The role of energy-efficient renovation in the sustainability of cities and settlements: European experience

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Abstract. Building renovation is one of the industries with the largest investment gap. To achieve the proposed climate target of 55% by 2030 in the EU, additional investments of around €275 billion will be required annually. In the housing sector, the lack of simple, attractive and easily accessible state incentives for renovation and the absence of common financial products are often the main obstacles. The experience of energy-efficient renovation in European countries allows for calculated decisions when modeling housing policy and achieving sustainable development goals. To support this, some countries have already introduced minimum common efficiency requirements that apply from a certain date or at certain points in the building's life cycle. Such requirements form the basis of companies' expectations and work best along with reliable energy performance certificates and reliable financing. As for residential buildings, insufficient understanding of energy consumption and energy saving is seen as an important barrier for more participants in open public consultations on renovation work than any other obstacle. Various interests of building owners and users, differences in opinions among different owners, and difficulties in planning renovation work are also major obstacles to the formation of sustainable cities and settlements.

Keywords: energy efficiency, capital repairs, European standards, sustainable development, carbon trace, investments.

1. Introduction

The housing stock is unique and diverse, with over 220 million housing units built in Europe alone by 2001 - 85% of the EU's housing stock. From 85 to 95% of today's buildings will still be in use in 2050. Most existing buildings are not energy-efficient [1-3]. Many buildings are heated and cooled with hydrocarbon fuels and are equipped with outdated technologies and devices that consume too much energy. Millions of people suffer from energy poverty. Overall,

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buildings account for about 40% of total energy consumption and 36% of greenhouse gas emissions related to energy [4]. New Building codes may lead to changes in the energy and resource profile of the building. Like efforts to overcome the COVID-19 crisis, renovation work represents a unique opportunity to fundamentally rethink construction technologies, reconstruct and modernize buildings.

In its climate target plan for 2030, the European Commission proposed to reduce net greenhouse gas emissions in the EU by at least 55% by 2030 compared to 1990 levels [5-7]. Energy efficiency is an important starting point, In this regard, especially given that construction is one of the sectors in which efforts need to be increased. To achieve the goal of reducing emissions by 55% by 2030, the EU must reduce greenhouse gas emissions from buildings by 60%, their energy consumption by 14% and energy consumption for heating and cooling by 18% compared to 2015 [8].

Norms and rules with special requirements for the thermal insulation of the building shell have been applied in Europe only since the 1980s. This means that most of today's EU building stock was built without energy efficiency requirements: a good third (35%) of the EU building stock is over 50 years old, and more than 40% of the building stock was built before 1960. Almost 75% of them can be classified as energy efficient in accordance with today's construction standards. [9-12]

2. Methods

Currently, only 11% of the building stock in the EU is being renovated to some extent each year. However, buildings only become energy-efficient in very rare cases during renovation works. The average annual rate of energy-efficient renovation works is only about 1%. Only 0.2% of the building stock in the EU undergoes major renovations each year, which reduce energy consumption by at least 60%, and in some regions, energy renovation is practically non-existent. At such rates, it will take significantly more time for CO2 emissions in the construction sector to reach zero.

It is not just about reducing energy costs and emissions. Renovation can open up many opportunities and bring far-reaching social, environmental, and economic benefits. During renovation, buildings can become more environmentally friendly, closely linked within the urban area, more accessible, and resilient to extreme natural events. While the measures described above are intended to promote the renovation of all buildings, particular attention is paid to three areas:

a) energy poverty and buildings with the worst energy performance;

b) renovation of public buildings such as administrative, educational, and healthcare facilities;

c) decarbonization of heating and cooling systems.

Cost-neutral solutions for low-income households should take into account issues of rent, energy, operating expenses, and local taxes.

3. Results

Investments in buildings can also provide the much-needed boost to the entire construction sector and economy. Renovation works are labor-intensive, create jobs, and lead to investments that are often linked to local supply chains. They can increase demand for energy and resource-efficient devices and increase the long-term value of real estate. A wave of energy-efficient renovation can create an additional 160,000 "green" jobs in the EU construction industry by 2030. This can provide a valuable boost to an economic sector where over 90% of companies are small and medium-sized enterprises and which is seriously affected

by the economic consequences of the crisis. Construction activity decreased by 15.7% in 2020 compared to 2019, and investments in energy efficiency decreased by 12% [13]. These losses are likely to have long-term consequences for the construction industry.

