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MINIMIZATION OF ENERGY EFFICIENCY BARRIERS IN THE CONTEXT OF OPTIMIZATION OF MANAGEMENT DECISIONS IN THE PROCESS OF SUSTAINABLE DEVELOPMENT

The object of research is the socio-economic model of the country in terms of energy efficiency factors in the process of economic development. The author has adapted the taxonomy of barriers and identified a new group of barriers inherent in the socio-economic models of countries with economies in transition. Achieving the goals of sustainable development is possible by achieving overall energy efficiency, which is provided by the implemented innovative energy technologies. The ability of the studied subjects to perceive and promote innovative energy technologies is determined by the level of their economic development. When building the concept of energy efficient management, the studied subjects should take into account the exhaustion of primary resources against the background of growing needs. One of Harrington's logical functions was used to determine the level of economic development of the studied subjects. In the indicators of the particular desirability of Harrington's logical function, indicators from 0.37 to 0.8 are the potential for development, currently unrealized in the studied subjects, which is the path to sustainable development. According to certain levels of private preferences, economic agents are given recommendations on the economic feasibility of introducing innovative energy technologies. At the same time, the research process involved the identification and localization of energy efficiency barriers in the studied subjects, which expanded the analytical opportunities in terms of providing practical recommendations. Such recommendations, combined with the private preferences of the studied subjects, allowed to formulate a conceptual scheme to increase the efficiency of energy resources of economic development management. The author proposes measures: scaling of grant financing, decentralization of energy sources, introduction of knowledge, cooperation of communities and in the community, development of entrepreneurship and greening of the environment. Directions strengthen the motivation of management decisions in the context of the effective impact of energy factors on the dynamics of economic development in modern conditions and can be used in the development of current and strategic plans and programs.

Keywords: *energy efficiency barriers, taxonomy of barriers, management decisions, sustainable development.*

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1. Introduction

In today's economic environment, overall energy efficiency is a global goal of sustainable development, but the achievement of such energy efficiency is possible through the introduction of innovative energy efficient technologies. Barriers to implementation prevent the diffusion of innovations and offset the expected economic effect of the introduction of innovative energy efficient technologies, creating a gap in energy efficiency. Such causes are classified and studied in developed economies as barriers to energy efficiency.

The taxonomy of barriers has been adapted and a new group of barriers inherent in the socio-economic models of different states has been identified. The taxonomy of energy efficiency barriers, typical of countries with economies in transition, is considered in the article, it is considered on the example of Ukraine. These are the barriers of the transition period, which are the result of the socialist way of life and joint ownership of the means of production, formed by the peculiarities of the socialist system and the miscalculations of the transition period. The application of taxonomy in practice for the analysis of used grant funds shows the direct direction of funds, the localization of grant activity which may indicate energy saving problems that require priority intervention and creates the need to develop a system of energy efficiency factors in managing economic development. The reflection of these problems focuses on the failures of grant activity, which, in addition,

systematize the infrastructure and socio-economic processes deprived of economic support.

2. The object of research and its technological audit

The object of research is a socio-economic model of the country in terms of energy efficiency factors in the process of economic development on the example of Ukraine. The socio-economic model of Ukraine has certain features inherent in the transition economy. The market structure of Ukraine is not fully formed. The energy efficiency barriers identified in the Ukrainian socio-economic model make it possible to analyze the obstacles to the introduction of energy efficient technologies and use this approach in the energy management system when planning energy efficiency measures. At the same time, the measures introduced as a result of such observations can reduce the energy efficiency gap with the introduction of innovative energy efficient technologies.

Thus, one of the most problematic places is the formation of approaches to improving the efficiency of energy factors in managing the economic development of the region. Such approaches should be based on the concept of sustainable development, summarizing the trends and factors of modern energy on the basis of European integration opportunities and management tools provided by the decentralization reform. In addition, to overcome the disproportion and regression of local actors and to focus not only on energy efficiency and energy saving, but also on infrastructure development and social development.

