

ЕКОНОМІКА ТА УПРАВЛІННЯ НАЦІОНАЛЬНИМ ГОСПОДАРСТВОМ

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**FINANCING OF PROJECTS OF USE
OF RENEWABLE ENERGY SOURCES****ФІНАНСУВАННЯ ПРОЕКТІВ
ВИКОРИСТАННЯ ВІДНОВЛЮВАНИХ
ДЖЕРЕЛ ЕНЕРГІЇ**

Urgency of the research. The issues of the use of renewable energy sources have the most active and positive impact on resolving three global humanity issues: energy, ecology, and food.

Target of setting. Against the backdrop of rapid increase of population of the Earth and growth of world GDP, catastrophic depletion of natural capital takes place. To avoid such negative consequences is possible on condition of providing of global sustainable development and use of alternative energy.

Actual scientific researches and issues analysis. In scientific and expert communities the questions of the development of RES are paid the most careful attention regardless of their significance in the context of economy, ecology and energy safety. There are many works of local scientists (O. M. Gudima, D. V. Zerkalov, L. L. Tovagnyanski, S. B. Tulub, A. I. Shevzov, A. K. Shidlovski, T. E. Yasnuk), who made a considerable scientific contribution to development of RES.

Uninvestigated parts of general matters defining. Statistics of RES remains very fragmented and heterogeneous in terms of the set of indexes and methods of their calculation. Present researches on the development of RES as energy efficiency tool, usually don't touch a question of their comparative cost and terms of implementation of new technologies.

The of research objective. The aim of the research is profound study of financing of projects of use of RES, justification of aggregated financial instruments, that help to overcome certain investment barriers in the field of renewable energy.

The statement of basic materials. In the article it is justified that viability of projects of renewable energy sources largely depends on market risks, that are the result of political framework conditions and limited knowledge in terms of new technologies, that is expressed in the increase of capital cost.

Conclusions. Tendencies require review of energy paradigm, moving away from the system of domination of several large energy supply objects to a lot of distributed energy systems, where consumer of electric power is a producer, and at the same time identifies and controls by himself how and where energy is consumed.

Keywords: renewable energy sources; alternative energy; crowdfunding; electric energy; energy; solar leasing; green bonds.

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Актуальність теми дослідження. Питання використання відновлюваних джерел енергії найактивнішим і позитивним чином впливають на рішення трьох глобальних проблем людства: енергетика, екологія, продовольство.

Постановка проблеми. На тлі стрімкого збільшення населення земної кулі і росту світового ВВП відбувається катастрофічне виснаження природного капіталу. Уникнути таких негативних наслідків можливо за умови забезпечення глобального стійкого розвитку і використання нетрадиційної енергетики.

Аналіз останніх досліджень та публікацій. У науковому і експертному співтоваристві питанням розвитку ВДЕ приділяється найпильніша увага зважаючи на їх значущість в контексті економіки, екології і енергобезпеки. Є багато робіт вітчизняних учених (О. М. Гудима, Д. В. Зеркалов, Л. Л. Тобагнянський, С. Б. Тулуб, А. І. Шевцов, А. К. Шидловський, Т. Е. Яснюк), що внесли значний науковий внесок в розвиток ВДЕ.

Виділення недосліджених частин загальної проблеми. Статистика ВДЕ залишається дуже фрагментарною і різномірною по набору показників і методикам їх числення. Наявні дослідження про розвиток ВДЕ як інструменту енергоефективності, як правило, не зачіпають питання їх порівнянної вартості і термінів впровадження нових технологій.

Постановка завдання. Метою дослідження є глибоке вивчення фінансування проектів використання ВДЕ, обґрунтування агрегованих фінансових інструментів, які сприяють подоланню певних інвестиційних бар'єрів в сферу відновлюваних джерел енергії.

Викладення основного матеріалу. В статті обґрунтовано, що життєздатність проектів відновлюваних джерел енергії значною мірою залежить від ринкових ризиків, які, у свою чергу, є результатом політичних рамок умов і обмеженого знання відносно нових технологій, що виражається в збільшенні ціни капіталу.

Висновки. Розглянуті тенденції вимагають перегляду енергетичної парадигми, відходу від системи домінування декількох великих об'єктів енергопостачання до безлічі розподілених енергосистем, де споживач електроенергії одночасно є виробником, і при цьому сам визначає і контролює, як і де споживається енергія.

