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Research paper

Buildings Energy-Efficient Renovation Investment

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Abstract

The scientific approach to the definition of strategic investment priorities in the complex renovation of areas affected by natural and technology-related emergencies, the introduction of energy-efficient technologies and alternative energy, which involves the construction of strategic priorities selection matrix with the investment processes coordination in the regional and alternative energy sectors is proposed. Its carrying out allows to improve the investment management process in multivariance terms of investment process implementation options. Influence on certain elements of the territories renovation organization, which will facilitate the additional resources investment involvement for the building structures renovation, is determined.
The economic effect of the research and development introduction is to reduce the energy and material intensity of the reconstruction complex of works due to the most efficient materials use, as well as the reduction of construction time, labor costs and energy consumption during construction.

Keywords: *alternative energy, area renewal, energy efficiency, renovation of buildings, state construction policy, strategic priorities*.

1. Introduction

Occurrence of technology-related emergencies on the part of the Ukrainian territory have resulted in mass damage and destruction of residential, public and industrial buildings, civil defence facilities, engineering infrastructure objects, etc. Taking into account the actual national and foreign renovation experience, modern advanced building technologies and personal research and developments, a promising way to solve this problem is implementation of new energy-efficient methods for the urgent construction and strengthening of damaged load-bearing and cladding structures for destroyed building reconstruction in short construction terms during operation and liquidation of natural and technology-related emergencies consequences.
Hence, the aim of the work is comprehensive problem solution of investment into energy-efficient industry renovation, residential and public construction and engineering infrastructure of areas affected by natural and technology-related emergencies (military operations as well) with the use of new complex high-tech and resource-economical methods and structures.
This problem comprehensive solution requires development and introduction of new types of energy-efficient building structures, methods and technologies for their design and construction, as well as investment efficiency assessment, taking into account international experience in the development of energy- efficient technologies and alternative energy introduction as a state policy priority area at the present stage of the Ukrainian economy development.

2. Main Body

At present stage of productive forces development among the priorities of the national interests of Ukraine, our state determines the necessity of providing ecologically and technologically safe conditions for the citizens and society, natural environment preservation and natural resources rational use. National security of Ukraine directly depends on expedient state policy of national interest's protection in political, economic, social and environmental spheres. Under the conditions, introduction of energy-efficient technologies and alternative energy in the renovation process of areas affected by natural and technology-related emergencies is a priority area of the state policy at the present stage of Ukrainian economy development.
A state policy effective mechanism in the field of energy efficiency and renewable energy is a fundamentally new model of work based on the public-private partnership principles. Through the introduction of economic incentives, the state has provided the necessary impetus to business entities, contributing to the intensification of activities in this area and, in fact, it has created a new, high-tech industry in Ukraine which has a high added value, the industry that can successfully compete in world markets. Implementation of energy-efficient technologies and alternative energy in rehabilitated areas, affected by natural and technology-related emergencies has become an urgent need, as it contributes to solving not only energy supply problems, but also many environmental, economic and social problems.
When investigating the investment support of energy-efficient technologies and alternative energy introduction in the rehabilitated areas affected by natural and technology-related emergencies, it

should be noted that characteristics of investment results are not always taken into account in investment interpretation. Investing result, besides making a profit, is undoubtedly an achievement of a positive social, environmental, innovative effect, etc. The most important stages in investment process are the following: first, the emergence of objective needs and opportunities for investing; second, justification of investing expediency; third, forecasting and planning of investment activity, taking into account current norms and legislation; fourth, preparation of investment projects and their efficiency substantiation; fifth, verification of the real conditions for project financing; sixth, insurance of investment projects; seventh, the investment projects implementation and formation and results control [2].

On the basis of generalization of scientific approaches to the investment process essence definition, the stages of its implementation and component provision, implementing the investment process model in the field of alternative energy was constructed. The model includes certain stages, in particular the definition of investment resource requirements in the field of alternative energy, justification of alternative energy objects choice for investment and investment projects implementation. These stages determine the sequence of actions for the investment process implementation in the field of alternative energy and are detailed by the relevant types of work, risks at certain stages of its implementation, and the state support levers.

