitization) and presentations.
- The wording of the invitations and the way they were delivered is significant because the more personal they are, the more effective they are.
- Remember to involve local "opinion leaders" in the preparation.
- Preparation of pre-decision studies, interpretation, documentation, extraction and presentation of expert materials.
- Coordinating and setting up the logic of decision points.
- Choice of the venue (suitable room, nearby school or community classroom with chairs and tables).
- Setting the time frame for a meeting at the time of invitation. In the preparation phase, draw up a schedule that sets out what is planned and when. Later, actors who try to rush the process could be reminded of this.
- Organizing a residents' meeting in a "World Café" style or with other methods means it is a moderated discussion, there are no taboos.
- Project preparation, involving the contractor in the design process. Selecting the contractor through an open and transparent procedure.
- Further meetings with participants after the project is completed, either at a garden party or in a more formal setting

IT IS IMPORTANT TO NOTE THAT EDUCATING THE PEOPLE INVOLVED IN THE WORK IS ALSO IMPORTANT FOR SUCCESS:

- Sensitizing engineers to communication with the community.
- Sensitizing residents' representatives to the basics of moderation, facilitation, and basic conflict management tools.

In conclusion, with proper preparation it is possible to use the formal system of general meetings for community planning meetings. The element of surprise usually energizes the participants well.

THE FACILITATOR'S ROLE

The owners and facilitators of the participation process bear responsibility for communication and related tasks. In participation planning, a person who works to create the most effective work is referred to as a facilitator (moderator, helper) or as a mediator. Engaged to ensure that everyone involved in the process performs at the right level, they adequately prepare with the right methodological sensitivity, and see that everyone can contribute to the results during the planning activities.

"Facilitation is a method of leading a negotiation in which an external, impartial person helps a group to identify and find a solution to a problem. The facilitator's role is to make the process of problem identification and problem-solving discussions and group decision-making more effective. But it is important that the decision itself is taken by the participants."[36]

The aim of facilitation is to establish, initiate and maintain the process, while also maintaining the intention for communication between the participants in the process.

> **"Facilitation is based on the belief that it is worthwhile for the parties to follow through with the process initiated by the facilitator, but more importantly, it is the participants who then determine the details**

Thus, the facilitator just makes sure that the discussion is conducted in a fair way (for example, if one of the parties promises to do something next time to support an argument, the facilitator should pay attention that this actually happens).

During the process, the facilitator takes care of the framework and the right atmosphere of the negotiation, the balance of power between the participants and their involvement in the joint work. The facilitator does not help the participants arrive at the decision, but rather helps the participants in the process to make it in an efficient framework.

In the case of a conflict, the facilitator may propose to resolve it separately, including through mediation.

[36] Krisztián, B., dr. (2002) Facilitáció és mediáció a személyügyi gyakorlatban [Facilitation and mediation in human resources practice]. Humánpolitikai Szemle [Human Policy Review], 13., 3-13.
[37] Péter, Zs. (2015) A facilitálás tíz lépése [The ten steps of facilitation.], Jel-Kép, 2015, 1, 79-89.

Preparing investment decisions and managing the investment from a condominium perspective

One of the results of a successful decision, and a guarantee for future community planning, is that what has been decided will be implemented. The project remains, therefore, fundamentally separate from the previous process because of the construction activities, but at the same time both the experts and the contractor (all its employees) need to understand that they are at a special work site. The house is inhabited, people are doing their best to adapt but expose their privacy to strangers, noise, dust and other distractions.

One of the most important issues in investment decisions is thus to ensure the best possible flow of information, to seek safety as well as to gain and maintain trust. This includes transparency in the contractor selection process, correct and verifiable documentation of the work process after the contract has been signed, and continuous technical inspection and quality control.

When determining the estimated timeframe, the preparation of the decision support material should be taken into account, as well as the time dedicated to general meetings, the investment decision, the choice of the contractor and the choice of the financing method. Under realistic conditions, this can be up to four to six months.

PLANNING AND PREPARATION:

- Choosing the designer (one month): it is worth asking for several offers based on a predefined design programme.
- Preparing the implementation plans (three months, based on a design programme): not always necessary, but engineering upgrades and some local regulations may require it.
- Hiring a project manager: it is advisable to ask for a complex offer, which may include technical inspection, financial and tender management tasks as well.
- Other participtants: energetics engineer/auditor, technical controller, lawyer.