Ключові слова: відновлювані джерела енергії; альтернативна енергетика; краудфандинг; електроенергія; енергетика; сонячний лізинг; зелені облигації.

Urgency of the research. The issues of use of renewable energy sources (RES) are actual for all countries of the world due to different circumstances. For industrially developed countries of the world,

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dependent on import of fuels and energy resources (FER) - this is, first of all, energy safety. For industrially developed countries of the world, rich in energy resources, it is ecological safety, conquest of markets outlet for equipment.

For countries that develop, this is the fastest way to improve social and living conditions of the population, possibility of industry development in environmentally acceptable way. And for the world, it is opportunity to reduce greenhouse gas emissions and avoid global energy and economic crisis in the near future. RES is not alternative to existing energy, it is energy of not so distant future.

However, energy is not confined to the role of RES. They have the most active and positive impact on resolving three global humanity issues: energy, ecology, and food. Naturally enough, in the whole world, scientific researches are carried out in all types of renewable energy sources. In different countries the level of financing of scientific works on renewable energy is from 10 to 30 % from the amount of financing of works on energy [1].

Target setting. Actuality of research topic is related to general tendencies and issues of world economy, in particular, its financial system in the context of ensuring global sustainable development. Against the backdrop of the rapid increase of population of the Earth and growth of world GDP, catastrophic depletion of natural capital takes place. All of these according to UN predictions, can lead to reformation of world economy taking into account profound social, economic and ecological changes. To avoid such negative consequences is possible on condition of providing global sustainable development and use of alternative energy.

Actual scientific researches and issues analysis. Significant contribution in the research of present state and prospects of development, as energy of Ukraine on the whole and renewable in particular, has made O. M. Gudima, D. V. Zerkalov, L. L. Tovagnyanski, S. B. Tulub, A. I. Shevzov, A. K. Shidlovski, T. E. Yasnuk.

In scientific and expert communities the questions of the development of RES are paid the most careful attention regardless of their significance in the context of economy, ecology and energy safety. There are many works of scientists of neighboring CIS countries (Bezrukih P. P., Elistratov V. V., Kanugin P. S., Osadchi G. B.) as well as foreign scientists (Autken D., Gubbins D., Sorensen B., Cher G.) who made a considerable scientific contribution to development of RES.

Uninvestigated parts of general matter defining. Additional investigation of questions of projects financing of RES, macroeconomic effects of development of RES, government control having regard to influence of economic problems and risks in this field in recent are needed. In addition, in the presence of a number of researches on certain types of RES, there are very few works on economic analysis and mechanisms of development of RES in the European Union with presentation of critical assessments, as well as on the possible use of EU experience in Ukraine. Statistics of RES remains very fragmented and heterogeneous in terms of the set of indexes and methods of their calculation.

Present researches on the development of RES as energy efficiency tool, usually don't touch a question of their comparative cost and terms of implementation of new technologies.

The research objective. The aim of the research is profound study of financing of projects of use of RES, justification of aggregated financial instruments, that help to overcome certain investment barriers in the field of renewable energy, identify problems of state support for renewable energy projects and ways to solve them.

The statement of basic materials. Viability of projects of RES largely depends on market risks, that are the result of political framework conditions and limited knowledge in terms of new technologies, that is expressed in the increase of capital cost. As compared to the objects of traditional generation, in the projects of RES large ratio of primary capital expenditure to operational, that makes them very sensitive to capital cost. According to IRENA (International Renewable Energy Agency), the normalized rationalized cost of windpower generation increases by approximately 60%, with capital cost growth from 5.5% to 14.5% [1]. Relative impact on capital cost will grow, as fast as technology cost will fall. As an example, the expenditures of network photovoltaic solar power plant in the life cycle (Fig. 1) can be illustrated [2].