The mechanism of investment process realization envisages identifying certain management factors, in particular, the investment volume, their orientation and directions of use; approval of influencing the management factors methods, which facilitates the investment process implementation, taking into account the level of technical and technological capacities, economic development, state of production capacities and financial resources; determining the amount of necessary resources at the expense of which the influence on the investment process management factors is carried out [1].

Investment process implementation in the field of energy-efficient technologies and alternative energy sources carrying out in the rehabilitated areas affected by natural and technology-related emergencies should create conditions for its stable functioning at the present stage and provide high potential for future development. In this regard, the investment process forms the basis for creating conditions for economic stability, independence, sustainability of alternative energy functioning and its ability to develop in the future. Formation of more effective mechanism for implementing the investment process can contribute to a positive chain reaction in terms of ensuring stable functioning and development of alternative energy.

Economy development in any country and the provision of investment processes are realized in the form of investment projects set. At the same time, the key role in the context of the national economy competitiveness is played by economic efficiency indicators of investment projects. The basis of investment decision-making process approval is to evaluate and compare the volume of expected investments with future cash inflows. The methodology uses cost-effectiveness indicators of investment projects that include: net present value (NPV), internal rate of return (IRR), discounted payback period (DPP), Discounted Expenditures (DE), Discounted Expenditure Profitability Index (DEPI), and a number of others. All indicators set values that characterize the project effectiveness throughout the entire life cycle from the construction beginning to the decommissioning.

Any investment project, regardless of its specifics at each stage t, generates different, positive and negative cash flow ϕ_t. The discounting method is applied to adjust them to a single moment t0, it is reduced to multiplying by the discounting member:

$$\phi_\tau = 1 \Big/ (1+d)^{-(t-t_0)} \quad (1)$$

where d is a set discount rate, t is the current step and moment.

From the investor's point of view, the most important indicator is the NVP, which is calculated by the formula:

$$NPV = \sum\nolimits_t \phi_\tau (d) \quad \text{or} \quad NPV = \sum\nolimits_{t=T_1}^{T_2} \frac{D_t}{(1+d)^t} - \sum\nolimits_{t=0}^{T_2} \frac{R_t}{(1+d)^t}, \quad (2)$$

where D_t - is current profits at moments of time t; R_t - current cash expenses at the time t; d - discount rate; T_1 - construction period, years; T_2 - project life cycle, years; t - discrete time (number of year or quarter).

Important additional assessments of the project's economic efficiency and sustainability are the project limit parameters. The project limit parameters x for the exponent f (x) is the value x0 for which the economic efficiency index is zero, that is, f (x0) = 0.

The limit parameters for NVP are:

– Project Internal Rate of Return (IRR), that is, the interest rate at which NVP is equal to 0.

– Project Discounted Payback Period (DPP), i.e., the time period necessary for revenues generated by investments including discount, to cover the investment costs. This indicator is deter-mined by sequential calculation of NVP for each project period. The point, in which the NVP will acquire a positive value, will be a payback point.

If the investor is the owner, for example, the state, then discounted costs (DC) are usually the main indicator of economic efficiency, which are calculated by the formula:

$$\mathrm{DC} = \sum\nolimits_{t=0}^{T_2} \frac{R_t}{(1+d)^t} \quad (3)$$

where T_2 is a project life cycle.

The DC indicator is also used in calculation of medium and long-term energy development programs. At the same time, the program, which in many options, provides the minimum value of the total DC to the program is considered an optimal one. When ranking projects, the indicator of specific discounted costs is often used.

It must be emphasized that in formulas (2) and (3), financial flows, in general, are set on the horizon of planning in the form of time functions and discounts. In modern foreign and domestic economic literature, the discounting concept is the basis on which the estimates and comparative efficient indicators of various investment projects are based. When taking into account the risk and inflation, more complex discounting formula is used:

$$\sum\nolimits_{t=0}^{T} \frac{1}{(1-I)^t (1+E)^t (1+R)^t} \quad (4)$$

where I – inflation rate; R – risk adjustment (risk premium); E – bank interest.