Construction works

For preparing the selection procedure, the manager should draw up a tender dossier based on the common technical specifications.

The method of evaluating the offers received must also be agreed on in advance. It is not always convincing if the competition is only based on the price. Verifiable reference projects (from a multi-family residential context) are also important. Remember that a thermal insulation project is not the same in the case of an inhabited building as in a school project during the summer holidays. Developing a scoring system is recommended to make the evaluation objective.

When choosing a contractor, besides professionalism, their liability insurance as well as the availability of factory certifications and quality assurance systems are equally important.

It is recommended to check the contractor's public balance sheet and financial statements.

The winning contractor will be required to sign a contract attached to the bidding documents. The construction log can be opened and the worksite handed over after signing. Informing the residents is recommended (before or) at this stage, introducing the construction site manager and explaining the basic rules. This should be made in writing and posted on the residents' message board or social platform.

The construction's completion will be marked by the technical handover, the disaster management inspection, and the consultations with the authorities. The warranty period starts after the commissioning test and trial run.

It is advised that the assembly meeting responsible for the decision on the retrofit works should set up a committee to monitor the construction process and communicate this transparent process to residents until the project's completion.

Decision -preparation documentation for decision-making

Particularly important is the preparation of decisions on renovations and assembling the decision preparatory material because on the one hand it is necessary for commercial loans while on the other hand, it is also expected for grants. As this can take several – up to six – months to prepare, it is important to have it available as often no time remains to have it done when the call for tenders is published.

The maturity of the housing savings can also make the preparation of such a plan necessary, just as with a life-threatening condition, a broken appliance, or an obligation from a professional authority.

It is important to engage a professional to help in the decision preparation process who can offer a realistic price for the renovation and take into account any expected price increase, as well.

THE DECISION-PREPARATION DOCUMENTATION SHOULD INCLUDE (CZABARKA, 2022):

- assessing the building's energy condition;
- realistic development proposals based on the cost-optimization principle;
- contractor offers;
- selection criteria;
- engineering/expert cost;
- amount of energy that can be saved;
- financing models;
- cost per flat, savings, subsidies;
- the ability to turn it into a renovation project.

Monthly cash-flow type accounting of the energy, maintenance, and upkeep costs that can be saved can significantly facilitate decision-making. If only the costs are observed in order to meet the conditions for a loan for example, it will not furnish a sufficient motivation. Based on the authors' experience – who have relevant practical expertise – show that should no worked-out scenario exist, almost a third of the decisions already approved by the general meetings are never implemented.

Condominiums are organizations set up to maintain the common parts of the property. Their financial decisions are mostly about the collection, management, and value-preservation of resources. They also decide about the necessity, impact, and implementation of renovations. These are sometimes interlinked, mutually conditional decisions that could reinforce but also weaken each other. It is difficult to see this clearly and make coherent decisions in a community of owners with reactive renovation decisions. These decisions are sometimes about choosing between saving, depreciation, or a loan.

Cost assessment

- A ranking can be set up for the decision based on the cost optimum.
- Secondary ranking can be based on the type and invoiced amount of energy used, the speed of payback regarding each intervention, the technological sequence, and the cost optimum.
- Choice can be based on the options for low- hanging fruits where the monthly cash flow of savings and previous contributions lie in balance; i.e., "self-financing". We can spend on jobs where the price increase is fastest and we want to avoid the negative effects.

One-stop-shop advisory network

The establishment of a one-stop-shop (OSS) advisory network emerges as a crucial strategy to streamline the retrofit process and empower building owners and residents to make informed decisions. A one-stop-shop advisory network serves as a central hub, providing comprehensive guidance and support to all parties involved in multi-apartment building retrofits. This network acts as a single point of contact. By consolidating expertise and resources, the network streamlines the retrofit process, reduces administrative burdens, and ensures that all aspects of the project are addressed effectively.

There are around 60 OSSs in the EU, with at least one active point in two thirds of the member states. EPBD requires Member States to establish OSSs to provide information and support to building owners and residents who are considering energy efficiency renovations to help increase the quantity and quality of deep renovations.

