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IMPROVING THE EFFICIENCY OF MANAGEMENT DECISION-MAKING WITHIN THE SELECTION OF ENERGY INVESTMENT PROJECTS

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Abstract: *At the half-time point of the 2030 Agenda, it became obvious that the set goals for climate conservation and environmental protection would not be achieved on time: 2024 was the warmest year in recorded history and this trend is likely to continue. The energy sector plays a fundamental role in achieving the environmental and climate goals, which increases the need to improve the efficiency of management decisions, especially at the stage of selecting investment projects especially in the traditional energy sector. At present, management decisions should be environmentally responsible, i.e. the implementation of the project should be aimed at achieving both the economic and environmental goals. The purpose of this study is to improve the framework for investment projects assessment considering the previously developed system of environmental and economic indicators. The paper presents a modified version of the efficiency assessment for two project selection options: (i) "with a project" and "without a project"; (ii) a comparison of alternative investment projects with subsequent selection. The updated framework increases the objectivity of the assessment, while maintaining the parity of economic and environmental indicators.*
Keywords: *Environmental and Economic Assessment, Eco-efficiency, Energy Project Assessment, Investment Projects*

1. INTRODUCTION

Eco-modernization of traditional energy facilities and the development of alternative energy "plays a primary role in achieving the Sustainable Development Goals (SDGs) #7 Affordable and Clean Energy, #11 Sustainable Cities and Communities, #12 Responsible Consumption and Production and #13 Climate Action" [1, 2]. Currently, "traditional energy sources such as coal, oil and natural gas are still leading the global energy production structure". According to data for 2023, they accounted for "81.5% in the structure of primary energy consumption, while the share of renewable energy sources (RES) was 8.2%" [3].

A more positive trend regarding the greening of the global energy sector can be traced in the structure of electricity production (Fig. 1). In 2023, the volume of electricity produced at renewable energy facilities exceeded the volume of production at hydroelectric power plants and nuclear power plants for the first time in history (15.87% versus 14.17% and 9.15%, respectively) [3, 4].

Despite the positive trends, the pace of energy sector's greening is significantly lagging behind the goals and deadlines set at the global level. "The predominance of traditional energy sources, in particular coal, in the structure of electricity production demonstrates that measures taken at the global and national levels are insufficient, and the energy sector remains the largest environmental polluter and consumer of natural resources, leading to irreversible changes in the ecosystem of the planet" [5,6].

The year 2024 became one of the hottest years in the history of observations, and the level of global CO2 emissions broke another record and reached 37.41 $GtCO_2$, which is 60% more than in 1990 [3,4].

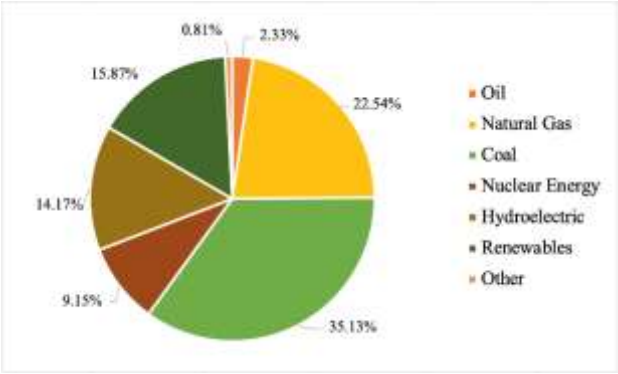

Fig. 1. World electricity production by fuel type in 2023, % [3]

The gradual abandonment of traditional energy sources by mankind and the transition to 100% clean energy are between the most favorable options for the development of human civilization [7]. However, at this stage, the implementation of a full-fledged transition to conceptually new and clean energy sources by 2050, especially in developing countries, faces a number of socio-economic, technological and political barriers [8]. Among them are the high cost of energy production at renewable energy facilities, the lack of necessary energy infrastructure and the need to attract large amounts of investment for construction of renewable energy facilities and renovation of traditional ones, the unavailability of innovations and technologies in the field of green energy for less developed countries, global geopolitical tensions and lack of motivation on the part of the governments of the largest exporters of energy resources to green the global energy system [9-14].