The necessity of applying the discounting method in the economic literature is considered to be the one not requiring a proof. The disputes are only about what discount rate d> 0 should be specified when conducting the calculations. Discount rate is the given exogenous basic economic standard, used in assessing the investment project efficiency.

It should be mentioned that while assessing the investment process efficiency it is necessary to take into account that Ukraine's significant natural, economic, technological and human resources have all the prerequisites for integration into the world economy. They have a global nature of implementing investment process and expand the possibilities for adapting domestic economy to the glob-al investment process. As international experience shows, the main characteristic of the state policy success in developing modern efficient mechanism for attracting investments is to increase national economy competitiveness. The competitive advantages

development will enable country investment potential realizing and ensure its economic development.

In recent years, energy-efficient technologies and alternative energy have become one of the world's most active directions in economy. The total number of people employed in the "green" technology sector was 3 million people, and investment in this area in the world amounted to about 270 billion dollars. Experts estimate that Ukraine has a huge potential for the alternative energy development. Energy production from clean renewable sources can be a strong factor in GDP growth. This is because new technologies and developments provide an increased level of added value.

The necessity to study the prospects of using alternative energy for the areas restoration affected by natural and man-made emergencies is caused by negative state and trends in the fuel and energy sector of Ukraine, namely: due to the growing scarcity of domestic primary energy resources, increase in their cost in the world market and the problems of external suppliers, the inefficient use of available energy resources, the diversification lack of fuel sources, the low rates of increasing energy production from renew-able sources, which creates a problem not only in energy supply, but also creates many environmental, economic and social problems, in particular, a threat to Ukraine national security.

The existing great potential for introduction of energy efficient technologies and alternative energy for the territories restoration affected by emergencies and exploring possible environmental factors for the development efficiency and investment implementation in this area was determined. The necessity of state authority participation in this process was substantiated. The author considers it expedient at the present stage of Ukraine's development to have a clear state strategy for the implementation of energy efficient technologies and alternative energy for the areas restoration affected by natural and man-made emergency situations. In this context, it is important to develop approaches for justifying the choice of energy efficiency and alternative energy development strategy in areas that require restoration.

The approach is suggested from the point of view of combining the basic prerequisites for choosing an alternative energy development strategy, assessing the implementation efficiency strategy for the energy efficient technologies and alternative energy development in areas requiring restoration and the process of developing the strategy for individual phases. This approach integrates the main elements of the development strategy justification and the synergetic effect resulting from this combination. It will enable developing a real, efficient and timely strategy for the energy efficient technologies and alternative energy development in areas requiring restoration, which will be taken into account and positive foreign experience in implementing such strategies, which is very relevant in modern conditions.

According to the proposed approach, a set of methods is scientific and methodological basis for analyzing the strategy implementing efficiency for energy-efficient technologies and alternative energy development in areas that require restoration. These methods are as follows: portfolio analysis (matrix method): BCG matrix – growth rates and market share analysis, matrix of MCC – business correspondence analysis of the enterprise mission and its key competencies, matrix GE/McKinsey – analysis of comparative market attractiveness and competitiveness business, Shell matrix – analysis of the resource-intensive industry attractiveness depending on competitiveness, Ansof matrix - strategy analysis in relation to markets and products, matrix ADL – analysis of the industry life cycle and relative position in the market, SWOT analysis: an analysis of enterprise strengths and weaknesses – in relation to other enterprises in the field of renewable energy, opportunities and threats.

The scientific basis for choosing an alternative energy development strategy involves the development of a toolkit for the state regulation of energy efficient technologies and alternative energy in areas requiring restoration using elements of strategic management.

The defined approaches to the strategy justification for the energy efficient technologies and alternative energy development in areas that require restoration allow a thorough study of the main factors of energy efficient technologies and alternative energy development, namely: the strategy forming process of energy-efficient technologies development, combining analysis of alternative energy saving strategies, calculating the size of investments from alternative strategies in energy saving, forecasting the alternatives approach dynamics, assessing the competitive advantages of the chosen strategy and its compliance with the overall goal of reducing the state's energy dependence, strategic plan, projects, programs development that are consistent with the Energy Strategy of Ukraine to 2030, implementation of renewable energy strategies and monitoring short-term and long-term strategy results.