The Croatian Environmental Protection and Energy Efficiency Fund[38] is a government agency that provides financial assistance for a variety of environmental and energy efficiency projects, including multi-apartment building retrofits. The Fund's one-stop-shop advisory network provides comprehensive guidance and support to building owners and residents who are considering a retrofit.

The Croatia Green Building Council (CGBC) is a partner in the **crOss renoHome**[39] project that currently plays a crucial role in promoting the establishment of one-stop shops in Croatia. By providing comprehensive information, guidance, and support, one-stop-shops can significantly facilitate the uptake of retrofits, improve their quality, and enhance their environmental benefits.

RenoPont[40], a one-stop shop (OSS) advisory service in Hungary, is built on two pillars: it operates informational websites and opens offices in Hungarian cities. It offers its customers technical, financial, and legal information as well as services for energy renovations in one place. The RenoPont network works to raise the awareness of energy efficiency renovations and promote energy efficiency improvements. While the offices provide personal consultations to local residents, the website offers services for a wider audience, including information about the benefits of deep renovation, support and funding options, guarantees, legal remedies. A set of additional checklists and registers is available, like good examples, product selection guide, professional and contractor database, an energy savings calculator, template documents (model contracts, contracting entities), a glossary, frequently asked questions, and misconceptions. The website also lists the OSS offices providing appointment booking and online consultation functions.

[38] Fond za zaštitu okoliša i energetsku učinkovitost [Environmental Protection and Energy Efficiency Fund]. (n.d.) Retrived from https://www.fzoeu.hr/ Last accessed: 18. January 2024.
[39] crOss renoHome (n.d.) Retrieved from https://crossreno.door.hr/ Last accessed: 18. January 2024.
[40] RenoPont (n.d.) RenoPont Retrived from https://renopont.hu/ Last accessed: 18. January 2024.

SIMILARITIES AND DIFFERENCES

Retrofit processes and responsibilities

While all three countries face common challenges such as obtaining consent, financial constraints, and recognizing the importance of energy audits, the nuances lie in their decision-making processes, renovation focus, and the level of municipal involvement in the retrofitting processes.

All three countries face challenges in obtaining consent from co-owners or residents for energy renovation works. In Croatia and Hungary, this consent is crucial for decision-making regarding building renovations. Similarly, Poland's authorities highlight the issue of limited comprehensive renovations due to residents' attitudes and lack of financial resources.

All three countries recognize the significance of conducting energy assessments and audits before the renovation. Energy performance certificates (EPC) are required by law for all new investments and major renovation works that need a construction permit, and for any transfer of ownership. Also, it is mandatory for most public funding or private financing schemes. Regarding the renovation measures, however, the order of implementation is made only in the energy audit. All countries mention the rarity of such audits. In Croatia and Hungary, observers highlight that the extra costs and time involved in this process limits people's willingness.

Financial limitations hinder comprehensive renovations in all three countries. Croatia and Hungary mention the unequal financial power of co-owners; Hungary furthermore emphasizes the homeowners' inability to afford full modernization. Poland notes that the lack of financial resources creates a barrier to comprehensive renovations in privately owned multi-apartment buildings.

The most common renovation works across these countries involve the insulation of the building's envelope, heating system upgrades, and replacing windows/doors. These types of renovations are prevalent in multi-apartment buildings across all three nations. Croatia requires a 51% consent for construction works on common building parts. Hungary emphasizes the need for consent from each owner affected in joint investment projects, and Poland discusses the rarity of comprehensive renovations due to residents' attitudes towards large loans.

In Croatia, the renovation of multi-apartment buildings often begins with the structure's envelope, followed by its heating and ventilation systems. Hungary points out a high number of renovation activities relating to structural conditions or with low depth, meaning renovations do not occur at all or do not significantly reduce energy consumption. In contrast, Polish commentators discuss a variety of works carried out, including the installation of heat meters, photovoltaic panels, and heat pumps, albeit on a smaller scale. In Poland, reviewers specifically highlight the case of municipal buildings managed by units subordinate to municipal authorities, where energy audits are carried out for renovation projects covered by external funding. This might indicate a more structured approach to renovations in publicly managed buildings compared to Croatia and Hungary.

Climate change and awareness

The motivations and approaches to renovation differ across Croatia, Hungary, and Poland. Common threads manifest in terms of challenges related to awareness, financial considerations, and practical constraints that influence homeowners' decisions regarding building renovations in each country.

