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ENERGY EFFICIENCY IN THE RESIDENTIAL SECTOR: CURRENT TECHNOLOGIES AND PROSPECTS

In times of martial law, the issue of energy efficiency is of particular importance. Apart from direct destruction, military conflicts pose additional challenges to the country's energy system, economy and infrastructure. Ensuring a stable supply of energy becomes critical for military needs, as well as for maintaining the livelihoods of the civilian population and preserving economic stability. Therefore, the implementation of energy efficiency measures that allow for more rational use of energy resources is not only economically feasible, but also strategically important (Поровський, 2024).

In today’s world, energy efficiency is one of the key components of sustainable development. Most developed countries have already made significant progress in this area, and for some of them it was a matter of economic survival. Ukraine, which is currently facing numerous challenges in the energy sector, can learn valuable lessons from other countries. We have analysed some of them: Germany, Denmark, Finland and Japan.

Germany is a leader in energy efficiency and the implementation of Energy Management Systems (EnMS) through a comprehensive approach that includes legislative initiatives, financial incentives and educational programs. The country has financial incentives for the implementation of EMSs in industry through tax reductions on EMS investments; in the residential and public sector, they have a system of energy efficiency certificates for buildings that stimulates the modernization of old housing stock and the construction of new energy efficient buildings. The government provides additional incentives for financing energy efficiency and energy substitution projects

through soft loans and grants (covering partial loans) for both energy efficiency and renewable energy.

Denmark is one of the countries for which the implementation of energy efficiency measures was a matter of survival after the oil crisis in the 1970s. The fatal shortage of energy resources and funds for them in the context of almost 95% dependence on oil imports led Denmark to maximise all possible energy efficiency measures in the domestic and industrial sectors, and to reduce dependence on energy imports, it created many renewable energy generation facilities, primarily wind farms, and successfully reintegrated coal-fired thermal power plants into biomass. As a result, the country has become one of the most energy-efficient in the world in 25 years, transforming from being completely energy-dependent to completely energy-independent and having more than 120% self-sufficiency in energy resources in the late 90s and early 2000s. Currently, thanks to the implemented energy efficiency measures, wind power, and biomass heat generation, the country almost fully meets its energy needs, and the Danish energy system is integrated with the energy systems of Sweden and Norway.

Finland is an example of successful implementation of high energy efficiency standards in construction. Thanks to strict requirements for thermal insulation, ventilation and energy conservation, new buildings in the country consume minimal energy. The government also actively supports the modernisation of the existing housing stock through financial incentives, a system of voluntary agreements with businesses, and educational programmes for the public.

Japan is known for its innovative approaches to energy efficiency in the industrial sector. The introduction of automation technologies, the use of energy-efficient equipment and the optimisation of production processes have significantly reduced energy consumption at enterprises and significantly increased generation efficiency. For a country that is dependent on energy imports, it is energy efficient technologies that have enabled it to become a top global economy and to be firmly in the top three most energy efficient countries. Government programmes encourage

businesses to invest in energy-efficient solutions through tax breaks and subsidies. However, the most influential element is the cultural and behavioural development element - the implementation of energy efficiency measures is a national priority at the societal level. Businesses in Japan are most afraid of public pressure if they inadvertently fail to meet their energy optimisation targets.

Due to the low energy efficiency of the economy, Ukraine spends an additional USD 1 billion annually. Therefore, the implementation of energy-saving solutions is a necessary component of the strategic development of our country. On a practical level, energy efficiency is a component of the survival and development of businesses and communities (Степаненко, 2010).

Consequently, there is currently no possibility of large-scale financing of energy saving projects in the residential sector of Ukrainian cities. It is necessary to support investment projects for thermal modernisation of residential and public buildings on a long-term basis at the legislative level with a transition to combined development financing using external loans, budget support and investor funds.

Ukraine, which consumes more than 60-70% of imported energy resources in its total balance sheet, is one of the most energy-dependent countries in Europe. This is caused not only by the lack of resources but also by inefficient use of resources. Therefore, addressing energy saving and energy efficiency is a top priority in the context of the energy crisis in the country.

The introduction of renewable energy sources is a highly effective way to improve the energy efficiency of residential buildings.

Thus, improving the energy efficiency of residential buildings during reconstruction is extremely important today. This will help to reduce the amount of energy used and thus reduce costs (Вознюк, 2020). Improving energy efficiency will significantly reduce the use of energy resources, which in turn reduces the need to provide the same amount of energy resources, and therefore less greenhouse gas emissions will be released into the atmosphere.

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ENERGY-EFFICIENT RECONSTRUCTION OF UKRAINE'S CIVIL INFRASTRUCTURE: STRATEGIC PRIORITIES, CHALLENGES, AND IMPLEMENTATION PATHWAYS

During the ongoing war context, Ukraine faces an unprecedented challenge: rebuilding its destroyed infrastructure. However, this challenge also presents a unique opportunity to embed energy efficiency as a core principle of reconstruction. Energy-efficient rebuilding not only reduces energy consumption but also enhances economic feasibility, environmental sustainability, and quality of life for citizens.

Ukraine continues to align its legislation with European Union directives. Key legal instruments include:

- Law of Ukraine No. 3764-IX, which regulates the powers of state authorities in the field of energy efficiency and establishes a clear hierarchy of institutional responsibilities (Official Law Portal). [1]