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Article

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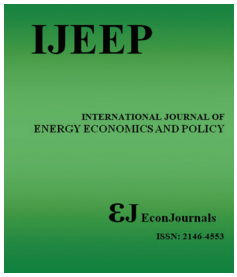

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Evaluation of Development Prospects of Renewable Energy Source for Russia

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ABSTRACT

The main mechanisms for supporting renewable energy sources (RES) in the wholesale electricity and capacity market, in the retail market and in isolated power systems have been studied. The article analyzes the ecological, social and economic effects of the development of renewable energy in the territory of Russia. Based on official information, the authors gave a quantitative assessment of the effects: Increasing export earnings, reducing environmental costs, creating jobs, etc. An integral effect was assessed for the Russian economy from the development of RES, including various levels of budgets and extra-budgetary funds in the form of duties, taxes and insurance contributions. During the analysis of the development of renewable energy in the territory of Russia, the authors identified the main effects of its use and proposed methods for quantifying the effects determined. The obtained results, like the methodological approaches described in the article, can be used at the federal and regional levels in the development of state support mechanisms for renewable energy, while carrying out technical and economic calculations for projects and programs in the field of renewable resources and energy sources.

Keywords: Renewable Energy Sources, Economic Effect, Ecological Effect, Social Effect, Development Prospects, Energetics of Russia
JEL Classifications: O10, Q40, Q41

1. INTRODUCTION

At present, an efficient economy, the so-called new-mode economy, does not imply the opposition of traditional generation of energy to renewable sources, but their combined use, considering the economy of hydrocarbons and the conservation of a favorable ecological situation. More than 170 countries use renewable energy to produce electricity and set their targets for the development of the industry. According to world statistics as of 2015, the capacity of power plants based on these sources was 785 GW, and more than $ 285 billion were invested in this sector (Global Status Report, 2016).

Energy development programs in Russia, unlike many countries in the world, focus on traditional types of energy resources. Although since 2013, renewable energy is being developed in many Russian regions. As of January 2017, 27 renewable energy facilities with an installed capacity of 160,157 MW were qualified, the largest share falls on solar power plants – 70,298 MW. The installed capacity of qualified geothermal power plants is 62 MW; Objects operating on biomass, biogas and landfill gas - 12 MW; midget power plant – 10.834 MW; wind power station – 3,225 MW, tidal power station – 1,7 MW.

Renewable energy is being supported by the Government of the Russian Federation on its territory as a promising area of development (Kulacov and Nazarova 2015). In 2007, the Government of the Russian Federation formalized the definition for alternative energy sources – "renewable energy sources" (RES).

The economic model of the operation of renewable energy facilities is fundamentally different for the wholesale and retail electricity market, for isolated power systems. Support measures such as establishing long-term tariffs for the purchase of electricity during the payback period, inclusion of RES projects in federal and regional target programs, ensuring the priority loading of generating objects of RES in the operational dispatch control are provided for isolated power systems. In retail markets, the main element of support is the obligation of grid companies to purchase electricity from qualified RES facilities at regulated tariffs in order to compensate losses. At the same time, for facilities <25 MW, expenses for technological connection to electric grids are compensated from the federal budget.

In the wholesale electricity and capacity market (WECM) for qualified renewable generation facilities, a mechanism is provided for the sale of electricity under a purchase and sale agreement, as well as capacity sales under a capacity supply agreement, which is the generator's obligation to build, commission and to bring a new generation to the WECM in the future.

The Government of the Russian Federation has specified the procedure for conducting competitive selection of projects for the construction of generating facilities based on RES, the rules for determining the price for the capacity of generating facilities for RES, ensuring the return of invested capital, as well as targets for commissioning of generating facilities for RES up to 2020, target levels of localization and maximum amount of capital and operating costs. At the same time, it was envisaged to stimulate the production of components and equipment in the renewable energy sector on the domestic industrial base due to high localization requirements and the prospect of expanding the number of facilities put into operation.

The development of renewable energy leads to the emergence of various effects from its use. And these are not only environmental effects, but also social and economic ones (Rutovitz and Harris, 2012). Among social effects, particular significance is the assistance in solving an unemployment problem, which is especially important for many Russian regions in view of the shortage of jobs (Republic of Dagestan, Ingushetia, Sakha (Yakutia), etc.).