In this regard, eco-modernization of traditional energy facilities and related infrastructure can be one of the ways to reduce the negative impact of the sector on the environment in the long-term. The key focuses of eco-modernization are the transition from coal-fired to gas-fired power plants, the improvement of technologies for treatment of emissions and discharges of harmful substances, the development and implementation of effective waste management and pollution monitoring practices, the development of eco-oriented approaches to managing traditional energy facilities and decision-making [15-17].

The latter area is an integral part of the successful implementation of the energy transition in the future: nowadays eco-modernization of the of traditional energy sector is impossible without the introduction of conceptually new management approaches that will consider both industry specifics and the basic principles of sustainable development and circular economy [18]. New management approaches, in turn, will become the foundation for a full-fledged transition to green energy in the future [19].

Making environmentally oriented decisions is one of the most important fundamentals of sustainable management not only in the energy sector, but also in other sectors of the world economy [20-21]. To ensure the parity of economic and environmental factors in the management decision-making process, it is necessary to apply new approaches and tools for environmental and economic assessment [22-24].

The interpretation and achievement of economic efficiency in the energy sector is different from other sectors of the economy. Obtaining economic benefits and improving the well-being of a company are fundamental business objectives; however, energy sector plays a significant role in the normal functioning of the society. Thus, the activities of energy companies cannot be focused solely on making a profit due to the high infrastructural importance, the system-forming nature of the industry and the high proportion of government presence and regulation. If the activity of an energy company is unprofitable or brings insignificant profit, but at the same time it provides an uninterrupted access to heat and electricity to the society and has a minimal environmental impact in comparison with other facilities with similar generating capacity, or there is a decrease in anthropogenic load in dynamics while maintaining or increasing production volumes, then the energy facility can be characterized as efficient. In the event of a negative financial result and a lack of funds for the implementation of activities, the state provides subsidies and other types of financial support to energy companies.

Thus, the importance of economic efficiency in the energy sector in the assessment of overall efficiency and sustainability in comparison with other areas of the economy is significantly

lower, and the role of social and environmental efficiency is higher. Environmental efficiency can be characterized as the achievement of environmental goals while maintaining or increasing production and economic efficiency.

Earlier, Karaeva A. and Magaril E. in [25] proposed a methodology based on a system of indicators of the natural resource capacity and environmental compatibility of energy production to determine the environmental efficiency of both projects and enterprises in the energy sector. The proposed methodology can be used as an additional tool for evaluating investment projects within the framework of cost-benefit and cost-efficiency approaches. For its more efficient application, it is necessary to improve the assessment framework, which will consider both economic and environmental components.

The purpose of this study is to improve the framework for investment projects assessment considering the previously developed system of environmental and economic indicators. The paper presents a modified version of the efficiency assessment for two project selection options: (i) "with a project" and "without a project"; (ii) a comparison of alternative investment projects with subsequent selection. The updated framework increases the objectivity of the assessment, while maintaining the parity of economic and environmental indicators.

2. MATERIALS AND METHODS

The previously developed system of indicators for assessing the environmental efficiency of energy projects and enterprises included two groups of indicators: “indicators of natural resource capacity and environmental compatibility of energy production.

Indicators of natural resource capacity of energy production:

- resource capacity of energy production (fuel capacity of energy production and water capacity of energy production);
- waste capacity of energy production;
- land capacity of energy production.

Indicators of the environmental compatibility of energy production:

- environmental damage capacity of energy production by toxic substances emissions
- environmental damage capacity of energy production by carbon dioxide emissions
- environmental damage capacity of energy production by discharge of pollutants into water bodies
- environmental damage capacity of energy production by pollution of soil and land resources”

The proposed indicators can be used within the framework of the cost-efficiency approach and cost-benefit approach of investment projects assessment. The study was conducted in four stages:

a) Literature review and analysis of existing approaches to assessing the environmental and economic efficiency of investment projects.
b) Development of the framework for assessing the economic and environmental efficiency of investment projects in the energy sector.
c) Implementation of the developed system of indicators into assessment framework.
d) Development of a full-fledged assessment framework for efficiency assessment of investment projects in the energy sector (comparison of alternative investment projects and options “with project” and “without a project”).