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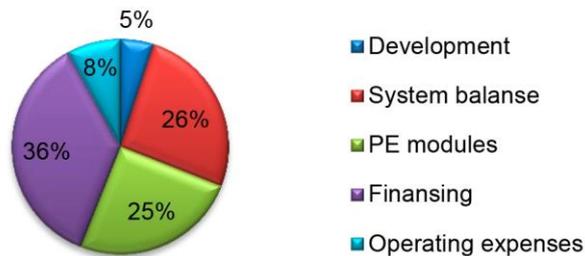


Fig. 1. Data of network photovoltaic solar power plant in the life cycle

Depending on the expected cash flows of the project and included risks, for most RES projects in developed markets, capital cost is 6 - 10%; in developing markets, this index is still higher. To finance RES projects, new financial instruments are created that are suitable for a variety of investment portfolios, - from small financial community to large investment funds. Hence, big business from traditional energy sector invests more in RES. As markets and technologies become more mature, projects of RES attract more investors: from private investment firms, developers and governments, to commercial banks and institutional investors (Fig. 2) [3].

Main volume of financing RES projects comes from private investor: developers, commercial banks and institutional investors. With the development of markets, private financing is growing, however, in young emerging markets of RES, state financing and international cooperation plays an extraordinarily important role. International financial institutions and banks of development in 2012 increased financing of projects of RES to \$60 billion [4].

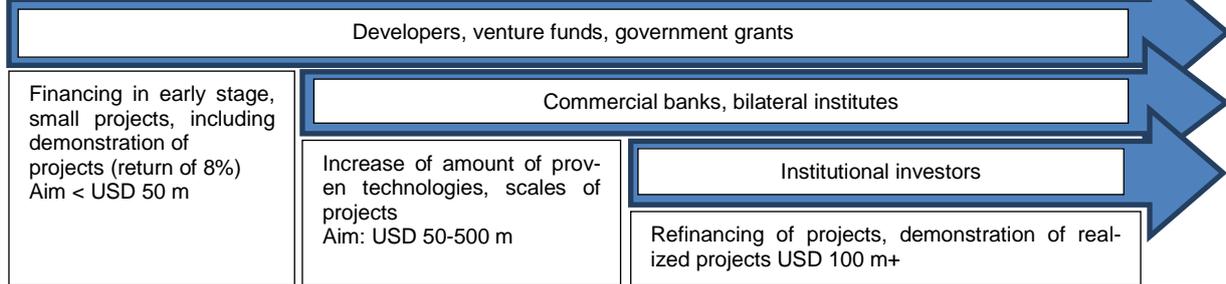


Fig. 2. Change of investment in the course of technologies development and increase of market maturity

Most of these facilities were allocated by national, interregional and bilateral financial institutions of development, which are coordinated by the International Development Finance Club. A great number of RES projects were financed by Climate Investment Fund and Green Climate Fund, that were created on the initiative of World Bank and regional banks of development. The activities of Green Climate Fund as well as of funds of climate investments are primarily aimed at stimulation of additional private investments. It is necessary, that state financing will not drive out private investor. For this purpose, it is necessary to develop new forms of agreements and financial instruments, so that concessionary state financing would be focused on reducing the risks that prevent private financing. It would stimulate big investor to enter the market of RES. It should be noted that institutional investors are getting increasingly concerned about the risks related to fossil fuel. In the end of 2013 coalition of 70 investors, the total volume of investments of which is \$3 trillion, called for the largest global power and energy companies to assess the risk of climate scenario (scenario of active actions against climate change) in relation to basic scenario of development [5]. In case of strengthening of climate policy, RES projects are becoming more favorable alternative in relation to projects of traditional energy for investor. Stable, reliable and long-term framework conditions for functioning of power generating industry and state credit are key success prerequisites on reduction of risk for investors in RES projects. Good example of it is a station of concentrated solar energy of 500 MW in Morocco, that is the biggest

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solar power station of concentrated type in the world. First 120 – 160 MW of power was put into operation in 2015, the first block of this power station was launched in 2016. The project is unique in its nature, as several investors have joined together with the government and international financial institutions, which have focused their efforts on reducing risks [6]. National support of projects of renewable energy that is accompanied by demonstration of real projects with the moderate level of risk and profitability, and also establishment of state goals on increasing the shares of RES in national energy balance with corresponding reflection of it in national long-term strategies can be an impulse for attracting new investors to the field. Government also can integrate ecological imperatives in credit and monetary policy, getting additional financial resources for the development of RES. Such practices are already widespread in the world: Bank of Japan, for example, has established lower rate than one percent for internal banks with the purpose of crediting «green» industries of economy. At international level, integration of «ecological imperatives» to requirements of capital in the Basel Accords could provide additional liquidity to RES sector. In developing countries financing of projects of RES also has changed dramatically, in several stages: from the banks of development in 1990 – 2000, state financing in 2000, to mainly commercial financing today. Previously, developers had to apply for financing to traditional institutions of development, such as World Bank, European Investment Bank or Asian Bank of development, but now, in economics with relatively mature market of RES, proprietors of projects more often can receive necessary financing in independent commercial financial institutions often even local. Investors by their nature tend to invest capital in assets that they know well, accordingly, the degree of «awareness» of investor in relation to one or another financial instrument determines the degree of risk for him greatly. RES are new participants in the market of financial assets, and they can attract investors by means of integration in financial instruments of other sectors, in particular. Such hybrid instruments exist in all levels: from local public projects to Renewable Energy Platform for Institutional Investors, organized by the European Investment Bank.