3. The aim and objectives of research

The aim of research is to identify approaches to improving the efficiency of energy management factors by minimizing energy efficiency barriers in the context of optimizing management decisions in the process of sustainable development.

To achieve the aim of research the following scientific tasks are set:

1. To identify grant funding as a factor influencing the increase in productivity of energy efficient technologies and infrastructure development in the studied subjects.

2. To develop a conceptual scheme to increase the efficiency of energy resources for managing the economic development of the region.

4. Research of existing solutions to the problem

Promising methods of energy resources management are combined with extensive practical experience and scientific and technical achievements of evolutionary economic theories.

Modern economic theory, which systematizes the effects on the actual economic effect of the introduction of innovative energy technologies, is the theory of energy efficiency gap. The theory describes a situation in the socio-economic system when the available technical and technological opportunities to improve energy efficiency, despite their potential economic efficiency, are not fully applied due to various reasons. In scientific sources of literature such reasons are investigated using the terminology of energy efficiency barriers [1].

In 1994, the concept of «energy efficiency gap theory» was introduced for the first time [2], which marked the beginning of research in this area as a theory [3]. Prior to that, in 1980, the existing social and institutional barriers were systematized and classified [4], which formed five non-price categories of energy efficiency barriers:

1) inconsistency of incentive measures;
2) lack of information;
3) regulation system;
4) market structure;
5) traditions [3].

Subsequently, energy efficiency barriers were identified and systematized from different perspectives [5, 6]. In the implementation of energy efficient technologies, taxonomy of barriers to energy efficiency [7–9] are the most complete and thorough study of the energy efficiency gap in different countries. At work [10] theoretically substantiated energy efficiency barriers in relation to Ukraine. The author adapted the basic structure of energy efficiency barriers for the Ukrainian socio-economic model. The study identified a new set of barriers inherent in this model, which on the one hand is a consequence of the socialist way of life and joint ownership of the means of production, and on the other – the miscalculations of the transition period. These barriers have been identified and described, and their main characteristics have been identified. Logically, the new group of barriers has been dubbed the «barriers of transition» and includes five barriers: oligarchic, post-Soviet, subsidy, reputational and communal. However, barriers have not been considered in practice. The application of the taxonomy of energy efficiency barriers in practice allowed to offer an approach to assessing the ability of the studied subjects to perceive and promote innovative energy efficient technologies [11]. At the same time, the methodological approach to the calculation of the integrated indicator of innovation orientation was improved by practical determination of indicators of innovation orientation according to new primary indicators calculated using the taxonomy of energy efficiency barriers in the studied administrative units. At the same time, this work did not identify dominant and most focused barriers, nor did it focus on grant failures. In addition, in addition to the study, it is advisable to calculate «private preferences» from the obtained generalized integrated indicators, to provide recommendations for minimizing barriers and improving the efficiency of energy resources for economic development management.

5. Methods of research

The following scientific methods were used in the study:
– method of historical analysis, abstract-logical analysis – when considering the concept of energy efficiency gap theory and defining the theory of energy efficiency barriers in the world;
– comparative and statistical analysis, dynamic analysis, economic analysis and synthesis – in the course of consideration of the current state and prospects of the energy sector, energy consumption of the studied agents, identification of energy efficiency barriers in Ukraine;
– system-structural analysis and synthesis, economic-mathematical analysis – during the formation of recommendations for improving the efficiency of energy factors in managing the economic development of the region.

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6. Research results

Summarizing the research presented in [11], it should be noted how grant funds developed in communities reduce the impact of six energy efficiency barriers, namely: barriers to corporate culture, heterogeneity of economic agents, values, lack of information; and a group of barriers of the transition period of communal, subsidy. This is clearly shown in Fig. 1.

Three barriers that dominate Ukrainian communities:

1) communal (Chuhuiv, Natalinka UTC (united territorial community), Merefa UTC, Izium UTC, Krasnokutsk, Chuhuiv, Chkalovske UTC, Zolochiv UTC, Pervomaisky, Pisochyn UTC, Mala Danylivka);

2) corporate culture (Rohan UTC, Babai village, Staryi Saltiv UTC);

3) heterogeneity of economic agents (Bohodukhiv).