3. RESULTS AND DISSCUSSION

“An investment project is a set of measures, limited in time and resources, aimed at the creation and subsequent operation of the new enterprise or modernization of existing one, which is implemented by a participant in the free economic zone in order to produce new goods, perform works, provide services or maintain and/or increase the volume of goods produced, works performed, services rendered by implementation of capital investments” [26].

As a result of conducted literature review, the common framework of environmental and economic assessment for investment projects in various branches of the economy was identified (figure 2).

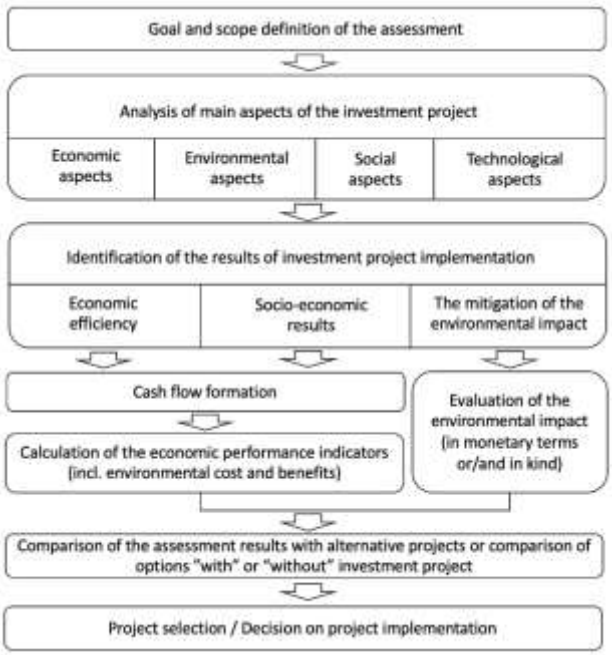

Fig. 2. The typical framework of the environmental and economic efficiency assessment procedure for investment project

The economic and environmental aspects are evaluated in parallel, however, in most cases the environmental component is evaluated in monetary terms and/or in absolute terms, which does not enable to compare investment projects with each other. One of the key advantages of the proposed system of indicators is the ability to compare alternative projects of different production capacities with each other by dimensionless indicators.

In addition, it should be noted that often using only one assessment approach (for example, only the cost-efficiency approach or the cost-benefit approach) does not demonstrate high performance in comparing projects and then choosing the most effective one.

The authors propose to apply both statistical and discounted indicators of economic efficiency assessment, regardless of the chosen assessment methodology. This makes it possible to expand the information content of the results obtained and provide stakeholders with the prospects of the project "here and now" and taking into account the future value of money. Often, a project that demonstrates high performance in calculating statistical indicators may be ineffective when discounting cash flows, which considers the future value of money, taking into account constantly changing market conditions and potential risks [23, 25]. However, for quick-to-implement (for example, within one year), low-cost activities and projects, there is no need to calculate the indicators associated with discounting.

Let's assume that the project/s have social significance and have a positive impact on the socio-economic indicators of the region's development.

At the first stage, the Net Profit (NV_e) and Payback Period (PP_e) of the project are calculated in order to determine the "basic" economic efficiency. If the project demonstrates a positive NV_e and the PP_e is higher or equal to the Expected Payback Period (EPP_e), then discounted performance indicators are calculated. This approach makes it possible to simplify and improve the quality of economic assessment at the same time. Next, Net Profit Value (NPV_e) and Discounted Payback Period (DPP_e) are calculated, and as part of the assessment, DPP_e compared with the Expected Discounted Payback Period ($EDPP_e$).

Then, Internal Rate of Return (IRR_e) is compared with HR (hurdle rate), a barrier coefficient chosen as the level of desirable return on investment, and Profitability Index (PI_e) is calculated. It should be noted that when calculating economic indicators, consideration of environmental costs and benefits is required [23]. This allows to evaluate and fully consider the maximum number of environmental aspects of the project.