In accordance with the investment process implementation structure, identifying the potential of alternative energy, it is necessary to justify the choice of real investment objects.

The primary task is formation of criteria for choosing an investment object during the restoration of areas destroyed by emergency situations, with further monitoring and evaluation of potential investment objects. At the final stage a selection of objects from a range of potential ones is conducted. The most accurate and easy way to assess the potential of alternative energy types is the index method, followed by calculation of integral indicator. In this case, calculated integral estimation index determines the most promising area of alternative energy, because the attractiveness of investment is determined primarily by the level of investment effectiveness.

The integral indicator of alternative energy potential estimation according to the energy types and determination of its territorial structure is based on the calculation of alternative energy potential estimation individual indicators and importance of these indicators, which is determined by the expert group, in the aggregate. In order to avoid subjective judgments in determining the importance of indicators, we have used the hierarchy method (MAI), which involves decomposing of the problem into the simple components. As a result, the relative significance of the investigated alternatives is determined for all the criteria found in the hierarchy. Relative significance is expressed numerically in the form of priority vectors. Calculated vector values are estimation indicators on the scale of relations and correspond to the so-called hard ratings.

In accordance with the task of choosing alternative energy priority type during the restoration of areas destroyed by emergency, we have created a hierarchy with the same number and functional com-position of the alternative according to the criteria. The hierarchy itself includes the aim which includes the choice of priority type of alternative energy located at its top, intermediate levels and alternatives, those are alternative energy types that form the lowest hierarchical level.

According to the criteria for choosing alternative energy priority type during destroyed areas restoration, it is necessary to indicate vectors of alternatives priorities. The general formula for calculating the vectors of alternative priorities is determined as follows:

$$WAEij = [WAE1i - 1, WAE2i - 1,., WAEni - 1] WEEji – 1, \quad (5)$$

where WAEij is the vector of alternatives priorities relative to the element E1i-1, defining the j-th column of the matrix; WEEij - the vector of the priorities of the elements E1i - 1, E2i - 1,., Eni - 1, related to the element Eij in the higher-level hierachy.

The law of hierarchical continuity requires the elements of the hierarchy upper level to be compared in pairs, in accordance with the elements of the next level, and so on up to the top of the hierarchy. The matrix of pairwise comparisons for the second level of selecting the priority type of alternative energy destroyed area restoration has a dimension of 5 (by the number of criteria).

The matrices of pairwise comparisons for the third level priority alternative energy type choosing task have a dimension of 5 according to alternative energy types. These matrices are constructed so as to determine the certain hierarchical level element advantage relative to the elements of the already placed level with which they are directly related.

The resulting vector of alternative priorities relative to the root top of the hierarchy is calculated as follows:

$$WA = [WAE11\ WAE22.\ WAE2m]\ WEE11, \quad (6)$$

The results of the priority vector calculations and the definition of global priorities for choosing the alternative energy priority type during destroyed by emergency area restoration are presented in Table. 1. As a result of calculations, it was determined that solar energy is the most important for the criteria under study, while wind power is less significant, and bioenergy is the least important.

Before calculating the integral indicator of the alternative energy potential by territoriality (W) it is necessary to standardize all selected indicators of potential to the common dimension and unit of measurement.

The basis of the developed method of bringing indicators to a comparative type is the modification of numerical intervals interpolation method, which allows reducing any comparative data to a closed interval [0; 1].

The value of the integral estimation will belong to the closed interval of estimation [0; 1]. Thus, based on the results of alternative energy potential integral indicator calculations by territorial basis, we have developed a cartogram of the alternative energy potential of Ukraine.

Table 1: Matrix of pairwise comparisons for the second level task of alternative energy priority type choosing during destroyed area restoration

Criteria	Installed power	Annual technical achievable potential	Capacity for a potentially feasible scenario before 2030	Capital expenditures for the recovery of districts affected by emergencies using alternative forms of energy	Ecological and economic efficiency
Installed capacity	1	**3**	**1/5**	**1/6**	**1/8**
Annual technical achievable potential	1/3	1	**1/6**	**1/8**	**1/9**
Capacity for a potentially feasible scenario by 2030	5	6	1	**1/3**	**1/5**
Capital expenditures for the restoration of area affected by emergencies using alternative forms of energy	6	8	3	1	**1/3**
Ecological and economic efficiency	8	9	5	3	1

According to the results of proposed methodical approach application, a matrix of strategic investment priorities choice for area affected by natural and man-made emergency restoration with the introduction of energy efficient technologies and alternative energy has been created, which establishes the dependence of strategic priorities on the types of alternative energy sources that have the greatest potential and economic attractiveness for the region concerned.

