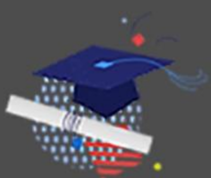
SUSTAINABLE DEVELOPMENT: MODERN THEORIES AND BEST PRACTICES



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Sustainable Development: Modern Theories and Best Practices

Materials of the Monthly International Scientific and Practical Conference (October 31 – November 1, 2024)

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The collection consists of materials from the Monthly International Scientific and Practical Conference "Sustainable Development: Modern Theories and Best Practices". They represent scientific research results in such scientific areas as financial and economic, managerial and legal, social and cultural, ecological and technical, educational and pedagogical issues of sustainable development on local, regional and international levels.

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The problems of sustainable energy supply for household consumers during wartime in Ukraine are exacerbated due to the critical destruction of the power infrastructure caused by constant shelling and, therefore, growing costs of energy companies for its restoration and maintenance. This situation leads to an objective increase in utility prices and deepening energy poverty. To reduce the financial pressure on the state to subsidize socially vulnerable groups of the population, it is promising to introduce strong investment support for the transition of such households to partial or full energy supply using renewable energy (RE) technologies and actively implementing energy-efficient (EE) measures. These technologies and measures reduce the negative impact of rising utility costs and deteriorating reliability of power supply to household consumers while advancing environment quality.

Improved energy policy in the residential sector should financially motivate households to make EE changes and implement green energy technologies, turning households into prosumers. Such support can be implemented in two forms, adapted to the international experience and the particularities of Ukraine's households:

1) providing interest-free loans for the implementation of EE measures andRE technologies (Sotnyk et al., 2022);

2) providing partial compensation for investments in such projects(for example, along the lines of the pre-war "warm loans" program) (CMU, 2011; SAEESU, 2021).

The specific feature of such support should be a focus on financing those households that cannot afford to take measures to improve their energy supply. This focus provides equal rights to the poorest to take advantage of opportunities to increase their energy independence and break the cycle of energy poverty. However, it raises the question of how to manage the budget funds allocated for investment support to maximize the effect at the state, regional, and individual household levels so that these funds do not repeat the fate of utility subsidies, which are consumed without any positive effect for the state and its energy independence. In this regard, the pre-war program of "warm loans" for EE measures (CMU, 2011; SAEESU, 2021) was quite effective, as the state provided partial compensation for the body of the loan taken from a bank to implement such measures, while some regions and municipalities offered additional compensation for part of the loan interest. As a result, public investment in energy savings was leveraged with private household investment at a ratio of 1:3, meaning that for every 1 hryvnia the state invested in compensation payments, households invested 2 hryvnias of their funds (Economic, 2021). However, the problem with this program was the high number of applicants for such loans, which meant that the funds allocated by the government were insufficient and quickly used up each year.

In wartime, the question of the efficient distribution of public funds is highly acute. Therefore, precise approaches are needed to define and differentiate the levels of state support for investments in households' energy independence. To this end, the minimum percentage of state compensation for "energy independence loans" to the population should be determined based on budgetary capacities and the attraction of donor support from other countries and international organizations and then increased differentially using various coefficients that consider regional peculiarities, the financial situation of households, the technologies and measures planned to be implemented, etc. Table 1 provides a basic list of factors that could be considered at the national/regional level through the relevant coefficients for implementing EE measures and RE technologies in the residential sector.

Table 1

Characteristics of factors and coefficients that may be considered in providing state (regional) investment support for EE measures and the installation of RE technologies in the household sector

The coefficient that considers:	Factors considered in the respective coefficient:
1Economically expedient unrealized potential of RE/EE technology	• natural conditions for the development of RE technology; • types of EE measures (technologies) that allow energy savings in the household sector; • a list of RE and EE technologies that are economically feasible for implementation in the residential sector of the country (region) at the current level of technological progress and their technical characteristics; • the economically feasible potential of implementing specific RE/EE technology in the residential sector of the country (region); • actual level of implementation of a particular RE/EE technology in the country (region).
2 Energy provision of the country (region)	• the total energy demand of the household sector in the state (region); • the energy demand of the household sector in the state (region) met through households' power generation based on RE technologies; • the energy demand of the household sector in the state (region) met through reduced (saved) energy consumption by households due to implementing EE measures.
3 Reliability and quality of energy supply	• status and level of power infrastructure development in the state (region) in the context of public access to energy services; • the quality and reliability of the existing power grids in the state (region), the frequency and duration of emergencies and scheduled outages in the power grids; • the level of destruction of energy facilities and the status of their restoration; • energy losses in centralized power grids.
4 Achieved level of energy supply decentralization	• available transmission capacity of power grids in the state (region); • the degree of decentralization of energy supply (in particular, the installed capacity of decentralized energy facilities) in the state (region), including in the household sector.
5 Impact of RE/EE technology on balancing the energy system of the state (region)	• level of energy system balancing in the state (region); • demand for maneuvering and energy storage capacities; • stability of energy supply based on a specific RE technology in the state (region), including the ability of RE technology to respond quickly to changes in demand and supply; • the installed capacity of maneuvering power plants and energy storage systems in the country (region); • projected reduction in load on power grids as a result of implementing a specific RE technology or EE measure.
6 Promotion of the development of RE/EE technology in the country (region)	• available national, regional, and local programs for preferential loans and tax incentives for investments in specific RE technologies and EE measures; • the existence and level of feed-in tariff for specific RE technology that can be implemented in the household sector; • regularity of feed-in tariff payments for specific RE technology; • the financial burden on the state budget due to feed-in tariff payments for specific RE technology in the household sector; • the financial burden on the state (regional) budget due to the provision of investment financial support for specific RE/EE technology in the household sector.
7 Environmental and social impact of implementing RE/EE	• level of environmental pollution in the state (region) and the potential for its reduction through the implementation of specific RE/EE technology in the household sector;