New aggregated instruments help to overcome certain investment barriers, such as, insufficient scale of project (project is too small for institutional investor), lack of quality information, unreliability of developer. It is necessary to distinguish three of such instruments:

- 1) green infrastructural bonds;
- 2) crowdfunding;
- 3) popular financing and solar leasing.

Green bonds are bonds that are provided by assets of corporate bonds issued to refinance the functioning of RES infrastructure, thus freeing up the developer's capital for further projects. Green bonds allow investor to get access to capital market with fixed income (bond market). Green bonds have been on the market for a long time, but until recently they did not have a high demand from investors. However now, as a result of rapid growth of RES sector, the picture has changed dramatically. The number of projects, that are suitable for financing by green bonds, as well as the number of organizations that are ready to issue them, has increased.

The basis of crowdfunding is the principle, which is absolutely opposite to green bonds. Here there are a lot of investors, including ordinary people, who can finance decentralized and cooperative RES projects. One of the most successful projects of crowdfunding is leader of American market Mosaic. Crowdfunding or popular financing was originally created to finance innovative creative projects without any financial income. However, later on, innovative companies began to allow a great number of investors to buy small shares of capital in RES projects. This principle is the basis of crowdfunding in its present sense. Crowdfunding tends to reduce the cost of capital for investor, including countries that develop. The pioneer of popular financing was nonprofit organization (NKO) of Kiva, that has already directed over \$ 60 million of loans to small enterprises in 78 countries. Similar organizations could invest globally, that would allow to finance specific projects on markets, for which access to capital is limited for some reasons.

The principle of solar leasing lies in the fact that solar panels for roofs are owned, used and disposed of by third parties, while the equipment proprietor receives corresponding reward in the form of reduction in electricity bill or direct payments. It gives cheaper electricity to proprietor of equipment, without the need for large investments. The proprietors of panels get their profit through mechanisms

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of political stimulation and sale of electric power. This mechanism of financing was successful in the USA, and also in Italy and Bangladesh.

The question of adaption of state support level to changing market conditions is of great interest. The degree of maturity of RES market determines the level and form of state support. As the cost of technologies falls, there is a reduction of the cost of RES-generators, and, accordingly, their need for external help. Thus, financial support that is needed for stimulating new RES projects, should be gradually reduced, that eventually, should decrease loading on taxpayers and superprofits of proprietors of projects. However, as it was already mentioned, in young markets of RES, state financing remains the key condition of realization of RES projects [7]. The state policy of supporting RES firstly ensured the development of industry at the expense of providing substantial financial benefits to investor. On many markets this goal was reached: industry was developing headily, project expenditures were falling, what is more, much faster than it was expected and predicted in government programs. There was a need to review state policy and correct the amount of financial support that was allocated.

A number of governments of developed countries reacted by sharp reduction of subsidization or abolished subsidies and tax allowance. All of it destabilized local markets greatly: private investors rushed to complete projects before changes in rules. Destabilization took place on international market, since project developers did not know how big this reduction in subsidies would be, and which countries would follow this course. It should be noted that fall of expenditures and gradual reduction of direct financial support is in favor of industry development. If state financing is stopped in the planned order, that is clearly predicted and declared by government, this is the guarantee of stability of market of RES and expenditure fall, since such clear policy does not create new risks.

As market of RES grows, and technologies become more and more competitive, nonmonetary forms of government support starts to prevail, which may include special measures of reducing investment risks, protection of intellectual property, priority access to networks, changes in tax legal framework, development of educational programs and introduction of special industrial standards. These measures must be long-term, moreover, they should not be sensitive to budgetary movements. A good example of such non-monetary stimulation is national policy of support of RES in Malaysia, which, together with establishment of green tariff, as the priority goals of its program distinguishes R&D and human capital development.