In order to fully consider the environmental component of the assessment it was suggested firstly to calculate and include environmental costs and benefits in the projects cashflows, then to collect data regarding environmental impact caused by the energy facility within the certain period. After that, the suggested indicators could be calculated and analysed.

An updated framework for evaluating the energy project efficiency in the context of "with project" and "without project" is shown in Figure 3.

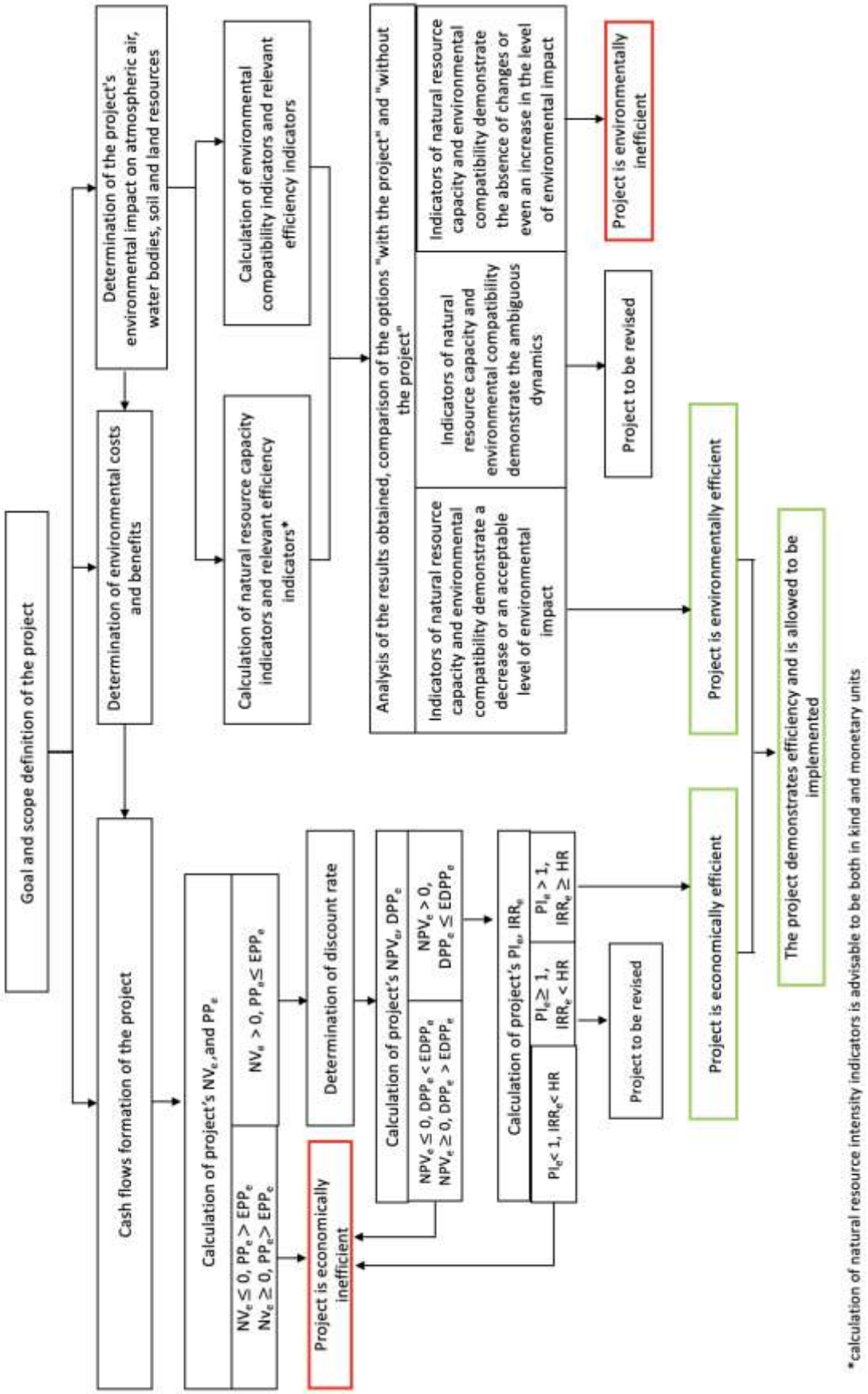

Fig. 3. The framework of the environmental and economic efficiency assessment of energy projects: options "with project" and "without projects"