All three countries face challenges related to the awareness and perception regarding renovation benefits among homeowners. The emphasis on reducing energy consumption and CO_2 emissions appears across Croatia, Hungary, and Poland as a motivation for renovation, albeit with varying degrees of prominence. Financial concerns are evident across all three countries, whether it's the high initial outlay, the impact on utility subsidies, or the homeowners' focus on cost-saving motivations such as reduced bills. Practical limitations, such as the need for available residences during renovation and the reduced usable space due to insulation or ventilation, are mentioned in the contexts of renovation challenges in these countries.

Croatia has a planned approach to renovate its housing stock, focusing on restoring a significant area of buildings in ten-year increments until 2050. They place emphasis on passive buildings and energy renovation to improve resource efficiency, comfort, and reduce CO_2 emissions. Motivation for energy renovation primarily stems from lower bills and reduced CO_2 emissions. Home or apartment owners in Hungary seem to lack awareness of the environmental, social, and economic benefits renovation leads to, thus leading to delays in decision-making. A lack of appropriate data systems to capture renovation impacts and communicate necessary steps to owners is highlighted. Utility cost subsidy systems have a negative impact on financing, environmental awareness, and owners' willingness to renovate. However, a recent study showed that aesthetic concerns regarding the external appearance and living environment play a significant role for homeowners. Polish homeowners generally are hesitant about renovations due to high initial financial costs, despite the potential benefits in maintaining monthly bills and increasing property market value. Energy renovation in Poland often focuses on exchanging heat sources, insulating walls, roofs or ceilings, but may be limited in comprehensive renovations due to practical constraints.

Documentation and legal aspects

While similarities appear across these countries in terms of legal frameworks and certain documentation requirements for building renovations, differences lie in the ease of access to technical documentation, the practice of energy certifications and audits, and specific legal regulations governing renovations, creating varying levels of complexity and requirements.

Similarities include a kindred reliance on the Construction Law, Public Procurement, Civil Code, and other implementing regulations for building renovations. There is an emphasis on energy audits for efficient renovations and optimal selection of works, particularly for buildings under subsidies or municipal ownership. Furthermore, a need exists for maintaining a building logbook containing records of inspections, technical checks, repairs, and alterations.

Differences include well-known legal requirements for carrying out renovations, along with available training courses for property operation. A varied practice occurs in commissioning energy audits, which is not standard among residential building managers but remains mandatory for subsidized and municipal buildings. Additionally, there is a need for an inventory and the creation of a renovation project for old buildings that lack building documentation.

Monitoring and verification

Facility managers conduct periodic inspections in all three countries; the nuances lie in the obligation levels, the depth of technical testing, the building owners' reluctance towards additional costs, and the role of legislative support in encouraging comprehensive verification practices for building maintenance and renovation.

Annual inspections are conducted by facility managers to assess building conditions, involving visual checks and inspections of various installations. Responsibility for specific inspections, like gas installations, is delegated to particular professionals or entities. Additional inspections, such as drainage checks with cameras, are optional and subject to approval, often incurring extra costs for co-owners. In all three countries, building owners exhibit reluctance to bear the expenses and lead times for thorough preparations before renovations. There is a common trend of challenges related to conducting additional verification tests (building diagnostics, thermographic survey) due to associated costs and a lack of legislative support. In all countries, periodic inspections occur either annually or every five years, focusing on various building elements and technical conditions.

Croatia exhibits a scenario where the approval of additional inspections or maintenance depends heavily on the willingness of co-owners. Croatia adopts a decentralized approach to inspections and maintenance by hiring professionals for specific segments in each managed building, while Hungary and Poland do not explicitly mention such decentralization. In Hungary, renovations often proceed without detailed implementation designs or precise technical specifications due to the building owners' cost concerns. Authorities in Poland emphasize the importance of energy efficiency monitoring before and after renovation but note the lack of widespread implementation due to data scarcity and legislative gaps.

Financing

While all three countries face the challenge of financing renovations and resort to loans as a common solution, the specific nuances lie in the available funding schemes, the role of state subsidies and renovation funds, the reasons behind co-owner reluctance, and the level of awareness and utilization of financial incentives among facility managers. Croatia emphasizes generational differences, Hungary focuses on subsidy-driven funding programs, and Poland highlights the challenge of insufficient financing streams and decision-making hurdles without comprehensive analysis.