The effects of renewable energy development should be quantified when developing mechanisms for the state support of renewable energy, when carrying out cost-benefit analysis of projects and regional programs in the field of renewable resources and energy sources.

Thus, it can be noted that the emergence of mechanisms to support renewable energy on the wholesale market initiated the beginning of formation of the renewable energy industry in Russia, which makes it relevant and appropriate to assess the effects of their development taking into account the parameters adopted in the existing regulatory framework.

Nowadays, many foreign companies (IEA, EWEA, IRENA, World Bank) pay much attention to the analysis of the development efficiency of renewable energy and its quantitative assessment. Among the scientists who contributed to the study of the socioeconomic and environmental effects of renewable energy development, one can single out works devoted to the study of the influence of renewable energy on the labor market and employment in Germany (Ulrich et al., 2012). Chinese experts studied the economic and environmental impact of renewable energy development on the country's economic growth in the long term (Daia et al., 2016). An analysis of approaches to assessing the environmental and economic aspects of wind energy projects is presented in the works (Savino et al., 2017). Evaluation of RES and developmental effect on innovations in the regions are considered in the works (Cebotari and Benedek, 2017). The relationship between renewable energy and economic development is studied (Apergis et al., 2010; Edenhofer et al., 2013). Environmental effects are presented in the works (Cicea et al., 2014). Actual works are devoted to the researches in the field of economics of RES, their impact on country and regional development, effects and benefits from their use (Barbosea et al., 2016; Cooka et al., 2016; Dvorak et al., 2017; Rafindadia and Ozturk, 2017; Willsteed et al., 2017). In Russia, the works of such scientists as (Bezrukih and Bezrukih, 2014) Shutkin et al. (2013) are devoted to this topic.

However, it should be noted that in all the works presented by the researchers, one-sided problem of obtaining either economic effects is often solved or an assessment of the environmental efficiency of the proposed technology is given. Also, the processes of development of renewable energy at the macroeconomic level are described, or a local assessment of a particular facility is given.

There is a lack of a systematic approach and a comprehensive solution to issues related to the promotion of alternative energy in the country under the influence of many different factors. Approaches to the evaluation of decisions in the field of renewable energy are also insufficiently substantiated taking into account the Russian specifics.

In this regard, the purpose of the study was to develop a methodology for quantifying the effects of renewable energy in Russia, taking into account the parameters adopted in the existing regulatory framework for the WECM on the system - based approach.

2. METHODOLOGY OF THE RESEARCH

At the first stage of the study, we accentuated the effects of renewable energy development, including:

1. Social effects
   - Creation of jobs in the renewable energy sector;
   - Creation of jobs in related industries.
2. Economic effects
   - Natural gas saving;
   - Additional export revenue through the sale of saved natural gas;
   - Additional revenues to the federal and regional budgets, the pension fund (RF pension fund), the social insurance fund (SIF RF), the compulsory health insurance fund (CHF), including

- Export duty on the sale of natural gas;
- Personal income tax (PIT);
- Insurance premiums;
- Reduction of budget expenses for benefits;
- Tax on the RES industry profits;
- Ground rent;
- Fee for the use of water resources;
- Property tax.

3. Environmental effects
   - Water saving;
   - Reduction of CO_2 emissions;
   - Reduction of emissions of nitrogen oxides;
   - Cost of CO_2 emissions;
   - Reduction of environmental costs.

The second stage of the study was to analyze the above-mentioned effects and quantify the results of the development of renewable energy under the existing exogenous economic parameters.

At the third stage, the integral effect was determined by the following formula:

$$IE = \sum_{1}^{n} (EP; ED; T; IP; R; IT; GR; F; PT; C; ER) \quad (1)$$

Where,
n - is the number of years of the calculation period;
EP - export proceeds from the sale of the saved gas, billion rubles;
ED - export duty on gas sales for export, billion rubles;
T - PIT, billion rubles;
IP - insurance premiums, billion rubles;
R - reduction of expenses for unemployment benefits, billion rubles;
IT - income tax, billion rubles;
GR - ground rent, billion rubles;
F - fee for the use of water resources, billion rubles;
PT - property tax, billion rubles;
C - cost of carbon dioxide emissions, billion rubles;
ER - reduction of expenses for ecology, billion rubles.