Persistent barriers to energy and resource-efficient renovation need to be eliminated, and new investments - starting with public and energy-efficient buildings - should be promoted in a more long-term perspective. The goal is to promote comprehensive energy reconstruction and at least double the annual quota for energy reconstruction of residential and non-residential buildings by 2030. If forces are mobilized at all levels to achieve these goals, 35 million units of housing can be renovated by 2030 for the EU to achieve its objectives.

The starting point for energy-efficient renovation is often an individual decision, in which the expected level of savings and expected costs are compared. However, insufficient information on the current energy and resource profile of buildings and potential benefits of energy-efficient renovation, lack of confidence in real energy savings, and a division of incentives between owners and tenants are some of the main barriers to such decisions.

The advantages of such regulatory initiatives include providing clear guidelines for decision-making in multi-owner buildings, reflecting the energy characteristics of the building in its value, and increasing overall low awareness of the benefits of energy-efficient decisions.

Energy performance certificates increase transparency in the energy efficiency of the building stock, especially if information is available in relevant databases.

Digital tools can help track construction progress and material usage, as well as increase productivity. For example, a digital twin of a building created using a three-dimensional map provides real-time information on its performance and can prevent serious incidents by warning of possible errors in building systems.

Intelligent buildings and construction with digital support provide large amounts of data throughout the entire life cycle of buildings - from construction and use to renovation - which can help improve operations. Building Information Modeling (BIM) increases transparency and reduces costs and resource consumption. By using intelligent meters, demand and supply for electricity can be well-balanced. Thus, buildings have transformed from energy consumers to energy producers, resulting in the following benefits: high energy efficiency, reduced electricity costs for households, integration of electromobility, and system benefits for grid stability. This is just one example of the results that can be achieved through digitally supported building reconstruction, when energy storage, load flexibility, energy generation from local renewable sources, internet of things in system components and devices, as well as charging points for electric vehicles are combined. Thus, citizens can also actively participate in the energy supply system as prosumers.

4. Discssion

According to experts [14-17], the energy efficiency vector should have a comprehensive and consistent strategy covering a wide range of issues and participants, based on the following key principles:

1. "Energy efficiency first of all". It is the basis of the guiding principle of the European climate and energy policy and beyond, both in the European Green Course and in the EU strategy for the integration of the energy system of the participating countries. The main efforts are aimed at ensuring that there is no need to generate more energy than is strictly necessary.

2. "Accessibility". The goal is to make energy-efficient and sustainable buildings widely accessible, especially for middle- and low-income households, as well as for disadvantaged people and in disadvantaged areas.

3. "Decarbonization and integration of renewable energy sources". During the renovation of buildings, renewable energy sources should be increasingly integrated, especially from local

sources, and the waste heat utilization should be increased. At the same time, local and regional energy systems should be integrated to decarbonize transport and provide heating and cooling.

Resource efficiency can help minimize the ecological footprint of buildings; in addition, some parts of the construction industry need to be turned into CO2 sinks, for example, through the development of green infrastructure and the use of organic building materials that can accumulate CO2, such as wood from sustainable sources [18-20].

Combined with intelligent energy supply systems, it is possible to create highly efficient buildings with zero emissions.

Due to energy efficiency requirements, more and more energy companies ensure that their customers save energy, for example by offering them more and more incentives to repair buildings and improve the system.

Renovation work is hindered by obstacles at various stages of the decision-making chain - from the initial decision to carry out repairs to financing and project implementation.

5. Conclusions

In 50 years, buildings will look very different than they do today. They will become part of a more sustainable, more environmentally friendly and digitized society and will become part of a closed system in which energy demand, waste generation and emissions are minimized at all points. The roofs and walls of these buildings will increase the greening of our cities, improve the urban climate and contribute to the conservation of biodiversity. Inside these buildings, intelligent digital devices will provide real-time data on the type, time and place of energy consumption.

District-level concepts will unite people and communities. Buildings will consume less energy and provide a more comfortable and healthy environment for all people. Cities are getting greener and closer to nature. New jobs and employment profiles will be created. The construction industry will receive a full portfolio of orders thanks to the opportunities offered by a consistently high rate of renewal and the expansion of its global leadership in the field of innovative building materials.

The positive effect will also extend to other industries. There will be new and larger markets for green construction, as well as for "green" loans and mortgage lending. The goal is to:

- contribute to achieving climate neutrality;
- implement the principles of circular economy;
- contribute to the achievement of the sustainable development goals;
- to increase the competitiveness of the industry;
- to protect the right of all people to an affordable, fit for habitation, affordable and healthy living space.

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