It should also be noted that reduction or abolition of fuel subsidies in power generating industry would have beneficial effect on the development of the RES sector, by creating strong market signals and strengthening of competitiveness of RES.

In addition, abolition of fuel subsidizing could free up a large number of facilities that can be redirected to the development of RES. The fact that traditional fuel power generators do not include in its factory expense air pollution and environmental damage is also a hidden form of subsidization that indirectly impedes the development of RES.

Regulatory mistakes, as well as excessive suggestion of emission quotas, have led to the fact that the price for CO₂ is now unjustifiably low and, in order to bring it to adequate level, there is a need of agreed international policy and a strong lobby of REE.

It is necessary to pay special attention to the impact of RES on prices on markets of markets of electric energy. Before liberalization of market of electric energy in Europe, production and sale of electric energy to ultimate customer was carried out by several small generating companies. Functioning of industry was very much opaque, measure of monopolization was big, and price was much higher than competitive level. To promote competitive pricing in the industry, exchanges were established. The first European exchange of electric energy was found in the Scandinavian region in 1993. Other European exchanges appeared after 1999 (1999 Amsterdam Power Exchange (APE), 2001 die of Energy Exchange Austria (EXA)) [8]. At these exchanges the product «electric energy» is traded in two main segments: the long-term and short-term (spot) market. In the long-term market agreements (contracts) are concluded for several years. Thus, a wholesale customer can now buy electric energy for the next six years. In the spot market, electric energy is traded, supply and consumption of which will occur during the day [9].

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Due to limited electric energy transmission capacity, there is still no single electric energy market in Europe, but trade is not limited to national boundaries of states. There are seven European market zones that unite electric energy systems of several countries. Accordingly, for every zone there is its exchange. Since 2008, the level of prices in these markets and their dynamics are similar [10]. The basis of pricing in the local electric energy market is classical supply and demand mechanism. Since the spot market is short-term, variable costs play the determining role for generating companies. Until the price is higher than variable costs, market participants have economic interest in using their generating capacity.

As variable costs of the morally and physically obsolete power stations have always been especially big, electro-generating companies, which operate on the newest factories, receive maximum profit when demand is especially high and when variable costs of old power stations are price-determining. At low power demand old power stations will not work because price is too low to cover their variable costs. At the same time, power stations that are used at low demand have small marginal profit [11]. As it is known, variable costs of many RES technologies is practically zero, because the sun and the wind we get for free [12]. In order to support renewable energy producers, in many countries electric energy that is generated on the basis of RES has the privileged status: it enters the network, is received and consumed first of all.

Conclusions. As the share of RES in the energy balance grows, the structure of power generating industry undergoes substantial changes. The field, which was made up of big objects of centralized energy supply, is becoming more and more decentralized, heterogeneous, dispersed.

In Germany, almost half of all RES generating objects of RES are in property of households and farmers, and only 12% of RES assets are managed by big energy companies directly. New technologies of energy conservation and so-called "intelligent" technologies (smart) of demand-oriented management of energy consumption are developing. In many emerging markets, autonomous and mini energy systems of RES have already been main source of electricity. Thus, many developing countries, where formation of energy systems is just beginning, have the opportunity to jump over the development of centralized energy supply systems and immediately create flexible decentralized system of mini-energy supply. These and other tendencies require the review of energy paradigm, moving away from the system of domination of several large energy supply objects to a lot of distributed power systems, where consumer of electric energy is simultaneously a producer, and at the same time identifies and controls by himself how and where energy is consumed. The state can do a lot to develop new energy paradigm, as well as, on the contrary, to support and preserve the old centralized model. Investors in technology of RES need stable and predictable framework conditions. They also need unified rules of the game, including the reduction of subsidies for fuel energy

In addition, investor needs new electric energy transmission infrastructure, which would allow to take advantage of the synergy of different types of RES. The new energy supply paradigm means that governments should realize and admit the full range of benefits and advantages from development of RES in all possible areas: it is care of population health, development of rural and isolated regions, energy safety and import substitution of fossil fuels. Current changes create potential for new industrial revolution, creation of new energy system based on renewable energy.

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