If the project involves the construction of a new energy facility, it must be considered that the indicators of natural resource capacity and environmental compatibility of energy production are calculated for the first year (or other time interval) of the operation of the energy facility; the calculated values of the indicators must correspond to the minimum permissible level of negative impact on all natural environments or be equal to or below the established ones.

If the project is implemented at the operating energy enterprise, then the proposed list of indicators after the energy project implementation are compared with the indicators before its implementation, calculated for the period preceding the implementation of the project at the energy enterprise. This option also could be considered as "with project" and "without project". To determine changes in dynamics and environmental performance, the related efficiency indicators should be calculated.

The evaluation of alternative investment projects (projects that do not allow simultaneous implementation) involves the selection of the most effective project based on the results of an environmental and economic assessment. It is proposed to carry out economic and environmental assessment in parallel, in two stages. Based on the results of the assessment, those projects that have demonstrated both economic and environmental efficiency are selected. The updated framework is shown in Figure 4.

Next, the projects are compared with each other (for instance, by using a matrix approach). Preference should be given to a project demonstrating high combined economic and environmental efficiency.

Comparing the options "with project" and "without project" enables to make a decision based on the project's feasibility. In some cases, the "without project" option is more favorable both from an environmental and economic point of view. In this case, a decision is made to abandon the project. The project, in turn, can be sent for revision, and the possibilities of its implementation in another place or time period are also being considered.

The developed assessment frameworks increase the objectivity of decision-making process at the project selection stage. In addition, parity of economic and environmental factors is achieved through two-stage parallel selection: if the project does not demonstrate environmental or economic efficiency, a decision is made to exclude the project (in some cases, it is allowed to finalize the project with subsequent evaluation).

7. CONCLUSION

As a result of the study, the frameworks for environmental and economic efficiency assessment of investment projects in the energy sector was improved, considering the previously proposed methodological tools. Frameworks were developed for two options: "with a project" and "without a project"; comparison of alternative investment projects.

The updated assessment framework increases the objectivity of decision-making process: if a project does not demonstrate environmental or economic efficiency, it is not allowed for subsequent selection, which guarantees the selection and implementation of only those energy projects that show a reduction in negative environmental impacts and an increase in resource efficiency of energy production. Moreover, the updated framework demonstrates the parity of environmental and economic indicators in the process of projects' assessment and selection.