Thus, inclusion of measures on the implementation of alternative energy sources during area affected by natural and man-made emergencies restoration to the priorities of regional policy should increase the level of economy and socio-economic provision of region population, reduce the harmful impact on the environment, create new jobs and stimulate the development of local industry.

In the system of investment processes activation in alternative energy the evaluation of investment projects efficiency is one of the most crucial phases. Taking into account the identified strategic priorities of alternative energy development, an important issue is the economic efficiency assessment of investment projects in recovering areas affected by emergencies of natural and technogenic character with implementing energy efficient technologies and alter-native energy.

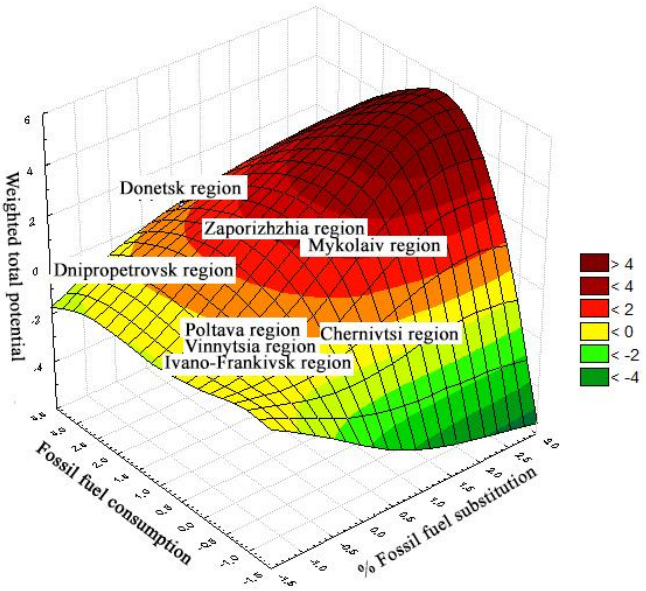

Fig. 2: Weighted total investment potential of alternative energy in recovering areas affected by emergencies

Based on the experience of successful alternative energy functioning in developed countries, it is possible to identify the directions that need to be developed in Ukraine in order to stimulate the growth of this industry aiming to increase investment activity and intensify the formation process of investment resources in the recovering areas affected by emergencies of natural and technogenic character with the implementation of energy efficient technologies and alternative energy.

When regulating investment processes on the renewing are-as affected by emergencies under modern conditions the use of active state investment policy is required, as far as the main source of investment resources can often include only public funds, in addition it is also necessary to regulate many aspects of investment activity: organization of depreciation policy, tax policy, alternative energy lending policy, innovation policy, labour resources policy and pricing policy.

The basis for ensuring the effective development of investment processes in recovering areas affected by emergencies of natural and technogenic character with the implementation of energy efficient technologies and alternative energy is general, not detailed planning of such activities, aimed at obtaining the required result, reaching a certain goal.

The conceptual principles of investment process management in recovering areas affected by emergencies of natural and technogenic character with the implementation of energy efficient technologies and alternative energy and the need to manage individual elements of the system are presented. Management of the investment process in modern conditions requires application of economic and organizational levers of influence with state authorities and providing comprehensive state support. The concept consists of two blocks of this process implementation: the essential block, which includes aim, object, subjects, subject matter of development strategy and the conceptual one, which contains tasks, principles and strategies for its realization.

In addition, the activation concept of investment processes in recovering areas affected by emergencies of natural and technogenic character with the implementation of energy efficient technologies and alternative energy includes an implementation block, which identifies the necessary measures, and a productive block, which assesses the success of the marked strategy, its effectiveness, which is expressed in the achievement of the intended effect.