The final stage of the study was a generalization of the results of the study and the conclusions.

The information base of the study was provided by the Russian State Statistics Service, the Central Bank of Russia, the Ministry of Economic Development of the Russian Federation, the Ministry of Energy of the Russian Federation, the Electricity Balance Forecasting Agency, AF-Mercados EMR, Enel Green Power, the European Wind Energy Association (EWEA), the European Energy Exchange EEX), NP "Council of the market," NP "Council of participants of the market of RES," etc.

3. THE RESULTS OF RESEARCH

Social effects are primarily expressed in the creation of jobs in the renewable energy sector and in related industries. The number of created jobs was estimated on the basis of specific indicators per 1 MW for different sectors according to the IRENA study (for European countries and the USA):

- Jobs in wind energy – 9.8 people/MW;
- Jobs in solar energy – 16.0 people/MW;
- Jobs in small hydropower – 20.5 people/MW.

The installed capacity of facilities operating on the basis of renewable energy in 2015-2016 is determined on the basis of the data of the NP "Market Council" and NP "Council of market participants of renewable energy" about qualified renewable energy facilities. The installed capacity of the facilities for the period 2017-2024, corresponds to the target indicators of the state development programs, and is presented in Table 1.

Based on the data on the number of created jobs and the installed capacity of RES for the period up to 2024, it was calculated that 65,756 jobs can be created in Russia up to this period, including sectors:

- Wind energy – 34,470;
- Solar energy – 18,942;
- Small hydropower – 12,344.

Then, it should be noted that the number of jobs is estimated for the period of construction of new RES facilities and does not include the period of operation of the constructed generating capacities, which can create additional work opportunities in future.

Evaluation of economic effects of renewable energy development is also important in the construction and operation of facilities. It consists of several components.

1. Saving of natural gas. The amount of saved natural gas was calculated on the basis of the hypothesis that electricity generation at renewable energy facilities (Table 2) will replace the same amount of electricity generated by gas power plants.
   - Volumes produced by RES were determined as the multiplication of the installed capacity (Table 1) and the utilization factor of the installed capacity (UFIC). To estimate the possible volumes of electricity generated for the specified period, the following values of UFIC were adopted: WES - 37%; SES - 14%; Mini-HPP - 50%.
   - According to Enel Green Power, every 100 GWh of renewable energy will save 30 million cubic meters of gas. Thus, up to 2024, 4.6 billion cubic meters of natural gas can be saved.
2. Additional export revenue through the sale of saved natural gas. Supposing that the saved volume of natural gas will be exported at an average export price that was established in the 1st quarter of 2015-265.13 USD/thousand cubic meters (data of the Central Bank of the Russian Federation on 01/01/2017) at a rate of 60 rubles/dollar for the entire calculation period, the additional export earnings will be 74 billion rubles.
3. Additional revenues to the federal and regional budgets, the RF Pension Fund, the Social Insurance Fund of the Russian Federation, the Obligatory Health Insurance Fund According to the official data, the export duty for the sale of natural gas is 30% or 22.1 billion rubles from additional export earnings.

Personal Income Tax, insurance premiums, budget cuts for benefits. The development of the renewable energy industry involves the creation of new jobs, the personal income tax from the wage fund

will come to the budget at a rate of 13%. Moreover, the creation of new jobs will help to reduce the budget expenses for the payment of unemployment benefits and result in the transfer of insurance contributions to the Russian Federation Fund, the SIF and the Compulsory Medical Insurance Fund in an amount equal to 34%.

The average salary in Russia was taken into consideration to estimate personal income tax and insurance premiums, 35,716 rubles per month as on 01.01.2017 according to the state statistics. The minimum unemployment benefit is 850 rubles per month according to the Regulation of the Government of the Russian Federation No. 1382 dated December 17, 2014.