All three countries rely on different funding schemes and financial incentives to support building renovations. These include subsidies, EU funds, municipal support programs, and renovation funds. There is a shared reliance on loans to complement the costs of renovations not covered by available funds or subsidies. This results in increased reserve funds or additional financial measures to support the renovation works. A common issue exists across these countries where some co-owners or members of the community are hesitant (owned but rented apartment owner, free-rider approach) or unable (single elderly person, lower yearly household income) to participate in comprehensive renovations due to concerns about costs, such as common monthly charges or increased contributions to the renovation fund.

All countries emphasize the struggle with insufficient public funds allocated for renovations. While Croatian citizens highlight generational differences in perceptions toward renovation investment — where pensioners are often reluctant due to unclear benefits while younger individuals prioritize renovation for health and well-being reasons — Hungarian citizens place importance on establishing renovation funds for eligibility in state subsidies and funding programs. Additionally, the popularity of housing savings funds with a 30% subsidy indicates a unique financial instrument used for renovation in Hungary. In Poland, on the other hand, people highlight the challenge of insufficient financing streams as a barrier to comprehensive renovations. It discusses the awareness among facility managers about available subsidies but highlights the difficulty in obtaining them. Polish observers also emphasize the lack of comprehensive analysis before making decisions on renovation stages, often due to concerns about increased costs and rent.

CASE STUDIES

RENEWABLE ENERGY HOUSE IN BRUSSELS (TRADITIONAL STRUCTURE BUILT BEFORE 1945)

Brussels, Belgium

SHORT DESCRIPTION

The 120-year-old monument- protected building with three floors and a usable floor space of 2,000 m² underwent a complete renovation in 2006. This has resulted in a heating and cooling system and electricity network based on 100% renewable energy. Throughout the building's renovation, three principles guided the designers: reduced heat loss, heat recovery, and efficient use of renewable energy sources.

RESULTS

Special attention has been paid to the building's thermal insulation: the windows have been renovated, the back facade has been covered with seven cm EPS (expanded polystyrene) and plaster, while the roof has been covered with 20 cm thick mineral wool insulation. Energy-efficient ventilation has been achieved using a heat recovery system. During the energy optimization, heat transfer through the building envelope was minimized by modelling, resulting in a 50% reduction in energy consumption compared to the reference building.

Renewable energy sources power the heating: an 80 kW wood pellet boiler, a 42 kW solar thermal collector, 25 kW ground source heat pumps and a 5,000 liter hot water storage tank. Cooling is provided by an absorption cooling system, supported by solar thermal collectors, biomass, and ground source heat pumps. A 3 kW PV system supplies the electricity.

The renovated building with modern meeting facilities of approx. 2000 m² is located close to the European Commission, the European Parliament, and the Council which also allows easy access to information on renewable energy for stakeholders and the interested public. As a result of the renovation, the building's annual energy efficiency has increased by 50% compared to its previous situation. The Renewable Energy House, for the first time, groups together all major actors in the field of renewable energy in Europe, thereby representing one of the fastest-growing economic sectors with an annual turnover of more than €15 billion, employing more than 300,000 people, and supplying 8% of Europe's current energy demand.

CHALLENGES

Limited opportunities present themselves for designing and using energy-saving technologies in an existing building. Roofs are shaded by the surrounding tall buildings, no directly south facing roof exists, and the available surface area for solar thermal collectors remains limited.

BENEFITS OF THE RENOVATION CONCEPT

As a result of the renovation, the building's heat transfer has been reduced by 50% compared to the reference building by using optimized energy models. During the renovation, windows with a good thermal insulation coefficient were installed, the back facade and the roof were also insulated. In addition, a heat recovery system with an 85% efficiency has been used to optimize the heating and cooling system, which renewable energy sources provide such as wood pellet boilers, solar thermal collectors, photovoltaic systems, ground source heat pumps and an absorption cooling system. As part of the system, a 5,000-liter hot water storage tank was also installed in the building. The institution brings together the major actors of the European renewable energy sector, enabling them to cooperate and exchange information[41].