Barriers of the greatest attention are formed in Chuhuiv, Merefa UTC, Bogodukhiv, Pervomaisky, and are divided into: corporate culture (Merefa UTC, Pervomaisky); heterogeneity of economic agents (Chuhuiv); communal (Bohodukhiv).

The barrier of the greatest attention is both the dominant barrier, i. e. both the amount of grant funds and the number of projects are concentrated in one issue in the following subjects: Natalinka UTC, Izium UTC, village Krasnokutsk, Chkalovske UTC, Zolochiv UTC, Pisochyn UTC, Mala Danylivka UTC, Rohan UTC, village Babai, Staryi Saltiv UTC.

Grant failures occurred in four groups of barriers. Economic barriers: subgroup nonmarket barriers: hidden cost of implementation, difficult access to capital, riskiness of investments. Subgroup of market failures: inconsistency of motives, unfavorable choice, form of information presentation. Behavioral barriers; limited rationality, lack of trust, inertia. Organizational Barriers: Conflict of Power. Transition period: oligarchic, reputational, post-Soviet.

Fig. 1 clearly shows that the first place in the number of projects went to Chuhuiv, the second place went to Zolochiv UTC, the third place went to the city of Pervomaisky. According to the totality of grant financing in the analyzed period, funds were distributed as follows (Fig. 2). In terms of monetary value, other infrastructural changes are dominated by Pisochyn UTC, Merefa UTC and the village Krasnokutsk. In terms of funds for the implementation of projects that reduce the impact of barriers, the leading positions are occupied by the cities of Chuhuiv, Pisochyn and Zolochiv UTC.

The taxonomy builds a hierarchy of barriers, the impact of which is reduced by attracting grant funds. Dominant barriers, most attention barriers and grant funding failures in the subjects were identified. At the same time, the infrastructure that formed the first group of other investments was analyzed from the point of view of infrastructure development and generalized. Both grant funding groups influence infrastructure and technological change, creating a chain of upgrades that determines the further development of the participants in these projects.

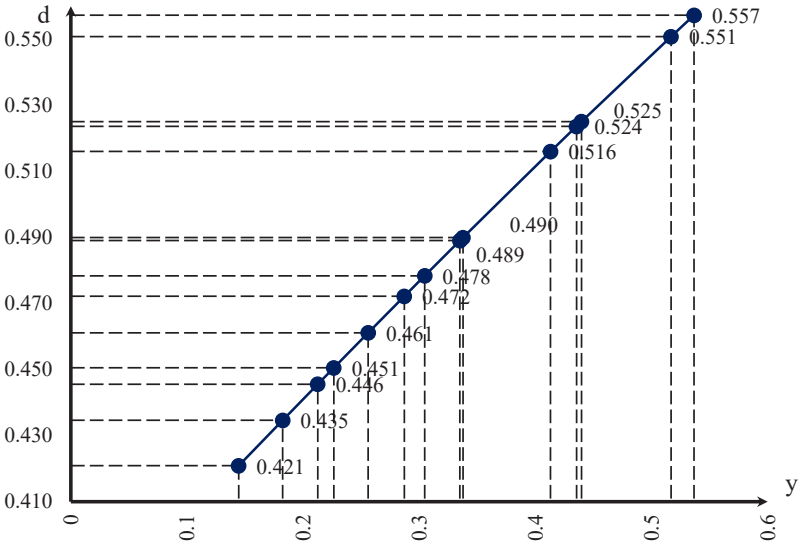

Fig. 2. Fragment of Harrington's «desirability curve» to reflect the innovative orientation of energy efficient technologies of administrative units of the Kharkiv region

