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ОЦЕНКА НА ИКОНОМИЧЕСКАТА ЕФЕКТИВНОСТ НА ИНОВАТИВНИ ПРОЕКТИ ЗА ВЪЗОБНОВЯЕМА ЕНЕРГИЯ ЗА УСТОЙЧИВО РАЗВИТИЕ НА ГРАДСКИТЕ ЕКОСИСТЕМИ

Yana Suchikova, Tetyana Nestorenko

EVALUATION OF ECONOMIC EFFICIENCY OF RENEWABLE ENERGY INNOVATIVE PROJECTS FOR SUSTAINABLE DEVELOPMENT OF URBAN ECOSYSTEMS*

Yana Suchikova, Tetyana Nestorenko[4]

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Abstract

This paper is devoted to methods for the financial evaluation of the efficiency of innovation projects of alternative energy. Taking into account the proposed methodology, the innovation project of renewable energy "An organization of production of solar cells based on nanocrystalline silicon" is evaluated. The innovative projects of alternative energy are the reliable foundation for sustainable development of the state.

Keywords: *efficiency, innovation, renewable energy, urban ecosystem, breakeven point*

JEL Codes: *G11, G32*

1. Introduction

In modern society, the pace of economic growth and the level of development of countries are largely determined by the role of scientific and technological progress in the intellectualization of production. In the global economic competition, countries that provide favorable conditions for effective innovation will benefit. Innovation activities are aimed at developing innovative projects and programs.

Innovative projects and programs are implemented in the form of large cross-sectoral projects for the creation, development and dissemination of technologies

[4]Berdyansk State Pedagogical University, Berdyansk, Ukraine, yanasuchikova@gmail.com, tetyana.nestorenko@ukr.net

that contribute to radical changes in the technological basis of the economy [1, 2]. Thus, innovative projects and programs play an important role in the state science and technology policy. They are essential for the development of many areas of science and technology.

Integration of Ukraine's economy into the international economic complex, especially taking into account the modern processes of entering the World Trade Organization, inevitably puts domestic companies in a highly competitive with foreign producers [3]. Typically, those companies that actively innovate and effectively organize their innovation activities will benefit. According to "Strategy of innovative development of Ukraine for 2010-2020 in the conditions of globalization challenges" [4], the priority objectives of innovation development of the scientific sector of the state are:

- transition of the domestic economy to the innovative way of development;
- formation of qualitatively new scientific and technical potential and its maximum using;
- providing an effective resource and intellectual base of world-level, which is expressed in the preparation of high-performance scientists, in the formation of modern technological equipment and information provision of their work, in rational organization of scientific research and development work, and in development of commercialization of scientific results system.

Implementation of these strategic directions is reflected in the Laws of Ukraine "On Priority Directions of Science and Technology Development" [5] and "On Priority Directions of Innovation Activity in Ukraine" [6]. The legal, economic and organizational foundations for understanding and implementing of innovation activities are reflected in the Law of Ukraine "On Innovation Activity" [7].

According to the priority directions of the development of science and technology in Ukraine, today there is a need for fundamental research to ensure Ukraine's competitiveness in the world of sustainable development of society and the state. Search for new energy sources and increase the efficiency of the well-known ones become the urgent task of the modern industry. Particular attention should be paid to safe, environmentally friendly types of energy, which become the basis for rational using of nature and ensuring the ecological safety of urban ecosystems.

Ukraine provides its energy needs only by 70%. So, it is an energy-dependent state. From the point of view of resource provision, the sufficiency and reliability of providing electricity and heat to the growing needs of the economy and population are crucial. From the point of quality of life, environmental cleanliness

of energy production is critically important. Energy problems are a key global problem of our time. Building a global economy and strategies for state development, as well as overcoming the ecological crisis, directly depend on the nature of their solution.

In 2009, the Ukrainian Parliament passed a law on subsidized tariffs for electricity produced from non-traditional sources, i.e. “green tariffs”. From January 1, 2013, in order to obtain the "green tariff" for electricity generated from the use of solar radiation, solar modules with a share of raw materials of Ukrainian origin in the cost of production of the constituent should be used not less than 30% and not less than 50%, starting from January 1, 2014.

Attention of technology parks and business incubators is turning to innovation projects and programs that propose the implementation of renewable energy sources to the energy sector of the Ukrainian economy.

Practical implementation of the results of innovation activity is carried out at the market stage, which includes the introduction of the product into the market, growth, maturity of the product and decline. In other words, at the initial stage of production of a new product it is necessary to take into account the product life cycle curve, to analyze changes in sales and profits.

The problem of improving the investment process in the long-term planning of the development of alternative energy is one of the priority management tasks, the solution of which requires a system approach.