[41] REH (2006) The Renewable Energy House - Europe's headquarters for renewable energy http://www.estif.org/fileadmin/estif/content/about_estif/downloads/REH_Brochure.pdf Last accessed: 18. January 2024.

HOUSING IN DIESELWEG, GRAZ (TRADITIONAL STRUCTURE BUILT AFTER 1945)

Graz, Austria

SHORT DESCRIPTION

The housing estate, built between 1950 and 1970, consisted of 204 social housing units in four-storey buildings without lifts. The buildings were heated by electricity, oil and solid fuels. CO_2 emissions stood at 700 t/year and energy indicators ranged from 142 to 225 kWh/m^{2}a. In 2007, the Gemeinnützige Industrie-Wohnungs-AG (Gemeinnützige Industrie-Wohnungs-AG) purchased the four buildings with the aim of carrying out a major passive house renovation to eliminate emissions of domestic fuels and particulate matter, and to reduce energy consumption in the long term.

OBJECTIVES

Through combining optimal thermal insulation and solar energy production, groundwater reuse for heating and cooling as well as supporting storage technology, pollutant emissions can be eliminated, resulting in significant air quality improvements for residents.

INNOVATIONS

Heat loss has been minimized by using solar facade elements made of glass, wood, and honeycomb cardboard, passive house windows integrated into the prefabricated wall panels and integrated ventilation ducts. In addition, a large solar collector system and a groundwater heat pump with buffer tank were installed. The heating duct and hot water supply were integrated into the old external wall ("climate wall"). The basement and attic floors were insulated. Heat production and consumption are monitored and controlled via the internet. Important elements of the project consisted of integrating balconies into the living space, installing lifts, and involving the residents.

RESULTS

The heating demand has been reduced (original energy performance indicators: 142 kWh/m^{2}yr to 225 kWh/m^{2}yr, new energy performance indicators: 9.6 kWh/m^{2}yr to 13.6 kWh/m^{2}yr). Heating and hot water costs have been reduced by more than 90%, which has led to high satisfaction among tenants.

BENEFITS OF THE RENOVATION CONCEPT

To improve the building's quality, a passive house energy solution was applied while preserving the existing structural system. The new system has eliminated thermal bridges. The renovation's high quality is guaranteed by prefabrication under factory conditions. The components utilized can be dismantled and partially recycled[42].

[42] Bundesministerium für Klimaschutz, Umwelt, Energie, Mobilität, Innovation und Technologie (BMK) (n.d.) *Passivhaussanierung Graz - Dieselweg Bundesministerium für Klimaschutz, Umwelt* [Passive house refurbishment Graz - Dieselweg Federal Ministry for Climate Protection, Environment] https://nachhaltigwirtschaften.at/de/hdz/projekte/passivhaussanierung-graz-dieselweg.php Last accessed: 18. January 2024.

TALLINN UNIVERSITY OF TECHNOLOGY DORMITORY, ESTONIA (PREFABRICATED BUILDING)

Tallinn, Estonia

SHORT DESCRIPTION

The Tallinn University of Technology dormitory, built in 1986, is a good example for the renovation of a building with prefabricated elements. Originally built for young student families, the building has become obsolete over the years. The dormitory had 70 one-room apartments of 32m² and ten two-room apartments of 53m², but the building's energy efficiency and indoor climate no longer met modern requirements. The problems included high heating bills, inadequate ventilation, and the deteriorating condition of the facade and balcony elements.

The university has carried out a pilot renovation as part of a research project using near-zero energy solutions. The building's renovation started with a detailed audit including inspecting all parts of the building, comprising utility systems and load-bearing elements. The condition of the facades and balconies was examined using laser scanning technology to obtain accurate geometric data.

METHODOLOGICAL APPROACH

Thorough surveys were carried out using nine scanning stations to create a detailed point cloud with millimeter accuracy displaying the building's facade. Special software was employed to analyze the data, identifying insulation problems and the corrosion of the external envelope. Sensors and thermographic tests helped measure heat transfer, temperature and humidity, and locate thermal bridges. Using innovative public procurement methods, a reliable designer was selected: the design firm Sirkel and Mall was hired to develop solutions to the above problems. As a result, the heat transfer of the facade was reduced, ensuring proper insulation, and the corrosion of the balcony railings was addressed, contributing to the building's long-term sustainability and the safety of its occupants.