Under the given parameters of budget revenue, personal income tax will amount to 3.7 billion rubles for the period up to 2024, and unemployment payments will decrease by 0.7 billion rubles. At this level of increase, receipts to extra-budgetary funds for the period under review will increase by 9.6 billion rubles.

The profit tax from the RES industry was calculated on assuming that the net profit would be 10% of the capital investment, based on the data of similar projects.

The estimation of capital investments in renewable energy was carried out according to the limits of capital investments (Table 3), as well as target indicators for the installed capacity presented earlier (Table 1).

According to the data obtained, the volume of capital investments in RES objects up to 2024 may amount to about 600 billion rubles in Table 4. Of these, more than 380 billion rubles will be invested in wind energy facilities, more than 126 billion rubles in solar energy facilities, and more than 87 billion rubles in small hydro generation.

Thus, the net profit in the RES industry for the period up to 2024 will amount to 59 billion rubles, and the profit tax will be 11 billion rubles.

The indicator of ground rent is calculated on the basis of the anticipated volumes of commissioning of renewable energy objects (Table 1), the necessary land areas of 2 hectares/megawatt, the land value of about 20,000 rubles per hectare (data of Aktiviti LLC) and the value of the rent 2% of the cadastral value. According to the calculations, the rent for land for the period until 2024 will be 0.004 billion rubles.

The fee for the use of water resources for the period until 2024 will be 0.4 billion rubles and it is calculated on the basis of the expected power generation by small hydro-generation facilities (Table 2) and water charges of 143 rubles/MW*h, as determined by analog projects.

The property tax for the same period will amount to 13.2 billion rubles or 2.2% of the value of renewable energy objects, calculated

Table 1: Installed capacity of renewable energy for the period up to 2024, MW

Type of RES	2015	2016	2017	2018	2019	2020	2021-2024	Total
Wind	3.3	3.3	200	400	500	500	1899	3506
Sun	55.5	70.3	250	270	270	270	-	1186
Mini hydropower plant	8.3	10.8	124	141	159	159	-	602
Total	66.9	84.4	574	811	929	929	1899	5293

RES: Renewable energy sources

Table 2: Estimated electricity volumes produced by renewable energy objects, billion kWh

Type of RES	2015	2016	2017	2018	2019	2020	2021-2024	Total
Wind	0.01	0.01	0.65	1.30	1.62	1.62	6.15	11.36
Sun	0.07	0.09	0.31	0.33	0.33	0.33	-	1.45
Mini hydropower plant	0.04	0.05	0.54	0.62	0.70	0.70	-	2.64
Total	0.11	0.14	1.50	2.25	2.65	2.65	6.15	15.45
Total, GW*h	115	144	1498	2245	2648	2648	6150	15453

RES: Renewable energy sources

Table 3: Limit values of capital investments by types of generation, thousand rubles/kW

CI according to type of RES	2015	2016	2017	2019	2020	2023	2024
Specific CI wind	110.0	109.9	109.8	109.6	109.5	109.1	109.0
Specific CI sun	114.1	111.8	109.6	105.3	103.2		
Specific CI mini-HPP	146.0	146.0	146.0	146.0	146.0		

RES: Renewable energy sources

Table 4: The forecast of capital investments in the RES industry up to 2024, billion rubles

Type of RES	2015-2016	2017	2018	2019	2020	2021-2024	Total
Wind	0.8	22.0	43.9	54.8	54.7	207.4	383.4
Sun	14.2	27.4	29.0	28.4	27.9	-	126.9
Mini hydropower plant	2.8	18.1	20.6	23.2	23.2	-	87.9
Total CI	17.7	67.5	93.5	106.4	105.8	207.4	598.2

RES: Renewable energy sources

being based on the values of the forecast of capital investments in the industry (Table 4).

Evaluation of environmental effects of renewable energy is also carried out in stages.

Calculation of water saving, reduction of CO_2 emissions, reduction of nitrogen oxide emissions was carried out on the basis of Enel Green Power data. It is the fact that every 100 GW/h of "green" electricity saves 13.5 million cubic meters of water, reduce CO_2 emissions by 53 thousand tons and reduce emissions of nitrogen oxides by 110 tons.