Additionally, at the household level, it is advisable to consider the following factors for adjusting the amount of investment support provided to specific households:

– complexity of the technical implementation of specific RE/EE technology in the household;

– investment in RE/EE technologies (per 1 kW of installed capacity of the RE plant, specific cost per 1 kWh of energy saved through EE measures);

– timelines for implementing an investment project (RE plant, EE measure) and the project's lifecycle duration (period of receiving benefits);

– the proposed installed capacity of the RE plant and/or energy storage system, the volume of energy savings resulting from the EE measure;

– annual electricity generation by the RE plant and energy savings resulting from the EE measure;

– type of RE plant (off-grid, grid-tied, with or without an energy storage system) and the degree of decentralization of household power supply achieved through specific RE technology implementation;

– household income level;

– level of household expenditures on utilities;

– possibility and stability of household access to the centralized power grid, etc.

The specified coefficients and factors identified for consideration at the state (regional) and household levels should be considered when determining the share of state compensation for investments in RE technology or EE measures for a specific household as follows:

$$CI_{i,j} = CI_b \cdot \sum_{i=1}^{N} (w_i \cdot F_i) \cdot \sum_{j=1}^{M} (w_j \cdot F_j), \qquad (1)$$

where $CI_{i,j}$ – the share of state compensation for investment in a particular RE technology or EE measure for a particular household, %; CI_b – base share of state compensation for investment in a specific RE technology or EE measure in the residential sector, %; F_i – coefficient reflecting the influence of the i-th factor on the development of a specific RE/EE technology in the country (region), the unit share; w_i – weight coefficient representing the importance of the i-th influencing factor at the state (regional) level, the unit share, where, $i = \overline{1,N}$, $\sum_{i=1}^{N} w_i = 1$; N – number of coefficients (influencing factors) at the state (regional) level; F_j – coefficient reflecting the influence of the j-th factor on the implementation of a specific RE technology or EE measure at the household level, the unit share; w_j – coefficient reflecting the influence of the j-th factor on the implementation of a specific RE technology or EE measure at the household level, the unit share, where $j = \overline{1,M}$, $\sum_{j=1}^{M} w_j = 1$; M – number of influencing factors at the household level. (1)

The proposed methodological approach will allow the state to co-finance EE and RE projects in Ukraine's residential sector to increase energy independence instead of spending funds on utility subsidies each year, which do not address the issues of energy poverty and sustainable household energy supply in wartime and the post-war period. Consideration of factors such as the existing potential of RE resources and energy efficiency opportunities in the residential sector, the level of energy needs satisfaction, environmental pollution in the respective region, and the potential for its reduction through the implementation of RE and EE projects in households, the state of the regional energy infrastructure, and the specific characteristics of projects at the household level, transforms this approach into a universal tool for effectively allocating state investment support within the framework of a just energy transition.

The practical implementation of the methodological approach will systematize the investment decision-making process based on clear criteria for assessing RE and EE projects in households and improve the monitoring of investment results, which will allow timely identification of problems and adjustment of investment strategies in line with the national energy policy. As a result, it will contribute to a more efficient and balanced development of RE and EE in Ukrainian households, which in turn will help build a reliable, environmentally sustainable, and cost-effective energy system.

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MODELS OF COMMERCIALIZATION OF DISRUPTIVE TECHNOLOGIES

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The theoretical and methodological essence of breakthrough technologies is to understand their impact on the development of markets, economic systems and society as a whole, as well as to study the approaches and methods used for the development, implementation and commercialization of such technologies. Disruptive technologies are innovations that fundamentally change the structure of the market, replace existing products, or create new market segments, often causing economic, social, and technological transformations.

Disruptive technologies are characterized by the fact that they offer new solutions that, over time, can completely change the structure of the market or form a new one. Distinctive features of such technologies:

- provide radical innovation: fundamental changes in approaches to solving