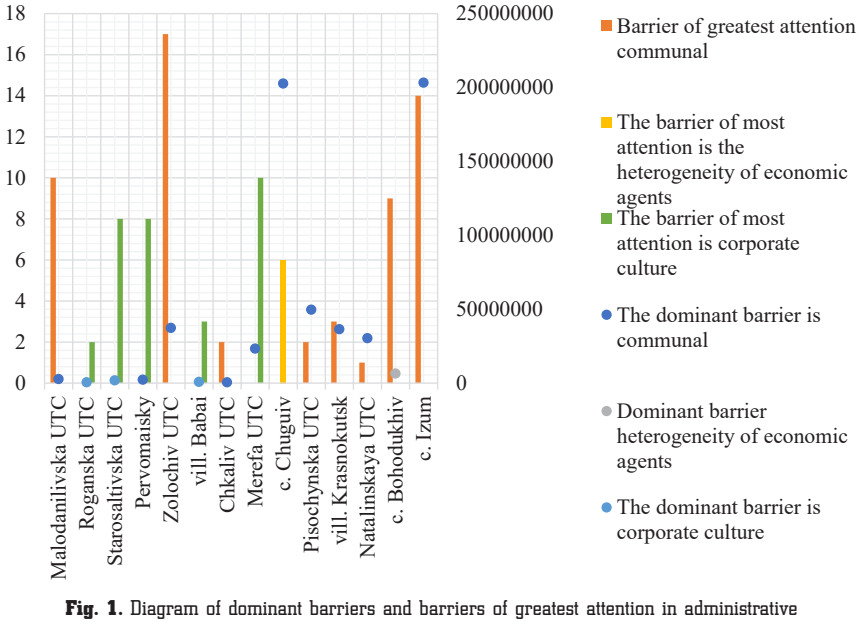

Fig. 1. Diagram of dominant barriers and barriers of greatest attention in administrative units of Kharkiv region

Failures of grant activity should be noted separately. These failures, classified by barriers, are identified for each subject separately as not covered by grant funding. The presence of such failures causes a disproportion of socio-economic development and affects the introduction of energy efficient technologies. Every failure becomes a barrier to the introduction of innovative energy efficient technologies.

To determine the ability of the studied subjects to perceive and promote energy efficient technologies, one of the logical functions of EK Harrington is used – the «desirability curve» [12]. This allowed to turn the generalized integrated indicators of innovative energy efficiency orientation calculated in the study [11] into private preferences for each research subject.

The segment 0.37–0.62 hypothetically possible comprehensive development; 0.63–0.8 development of the structure requires innovative development; 0.8–1.0 approach to perfection, development slows down, extraordinary innovations encourage; at 1.0 development is possible by changing the system [13]. The value of the function of the «desirability curve» from the mark 0.37 is an economic and mathematical definition of the beginning of economic development [14].

The results obtained are in the range of 0.420–0.557, which corresponds to a score of «satisfactory», which characterizes the average state of private desirability of the subjects. Graphically defined preferences belong to the third segment of the value of the Harrington desirability function.

Summing up the analysis, it should be noted that:

– the level of the generalized integrated indicator of the studied subjects is reduced by three groups of indicators: *introduction of innovations, creation of knowledge, leaders of innovations;*

– increases the level of the integrated indicator group of indicators of diffusion of innovations, due to the presence of energy efficiency measures in community strategies and energy saving and energy efficiency measures, which led to a reduction in energy consumption;

– economic growth rates in all subjects are not significant, due to lack of funding.

Thus, the level of the generalized indicator of innovation orientation of the studied subjects as a whole showed the tendency and intensity of innovative development. The latter cannot be assessed unambiguously, although indicators of *innovation diffusion* manifested in specific energy efficiency results, and indicators of *knowledge dissemination* have the lowest values in the subjects. It should also be noted the lack of funding, which according to the author slows down economic development.

At the same time, the obtained indicators of private desirability show that communities have gone through a period of stagnation and are progressing. The results of the study show the possibility of breaking down the green integrated indicator into groups: the introduction of innovations, economic growth, innovation leaders of knowledge dissemination. This allows to identify factors that significantly affect economic development in general, and the introduction of energy efficient technologies in particular. This ultimately allows for economic adjustment of the direction of further development of the subject of study and provides long-term dynamic planning [15].