According to the previously given data on the installed capacity (Table 1), we obtained the following values of environmental effects for the period up to 2024:

- Water saving – 2,086 million cubic meters;
- Reduction of CO_2 emissions – 8 190 thousand tons;
- Reduction of emissions of nitrogen oxides – 17 thousand tons.

The cost of emissions will be 3.63 billion rubles. Theoretically, as a result of emission reductions, the amount of carbon dioxide produced can be sold on the European Energy Exchange at a price of 6.82 euros per ton at a rate of 65 rubles per euro.

4. DISCUSSION

It has been assumed that the created jobs will not result in redistribution in the labor market, since the unemployment rate in Russia was 5.4% or 4.1 million people according to the state statistics at the end of 2016. Since 2013, a number of renewable energy facilities have been built in Russian regions with high unemployment:

- Small hydroelectric power plant "Kokadoy" (Chechen Republic, 135 thousand unemployed);
- Buribaevskaya and Bugulchanskaya solar power plants (Republic of Bashkortostan, more than 100 thousand unemployed);
- Perevolotskaya solar power station and Sakmarsk solar photovoltaic power plant named after A.A. Vlazneva (Orenburg region, more than 46 thousand unemployed);
- Small hydropower plants "Lyaskel" and "Kalliokoski" (Republic of Karelia, more than 26 thousand unemployed).

Evaluation of the role of RES from the point of view of obtaining social benefits is one of the priorities in solving the problems of unemployment in Russia. On the one hand, the construction of renewable energy facilities is economically feasible in remote and hard-to-reach areas where it is difficult to find job for the population. On the other hand, newly introduced renewable energy facilities, especially with the organization of production of equipment, can defuse the tense situation of shortage of work in such regions, for example, as the North Caucasus Federal District.

Economical effect in the net profit in the RES industry for the period up to 2024 will amount to 59 billion rubles, and the profit tax will be 11 billion rubles.

Reduction of environmental costs is expected due to the fact that the amount of electricity produced by RES (Table 2) will replace the same amount of electricity from gas stations and thereby reduce the costs of restoring the environment. For the purposes of this assessment, the cost of environmental measures was taken at $ 0.019/kWh, as the base for gas power stations according to the study "ExternE: Externalities of Energy" (European Commission, 1995). Accordingly, at a rate of 60 rubles/dollar the decrease in environmental costs will amount to 18 billion rubles for the same period.

Thus, based on the results obtained, it is possible to calculate the integral effect according to formula (1).

Integral effect will amount to 155 billion rubles for the Russian economy from the development of renewable energy, 60 billion rubles of which will go directly to budgets of various levels and extra-budgetary funds in the form of duties, taxes and insurance premiums. Export revenues will amount to more than 70 billion rubles, and environmental costs will be reduced by 18 billion rubles. 65,756 jobs will be created in the RES industry.

5. CONCLUSIONS

Hence, the following results were obtained in the research:

- Methodology for quantitative assessment of the effects of renewable energy development in Russia is proposed;
- Social, economic and environmental effects are identified;
- Significant statistical material is collected, forming the basis for the calculations.

The need for the development of renewable energy for Russia is fairly controversial. With the existing low natural gas and oil prices, developed infrastructure of the gas industry and traditional generation, the economic feasibility of building RES facilities is often questioned by many experts.

Nevertheless, the beginning of the development of the renewable energy industry is noted to have already been initiated. And a number of reasons for the development of renewable energy in Russia have been singled out:

- Russian production of equipment for wind generation, solar power stations and mini-HPP;
- Solving the problems of social tension by creating additional jobs;
- Supply of electric power to consumers in remote areas from the centralized energy system, where the use of renewable sources is dictated by economic feasibility.

The developed methodology was applied to assess the effects of renewable energy development in Russia at the parameters determined by the existing regulatory and legal framework.

The study of social effects requires further elaboration of the development of the renewable industry, including the identification of regions where the potential of renewable energy is combined with problems of unemployment and social strain.

The results do not show a multiplicative effect on the development of RES, which presupposes the influence of the RES industry on Russia's GNP through the development of such industries as metallurgy, power engineering, electrical engineering, power electronics, transport, telecommunications, information technologies, new constructional and structural materials, etc. The multiplicative effect requires further research in this direction.

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