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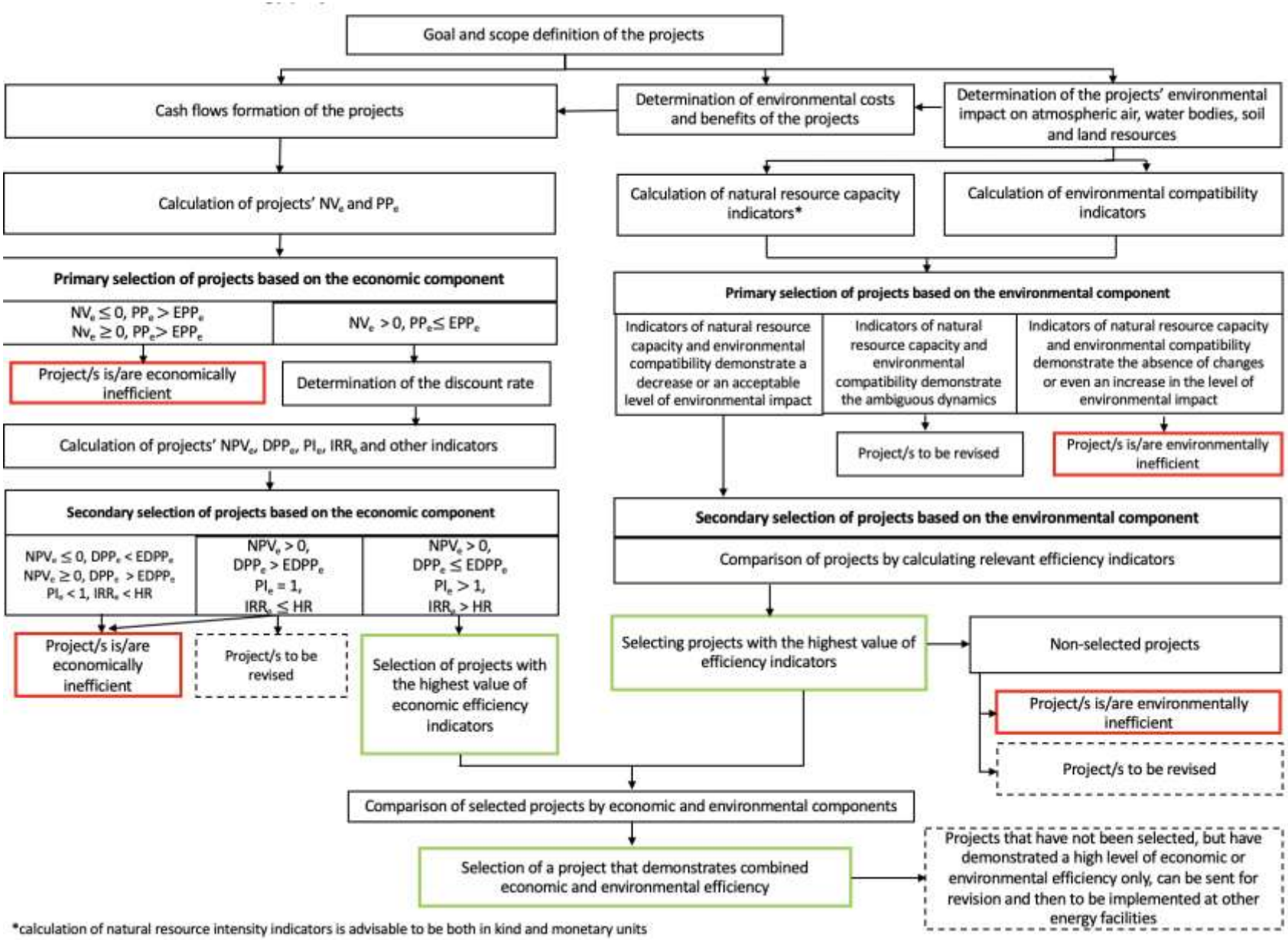

Fig. 4. The framework of the environmental and economic efficiency assessment of alternative energy projects

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Îmbunătățirea eficienței procesului decizional în cadrul selecției proiectelor de investiții în energie

La jumătatea perioadei de aplicare a Agendei 2030, a devenit evident faptul că obiectivele stabilite pentru conservarea climei și protecția mediului nu vor fi atinse la timp: 2024 a fost cel mai cald an înregistrat în istorie, iar această tendință probabil va continua. Sectorul energetic joacă un rol fundamental în atingerea obiectivelor de mediu și climatice, ceea ce sporește necesitatea de a îmbunătăți eficiența deciziilor de gestionare, în special în etapa de selecție a proiectelor de investiții, mai ales în sectorul energetic tradițional. În prezent, deciziile de management ar trebui să fie responsabile față de mediu, adică implementarea proiectului ar trebui să vizeze atât atingerea obiectivelor economice, cât și a celor de mediu. Scopul acestui studiu este de a îmbunătăți cadrul de evaluare a proiectelor de investiții luând în considerare sistemul de indicatori de mediu și economici elaborat anterior. Lucrarea prezintă o versiune modificată a evaluării eficienței pentru două opțiuni de selecție a proiectelor: (i) „cu un proiect" și „fără un proiect"; (ii) o comparație a proiectelor de investiții alternative cu selecție ulterioară. Cadrul actualizat sporește obiectivitatea evaluării, menținând în același timp paritatea indicatorilor economici și de mediu.

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