The purpose of the study is to establish a toolkit for conducting a financial evaluation of the effectiveness of innovation projects in alternative energy.

1. **Methods of Economic Evaluation of Innovative Projects**

At the current technological level for the production of silicon solar cells (with a total capacity of 100 GW), at least 1 million tons of high-purity silicon are required. To achieve the expected solar power of solar photovoltaics by 2030, it is necessary to have annual production of pure silicon at least on the level of 200,000 tons. It represents not only a complex technological and financial problem, but also an environmental one, because the production of pure silicon is carried out by environmentally harmful production.

Another disadvantage of traditional silicon solar cells is the relatively low energy efficiency: on average, their efficiency is about 11%. The use of nanostructures allows to greatly improve the characteristics of photovoltaic converters.

However, for the implementation of innovative technologies of the non-traditional energy sector into production the attraction of investment is necessary. The investment attractiveness of projects is determined, first of all, by their profitability. Therefore, at the stage of project preparation, an economic evaluation of the project's effectiveness is a prerequisite.

The financial evaluation of investment projects involves comparing the cash flows generated by this project and the costs of implementing the project. Typically, the implementation of an innovation project is carried out over a long period. Therefore, most often there is a need to bring cash flows that relate to different periods, to one moment of time, that is, the need for discounting.

In assessing the effectiveness of innovations, different methods of investments valuation can be used: methods that not based on discounting and methods based on discounting. Last ones refer to the expression of future cash flows associated with project implementation [8].

Among the first group of methods the following ones can be distinguished:

1. Calculation of the minimum of total cost.
2. Calculation of the payback period of an innovative project, which is determined by counting the number of years during which investments will be redeemed from net cash inflows. The formula for equally distributed cash flows for years is the next:

Payback Period = Investments / (Annual Depreciation + Annual Net Profit)

2. Calculation of the average rate of profit by dividing the average annual net profit by the average investment amount:

The Average Rate of Profit = Average Net Income / Total Investment

3. Determination of the breakeven point is the calculation of the algebraic or graphical point of the way in which the revenues from the sale of products are equal to the cost of its production:

Volume of Production at the Breakeven Point = Constant Costs / (Unit Price – Average Variable Costs)

These methods give an opportunity to determine the effectiveness of the implementation of the innovative renewable energy project from different point of view.

3. Financial Evaluation of the Innovative Project "Organization of Production of Solar Cells Based on Nanocrystalline Silicon"

We will evaluate the innovative project on renewable energy "Organization of production of solar cells based on nanocrystalline silicon". The amount of solar energy per unit area of the earth's surface during the year is 1000-1350 kWh / m2. By the level of intensity of solar radiation, Ukraine can be divided into four regions: Western, Central, Southeast and Southern ones. The average intensity of solar radiation here is about 1200 kWh / m2. In general, the territory of Ukraine belongs to the zone of average intensity of solar radiation. In real conditions, the density of direct and diffuse solar radiation depends on the latitude of the terrain, the transparency of the atmosphere, the characteristics of the earth's surface, as well as the time of day and season.

To obtain a solar cell (solar module, solar panel), the elements are connected sequentially or sequentially-parallel to obtain the required electrical parameters of electric current and voltage.

Synthesis of cheap modules of large area with acceptable performance is a key issue of photovoltaics, as the costs of producing of the module under used technology do not depend on its size. The costs of electricity from large area modules significantly reduce. In this case, in parallel with the increase of size, only the costs of materials will increase.

For example, if 10 modules in the size of 10 cm2 are synthesized, then total costs of their production (C) will be:

$$C = 10Cmat + Ctech,$$

where Cmat – cost of used materials;
Ctech – costs of technological operations for obtaining a module.

For a module with an area of 100 cm2, synthesized in the same process, production costs will be:

$$C = 10Cmat + Ctech,$$

with approximate equality of parameters.

The technology of produce of modules is almost the same as that of solar cells, except for additional operations on the separation of solar cells on the substrate of the module.

The form of the implementation of the innovation proposal is the creation of a new enterprise. The project is for 5 years with a gradual increase in the volume of production – solar cells (Table 1).

Table no. 1 – Planned volumes of production, by years

Total	**Output in kind (thousands items)**					**Average costs (ths. UAH)**	**Output in monetary terms, (ths. UAH)**				
	1 year	2 year	3 year	4 year	5 year		1 year	2year	3 year	4 year	5 year
2940000	140	400	600	800	1000	0,030	4200	12000	18000	24000	30000

The volumes of the issue are calculated from the possible purchasing power of the Ukrainian market, and a basis we took the lowest indicator. At a high level of sales and a successful market penetration, much larger output volumes are possible. Within the framework of the project it is planned to release the elements. The solar cell is a 125x125 mm plate. Subsequently, these plates are mounted in the modules and batteries.