The value of private desirability over a period of time determines the dynamics of the subject of development and the achievable level of perfection. Based on the results of private indicators of desirability of the studied subjects, it is possible to assess their capabilities, provide recommendations on ways to modernize them. Given the relative uneven economic development of the subjects, it is significant that the private desires of these subjects lie in one segment of the 0.37–0.63 «curve of desirability» of Harrington. This affiliation indicates a wide range of opportunities for development.

At the initial levels, it is advisable to carry out any development activities, as they will raise this subject higher. It is necessary to take into account the effect of energy efficiency barriers, which are indirectly indicated in the integrated assessment by the level of innovation diffusion. Lack of funding must also be taken into account. There will be no mass demand for cost energy technologies, and hence payback. Adjusted for infrastructure imperfections, it is advisable to implement the most affordable energy efficient technologies (e. g., LED lamps), energy saving technologies. Large-scale energy efficiency measures are justified on closed cycles, which become both a source of innovation and save energy resources. These can be infrastructure facilities (built or renovated) with a total minimum energy consumption (almost zero energy consumption). Given that high-cost energy efficient technologies are not economically justified in the conditions of the studied subjects, it is advisable to implement them through subsidy funding, such as grants. According to the results of the study, the following recommendations can be provided to accelerate economic development with an emphasis on energy resources (Fig. 3).

Introduction of knowledge. Innovative changes depend on human development – educational, cultural and creative. The grant orientation of communities should extend to this area as well. This will form an energy-conscious society, which today is a strategic task not only at the state level, but also at the local level. Educational, cognitive and creative activities from the authorities are well received by the human community, in contrast to slogans and appeals. Comprehensive digitalization is needed in educational institutions at all levels. Digital learning and expert learning contribute to the full development of students. On the basis of digitalized and modernized libraries to create centers of knowledge for residents of communities of all ages, to conduct training seminars, open microphones, to introduce circles and public platforms for public discussion. The measures taken should result in energy-saving and rational lifestyle skills. Introduce energy managers and auditors and conduct regular training for them. Digitalization should ensure the introduction of an energy management and energy monitoring system in all households, to ensure the sustainable work of energy managers, as well as to be able to monitor the results of energy saving measures. Dynamic energy monitoring should become an integral part of the life of the modern community on the basis of mass digitization and introduction of reading meters.

Greening the environment. Exchange and rejuvenation platforms, elements of the circular economy should be introduced at the community level. Introduction of separate collection and sorting points for waste for further processing, as well as introduction of controlled collection points for hazardous waste (batteries, light bulbs, medicines, thermometers, etc.) and their further transfer to licensed processors. With the support of activists and local authorities in communities, the introduction of «clean days», the program «Plant a tree», etc. Carrying out ecological and energy-saving measures by entrepreneurs contribute to the formation of an energy-conscious society. Local incentives and the system of fines create healthy competition in the social environment and form an energy-conscious society. The community should implement control programs to green water, air and land.

Entrepreneurship development. Local entrepreneurship promotes community development, creates jobs, fills the budget with taxes. Attention should be paid to the development of environmental energy companies, including those involved in the implementation of energy technologies, provide training services and facilitate access to capital for energy saving measures.