The investment processes concept development in recovering areas affected by emergencies of natural and technogenic character with the implementation of energy efficient technologies and

alternative energy determines the necessary measures to intensify investment activity in the energy sector, the sequence of their implementation and key trends at which it should be focused. Implementation of the presented concept assumes that sufficient amount of investment resources to ensure the effective performance and achieve the desired effect can be provided by several sources.

In the current situation, when areas affected by emergencies are recovering, it would be expedient to intensify interaction with credit institutions on the basis of already existing commercial banks. An important activity for improving the interaction between commercial banks and the energy sector is state assistance, special focus areas of the state investment policy in relation to growing pools of investment resources stimulation.

The best option for the development and activation of in-vestment processes in recovering areas affected by emergencies of natural and technogenic character with the implementation of energy efficient technologies and alternative energy is the effective management of the system individual elements that creates the necessary resources level, sufficient for investment projects realization, implementation of the investment applications with new and improved technologies as a result of investment development introduction under the conditions of limited budget financing. This will be facilitated by the proposed project implementation of the Program for investment processes intensification in recovering areas affected by emergencies of natural and technogenic character with the implementation of energy efficient technologies and alternative energy by 2025.

The purpose of the proposed draft Programme is to stimulate investment activity in recovering areas affected by emergencies of natural and technogenic character with the implementation of energy efficient technologies and alternative energy in Ukraine.

The main objectives of the draft Programme are:

- legislative arrangements concerning the investment activity in recovering areas affected by emergencies of natural and technogenic character with the implementation of energy efficient technologies and alternative energy;
- organization of regional and local strategies for the in-vestment processes development in recovering areas affected by emergencies;
- implementation of the investment projects in recovering areas affected by emergencies of natural and technogenic character with the implementation of energy efficient technologies and alternative energy, based on the strategic priorities and the territorial organization of capacity development.

In order to intensify investment processes, it is necessary to provide integrated, comprehensive, systematic support on compliance with existing regulatory acts, as well as active state support directions for recovering areas affected by emergencies.

Monitoring of the Programme implementation meets the following objectives: control over the use of budget funds; control of the targeted use of budgetary funds provided by the Programme; control over the effectiveness of using budget funds for measures envisaged by the Program; control by the State Agency for energy efficiency and energy savings of Ukraine; control over growing pools of investment resources for recovering areas affected by emergencies and development of investment activities as a result of the implementation of the Programme; control over the degree of investment processes intensification as a result of the Programme implementation; studying trends of investment processes development for recovering areas affected by emergencies.

Monitoring of the Programme implementation is carried out as follows: studying the reporting of enterprises and organizations functioning in the sphere of recovering areas affected by emergencies; studying the reporting on the use of budget funds provided by the Programme; studying the statistical information in terms of changes in profitability level, cost-effectiveness, investment in fixed capital for recovering areas affected by emergencies. Spending le-els can be adjusted during the programme implementation in accordance with the capabilities of the state and local budgets.

The following results are expected from the Programme project implementation: increasing the investment attractiveness of the recovered areas affected by emergencies of natural and technogenic character with the implementation of energy efficient technologies and alternative energy through legislative regulation of in-vestment activity, taking into account zonal and natural features of Ukraine; effective strategic development of regions taking into ac-count the intensification of investment processes in recovering areas affected by emergencies; increase in the number of effective investment projects being implemented that contribute to recovering areas affected by emergencies of natural and technogenic character with the implementation of energy efficient technologies and alternative energy; diversification of the energy matrix of Ukraine and reduction of the state's energy dependency; reducing of greenhouse gas emissions and the environmental stress; growing pools of investment resources focused on the field of alternative energy in Ukraine.

3. Conclusion

Thus, by acting on individual organization elements for recovering areas, it is possible to attract additional investment resources for the rehabilitation of building structures, increasing the number of investment projects being implemented. The suggested approaches will allow to intensify the investment processes, to attract additional investment both domestic and foreign investors, and also to increase the volume of investment resources assigned to this field with the aim of carrying out investment activity and investment projects realization in recovering areas affected by emergencies of natural and technogenic character with the implementation of energy efficient technologies and alternative energy.

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