The period of implementation of the innovation project is 14 months, the amount of necessary investments is 700 thousand dollars.

The cost and list of activities for the organization of production of solar cells are listed in an organizational plan (Table 2).

Table no. 2 – Organizational plan of the project

#	Beginning of work execution, months	Title of works
1	1	Development of design and technical documentation
2	1	Obtaining technical specifications in licensing authorities (state fire supervision, sanitary-epidemiological service, ecology, energy supervision, etc.)
3	2	Rent a building and create a class of cleanliness
4	1	Procurement of required equipment
5	6	Pre-production works: - Equipment installation and commissioning works; - Procurement of components and raw materials for the production of prototypes; - Production of prototypes and process control; - Training of scientific and technical personnel for debugging serial production of products.

The breakeven schedule of the project and the indicators of efficiency are shown on Figures 1-4.

Figure no. 1 Graph of breakeven production of solar cells

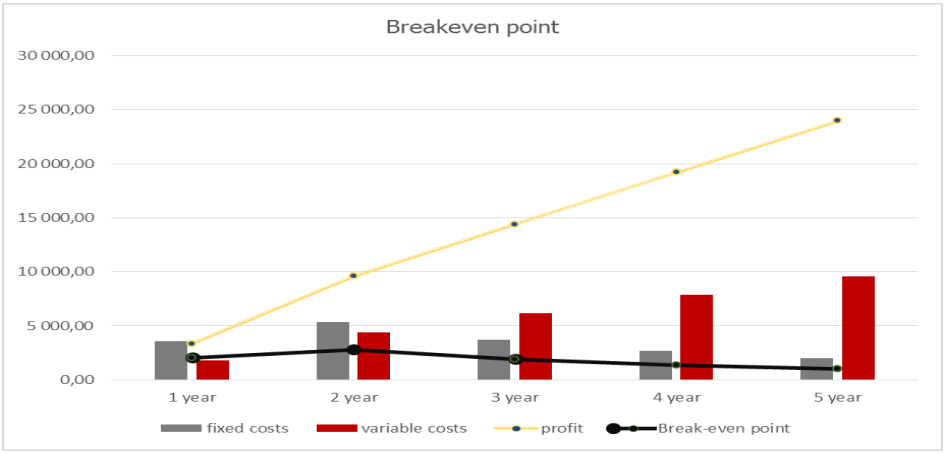


Figure no. 2 Value of revenue and total costs

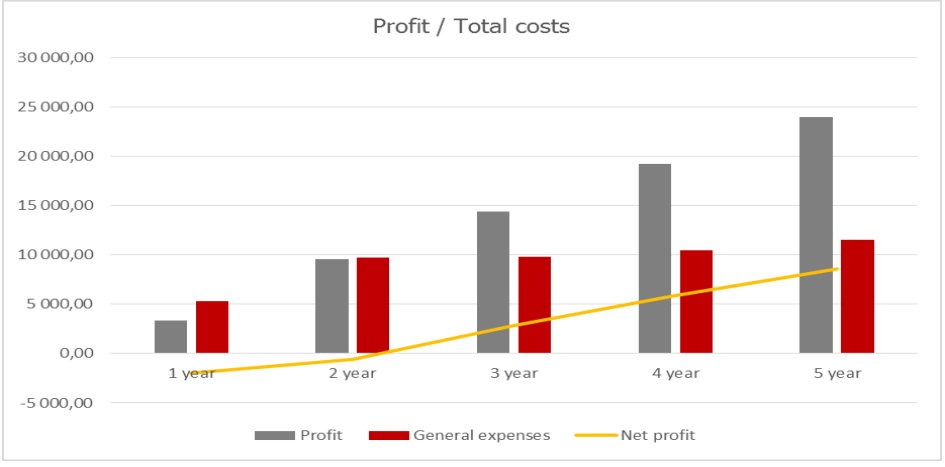


Figure no. 3 Graph of project payback

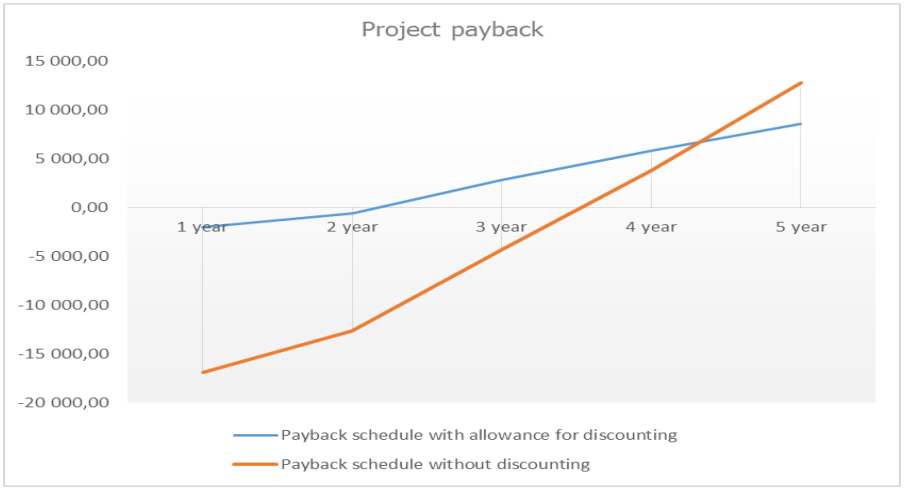
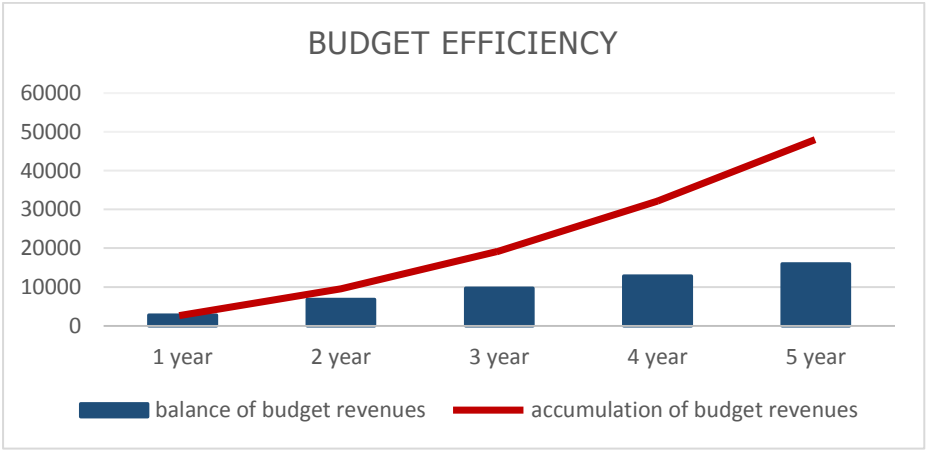


Figure no. 4 Graph of budget efficiency



The calculation of the internal rate of profitability showed that in order to achieve the full payback of the proposal in 5 years, the discount rate should be 7.7% in the quarter, i.e. 30.79% per year. But since for this proposal discounted rate is only 4% in the quarter, or 16% per year, the payback based on this rate will come much earlier, namely, at the beginning of the 14th quarter.

It should be noted that the above economic calculations are approximate and relate to a specific time interval. The profitability and investment efficiency depend on many factors, each of which must be explored in detail. Nevertheless, the

proposed economic approach can serve as the basis for conducting an analysis of the feasibility of introducing innovations to the energy sector.