RESULTS

The external building envelope's heat transfer capacity has been reduced by 90%, while that of the windows by 50%, leading to radically lower energy consumption. The project used PV panels and solar thermal collectors, and integrated an intelligent grey water-based heat recovery system into the building, maximizing the use of renewable energy sources and minimizing energy loss. Built-in sensors and internet-based systems allow occupants to monitor and control energy and water consumption in real time, optimizing sustainable energy use.

BENEFITS OF THE RENOVATION CONCEPT

The innovative solutions not only increased the building's energy efficiency but also provided comfort to the occupants, while the investment was carried out quickly and smoothly, minimizing the impact on the occupants' daily lives. These specifics render the project a benchmark for excellence in the construction industry. It proves that modern technologies and sustainable design can work in perfect harmony, contributing to the long-term sustainability of buildings and an environmentally conscious future[43].

[43] MORE-CONNECT (n.d.) More Connect Retrieved from https://www.more-connect.eu/ Last accessed: 18. January 2024.

STREET SJENJAK 101, OSIJEK, CROATIA (PREFABRICATED BUILDING)

Osijek, Croatia

DESCRIPTION

Completed in 1980, Sjenjak 101 is one of the largest residential buildings in Osijek. It houses 133 apartments and approximately 260 residents. The total annual revenue amounts to €59,725.26, with roughly two-thirds coming from alternative sources, such as antennas and leases that the building generates. The remaining third is derived from reserve funds, equivalent to the legally prescribed reserve amount of €0.203/m². To facilitate communication, their Facebook page was activated to establish direct contact with residents. Before the energy renovation, the building had an energy class D, and through the renovation, it reached class B.

The implementation of energy efficiency activities began in 2008 with installing motion detectors in hallways and elevators to eliminate the need for turning on the entire staircase lighting unless someone is inside the elevator. Contractors also installed LED lighting in these locations. Additional energy efficiency was achieved by installing pumps with frequency regulation for the water supply and circulation pumps for the heating system. Changing the electricity supplier also realized financial savings, resulting in a 5% reduction in shared electricity costs.

Regarding thermal energy savings, in 2011, the wooden and metal communal carpentry in the hallways did not provide adequate hermetic sealing, and so was replaced with PVC carpentry. The roof was in poor condition, and in 2013, a reverse roof approach was applied, introducing new waterproofing and 10 cm XPS insulation, providing the roof with both mechanical protection and additional thermal insulation.

Sjenjak 101, Osijek – building after partial renovation (resource: Krešimir Ižaković, condominium representative)

In 2015, the heating system underwent reconstruction. Contractors replaced the thermal substation, transitioning it from a direct to an indirect heating system. Balancing valves, thermostatic valves, and heat distributors were installed. The heating system's complete replacement, and the efforts comprising each of these elements, was crucial for its functionality. For instance, without balancing valves alongside thermostatic valves for heat regulation in individual apartments, a phenomenon known as 'hissing' or 'whistling' in the heating system may occur. The thermal substation replacement resulted in reduced costs for heat energy acquisition from HEP District Heating, achieved by reducing the quantity of acquired energy and the engaged power by 23.2%. The consumption of thermal energy was reduced by 36%. The entire project cost slightly over €88,526, with approximately €21,235 being co-financed by the Environmental Protection and Energy Efficiency Fund, and the rest covered by the building's expenses. The system was partially automated after reconstruction, consisting of frequency-regulated pumps that track outside temperatures and deliver heat to the building system based on a specific curve. The return on investment was calculated to be achievable within 4.4 years.

Following the reconstruction of the heating system, **an energy renovation project for the multi-apartment building** ensued. The total project value was €771,484.73, with co-financing amounting to €451,021.83. The project commenced in October 2016 and concluded in December 2018.

Preparatory activities before project implementation included:

- **Resolving property legal relations** – the building had construction and usage permits, but the land registry listed the parcel as arable land, necessitating partitioning and caution when satisfying the technical aspects of future applications.
- **Securing financial resources** – pre-allocated funds of €53,089.12 to reduce credit indebtedness.
- **Informing co-owners** about the need for energy renovation and the benefits it brings.

Sjenjak 101, Osijek – building before renovation (resource: Krešimir Ižaković, condominium representative)

Sjenjak 101, Osijek – building after renovation (resource: Krešimir Ižaković, condominium representative)

Given the thorough preparation and revenues from alternative sources, there was no need to raise reserves throughout the project's duration.