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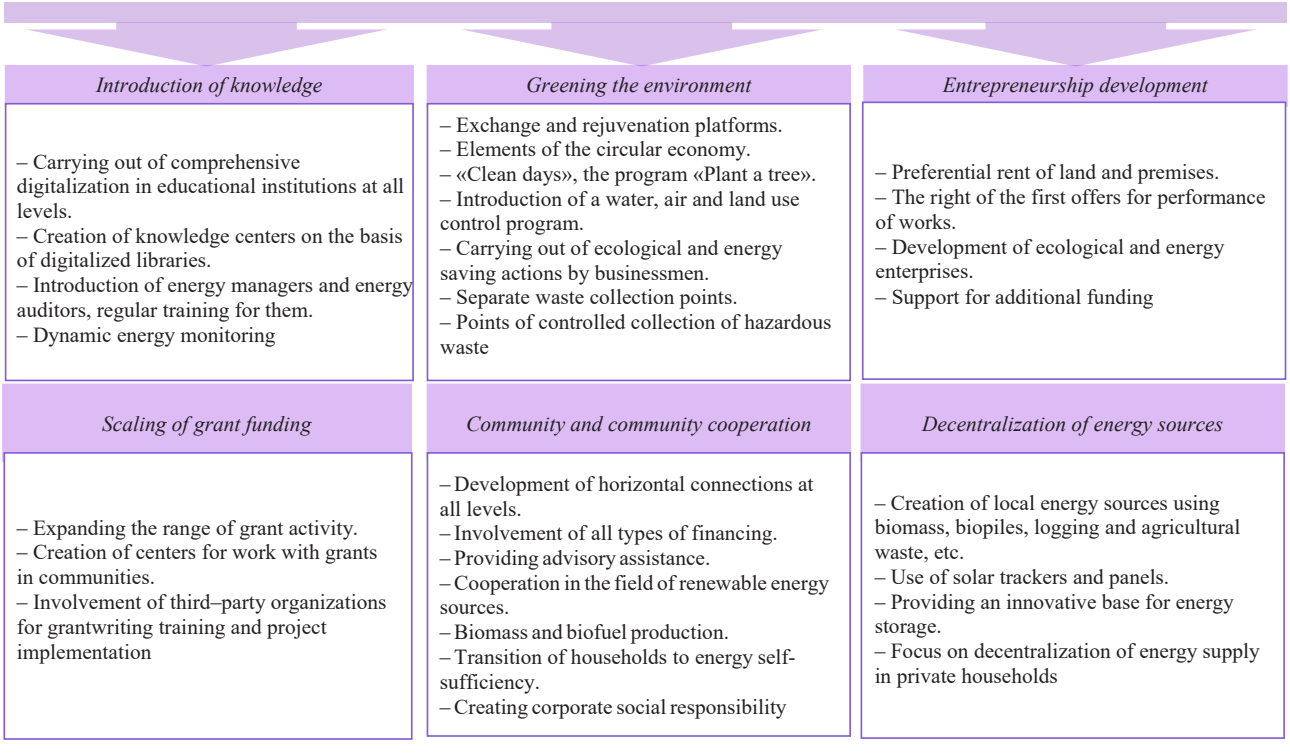

Fig. 3. Conceptual scheme of increasing the efficiency of energy resources management of economic development of the region

For such enterprises, the community can provide preferential lease of land and production space. Support local businesses by primarily offering community modernization work on energy modernization. Economic incentives for the creation of innovative entrepreneurship in the community make it possible to develop infrastructure and receive additional financial income, as well as ensure further harmonization with global development. The community can act as a guarantor when entrepreneurs receive low-interest loans for business development.

Scaling of grant funding. The analysis of grant projects showed that the range of grant activity of the studied subjects is narrowed and reduced to the overwhelming majority to the reconstruction and creation of communal and equivalent infrastructure, as well as the development of public places. The development of knowledge, skills, abilities, formation of values of social interaction and culture of resource consumption are not covered by grant financing. In order to scale up the grant programs, it is advisable for research subjects to involve as many of their own employees or their groups as possible, to conduct their training, and to regularly improve their skills by participating in specialized trainings. This is well received by grant-making organizations and inspires confidence in the structure. We consider it irrational to refuse the help of third-party organizations, on the contrary, they need to be involved and diversify the directions of grant initiatives. The fundraising initiative should be created within the administrative unit, and the implementation measures should be controlled by it independently of the project executors. Emphasis should be placed on grants from foreign foundations, organizations and representative offices, such grants are the export of technology, knowledge, human experience, which can be integrated into the community with the support of foreign specialists.