The level and dynamics of the development of innovative processes is a decisive indicator of the economic situation, the ability to actual market transformation through the creation, implementation, dissemination and practical use of new technologies, the modern technological processes, new products and raw materials, modern methods of production organization and its logistics.

The effective implementation of innovations allows to decisive strategic advantages in energy saving. Enterprises on the energy saving market achieve competitive advantages through innovations by the using of both new technologies and methods of work. But after reaching benefits keeping them is possible only through continuous improvement of continuous innovations.

Implementation in the Ukrainian energy sector of innovations as energy saving products will give the opportunity to increase the environmental friendliness of the Ukrainian economy by reducing harmful emissions, to reduce the energy dependence of the country on imported energy sources, primarily through the use of alternative fuels and improving energy efficiency in the economy.

In a situation where the economic relations of energy saving with scientific institutions are carried out on a market basis, the market of innovative products serves as the main source of implementation of innovative developments in the energy sector. In this connection, great attention must be paid to the development of organizational and economic measures to improve the mechanism for the introduction of innovation in the energy saving market of Ukraine, to create and improve its infrastructure, to regulate demand, supply and mechanism of pricing for innovative products. This will make it possible to increase the efficiency of scientific developments and the level of their use in production, and will provide a competitive development of the sphere of energy saving.

4. **Conclusion**

Thus, we have proposed methods for the financial evaluation of the efficiency of innovation projects of alternative energy. Taking into account the proposed methodology, the innovation project of renewable energy "An organization of production of solar cells based on nanocrystalline silicon" has been evaluated. The innovative projects of alternative energy are the reliable foundation for sustainable development of the state.

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