The project primarily encompassed the insulation of all heated surfaces, followed by the replacement of communal carpentry in fire staircases and basements. The final steps involved insulating terraces and roof surfaces. Ultimately, energy savings of 68% were achieved.

After implementing the energy efficiency project, a new mechanical project was devised, resulting in a further 45% reduction in engaged power compared to the initial state, and additional financial savings in energy. Living conditions in the building have improved significantly, energy bills have been substantially reduced, and the apartments' market value has increased, a factor often overlooked.

Sjenjak 101, Osijek – building after partial renovation (resource: Krešimir Ižaković, condominium representative)

Challenges during the renovation related primarily to financing, as it was one of the first buildings to embark on energy renovation, and communication with banks was exhaustive during the loan procurement process. The condominium representative emphasized the cooperative collaboration with employees of the Environmental Protection and Energy Efficiency Fund and the Ministry, assisting in completing the Energy Renovation Plan and addressing various challenges such as additional works and increased window replacement quantities.

Sjenjak 101, Osijek – building after renovation (resource: Krešimir Ižaković, condominium representative)

STREET DRAGE GERVAISA, RIJEKA – THE STREET WITH THE HIGHEST NUMBER OF RENOVATED BUILDINGS (PREFABRICATED BUILDING)

Rijeka, Croatia

A network of streets stretches about 2.5 kilometers and is home to residents of many multi-residential buildings constructed in the 1960s. During that period, energy efficiency was not a priority in building design, resulting in walls with little or no insulation and problematic flat roofs that caused significant energy losses and high bills. The high expenses motivated the building's co-owners to come to an agreement and embark on energy renovation projects together.

In 2014, projects were initiated on the first two buildings. Meanwhile, the Environmental Protection and Energy Efficiency Fund paid a total of €477,802 to the co-owners of the renovated buildings on this street in Rijeka. They continued with renovations even after the announcement of the first EU tender, for which another 13 buildings from the street successfully applied, receiving almost €1,858,119 in non-refundable European funds that covered 60% of the renovation investments. This significantly contributed to shaping the new appearance of this city quarter.

Thanks to the energy renovation, this Rijeka neighborhood now consumes at least 50-60% less energy for heating. The street offers an excellent example of positive experience sharing among neighbors.

Drage Gervaisa 24, Rijeka – a roof before reconstruction (resource: The Environmental Protection and Energy Efficiency Fund)

Drage Gervaisa 24, Rijeka – roof during reconstruction (resource: The Environmental Protection and Energy Efficiency Fund)

Drage Gervaisa 24, Rijeka – renovated buildings in the Street Drage Gervaisa, Rijeka (resource: The Environmental Protection and Energy Efficiency Fund)

LIST OF ABBREVIATIONS

AC alternating current

DC direct current

DCV Demand controlled ventilation

DHW Domestic hot water

EC European Commission

EE Energy efficiency

EED Energy Efficiency Directive

EEO Energy Efficiency Obligation Scheme

EPBD Energy Performance of Buildings Directive

EPC Energy performance certification

EPC Energy performance contracting

ERDF European Regional Development Fund

ESCO Energy Service Company

ESIF European Structural and Investment Fund

ETICS External Thermal Insulation Composite Systems

ETS Emission Trading System

EU European Union

EUROSTAT Statistical Office of the European Union

FM Facility Manager, Building Manager

LTRS Long Term Renovation Strategy

nZEB nearly Zero Energy Building

NECP National Energy and Climate Plan

NES National Energy Strategy

OSS One-stop-shop

PE Primary energy

PV photovoltaic

RE Renewable energy

RED II Renewable Energy Directive

RES renewable energy sources

ROI Return on investment

RRP Recovery and Resilience Plan

SBS Sick Building Syndrome

SECAP Sustainable Energy and Climate Action Plan

SRI Smart Readiness Indicator

HPT TCP Technology Collaboration Program on Heat Pumping Technologies

UC U-coefficient, U-value

RetrofitHUB

This project is part of the European Climate Initiative (EUKI) of the German Federal Ministry for Economic Affairs and Climate Action (BMWK).

CROATIA GREEN BUILDING COUNCIL
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