Community and community cooperation. Development of horizontal links based on common economic or cultural interests of individuals, households and communities, involvement of all types of financing, provision of advisory assistance. An example of such cooperation is the production of biomass and biofuels. The subjects are located around a large city that accumulates waste outside its borders – this exaggerates the problem of waste in communities. Given the compact location, as well as the common boundaries of some subjects, the author considers it appropriate to jointly build lines for sorting and processing of all types of waste, cooperation in the production and storage of renewable energy sources (RES). It is expedient to develop cooperation of communities in the elimination of unauthorized landfills, implementation of joint educational projects and construction, receipt and provision of advisory assistance and joint attraction of grant and other types of funding. Facilitating the transition of households to modern energy self-sufficiency provides not only energy savings and localization of energy sources, but also the transition to low consumption. The introduction of corporate social responsibility (CSR) is a modern form of cooperation between enterprises and government (communities), which improves the microclimate, food, environment, contributes to the consolidation of society.

Decentralization of energy sources. Creation of local energy sources using biomass, biopiles, firewood, felling and agricultural waste, etc. Use of solar trackers and panels to ensure a sustainable power supply. Providing a reliable base for energy storage, which consists in the use of reliable modern equipment that meets the technical requirements of local sources and modern trends in innovation. Based on the experience of European countries, private households should switch to autonomous supply and storage of electricity.

7. SWOT analysis of research results

Strengths. The strengths of the study and application of the taxonomy of energy efficiency barriers are the identification of the main characteristics of energy efficiency barriers in Ukraine in relation to those identified in foreign systems and the identification of a new group of barriers. The directions of increase of efficiency of energy resources of management of economic development of region offered by the author strengthen motivation of administrative decisions in the context of effective influence of energy resources on dynamics of economic development in modern conditions. They can also be used in the development of current and strategic plans and programs by economic entities and governments at various levels.

Weaknesses. The analysis showed that one of the most problematic places is the detection, identification of energy efficiency barriers and their minimization. The process of identifying barriers is complicated not only by the problem of identifying them in each case, but also by the lack of experience and specialists who can identify barriers and assess the extent of their impact. It should also be borne in mind that each barrier has a different impact on the detection and disposal of the main barrier, which will significantly reduce the impact of other barriers.

Opportunities. In order to control the impact of energy resources on economic development, the author proposed to monitor such development using the theory of energy efficiency barriers. Given the average level of economic development, the entities are recommended to localize in practice the sources of energy efficiency and infrastructure development, and to carry out large-scale measures through non-refundable investments. The role of this type of financing at a certain economic level, given the failures of infrastructure, is difficult to overestimate.

Threats. The process of introducing energy efficient technologies is associated with the complexity and duration of their promotion on the market, the relatively high cost, in addition, is hampered by a number of obstacles and barriers to energy efficiency. To identify the impact of energy factors on economic development in each, it is necessary to conduct basic research and collect primary data. Therefore, if the barriers and their degree of impact have been identified incorrectly, the result of the measures taken may be much lower than expected. Such a mistake can lead to significant financial losses, so a detailed analysis of the impact of energy efficiency barriers should be conducted before taking action and purchasing technology.

8. Conclusions

1. Grant funding is identified as a factor influencing the increase in productivity of energy efficient technologies and infrastructure development in the studied subjects. Measures are proposed such as:

– scaling of grant funding;
– decentralization of energy supply sources;
– introduction of knowledge;
– cooperation of communities and in the community;
– development of entrepreneurship and greening of the environment.

These measures are aimed not only at energy efficiency and energy saving, but also at infrastructure development and public development.

2. It was found that when building the concept of energy efficient management of the studied subjects, it is necessary to take into account the exhaustion of primary resources against the background of growing needs. Indicators of private desirability from 0.37 to 0.8 have a significant potential for development, including energy saving and energy efficiency. This should be achieved primarily through modern methods and tools that are widely represented in grant and other funding. The developed conceptual scheme of increasing the efficiency of energy resources factors in the management of economic development of the region outlines the potential for development that exists today in the studied subjects – this is the path to sustainable development.

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