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ENERGY CONSERVATION, NEW AND RENEWABLE ENERGY SOURCES

Analysis of Renewable Energy Projects' Implementation in Russia

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Abstract—With the enactment in 2013 of a renewable energy scheme by contracting qualified power generation facilities working on renewable energy sources (RES), the process of construction and connection of such facilities to the Federal Grid Company has intensified in Russia. In 2013–2015, 93 projects of solar, wind, and small hydropower energy were selected on the basis of competitive bidding in the country with the purpose of subsequent support. Despite some technical and organizational problems and a time delay of some RES projects, in 2014–2015 five solar generating facilities with total capacity of 50 MW were commissioned, including 30 MW in Orenburg oblast. However, the proportion of successful projects is low and amounts to approximately 30% of the total number of announced projects. The purpose of this paper is to analyze the experience of implementation of renewable energy projects that passed through a competitive selection and gained the right to get a partial compensation for the construction and commissioning costs of RES generating facilities in the electric power wholesale market zone. The informational background for the study is corporate reports of project promoters, analytical and information materials of the Association NP Market Council, and legal documents for the development of renewable energy. The methodological base of the study is a theory of learning curves that assumes that cost savings in the production of high-tech products depends on the production growth rate (economy of scale) and gaining manufacturing experience (learning by doing). The study has identified factors that have a positive and a negative impact on the implementation of RES projects. Improvement of promotion measures in the renewable energy development in Russia corresponding to the current socio-economic situation is proposed.

Keywords: renewable energy, energy engineering, economic analysis, promotion measures, localization index

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Russia, as a country with a developed energy system and a world leader in the deposits of basic types of primary fuel resources, will not face—either in the short or medium term—a problem of ensuring energy security through the development of renewable energy sources. However, in the last decade and a half, the most technologically mature sectors of renewable energy, such as solar and wind, have turned into a powerful high-tech business with a multibillion dollar investment, being the subject of competition both between separate regions and whole countries. The volume of investment in solar projects in 2015 amounted to approximately $161 billion USD and that in wind projects amounted to $100 billion USD [1]. According to the authors' estimates made on the basis of sectoral reviews and corporate reports of the largest manufacturers of photovoltaic modules and wind generators[1], the global market for photovoltaic modules in 2015 was $72 billion USD, which is more than 2.6 times higher than 2 years ago [2]. The global production and service of wind generators was close to $80 billion USD and increased in comparison with 2013 more than two times [2]. Multiplicative effects from the development of RES extend not only to power engineering but also to such sectors as electrical engineering, power electronics, metallurgy, and production of rare earth elements, transport, information and telecommunication technologies, building, construction materials, etc. and they are also drivers of innovative activity for energy companies, stimulating research and development.

In addition, a key feature of some renewable energy sectors is that they contribute to the development of the local labor market, regardless of where the equipment for generating facilities under construction is produced. Large dimensions and complexity of generating equipment operation makes it economically attractive to create even a single link of the manufacturing chain in situ, in the country or region where the RES project is implemented. Therefore, many governments have started actively supporting localization of the RES equipment manufacturing, to ensure both

[1] The total world market of PV modules was evaluated on the basis of a corporate report of First Solar for 2015 (5.1% of the world market), while the total world market for wind generators was according to Vestas (11.8% of the world market).

Table 1. Installed capacity limits of the RES generating facilities, MW*

Type of power generation facility	Year							
	2014	2015	2016	2017	2018	2019	2020	total
Solar PP	120	140	200	250	270	270	270	1520
Wind PP	100	250	250	500	750	750	1000	3600
Small HPP	18	26	124	124	141	159	159	751
Total	238	416	574	874	1161	1179	1429	5871

* Source: Executive Order of the Government of the Russian Federation no. 861-r of May 28, 2013.

accelerated growth of the industry and a technology transfer to the adjacent industrial sectors [3].

MECHANISMS OF STATE SUPPORT OF RENEWABLE ENERGY DEVELOPMENT IN RUSSIA

The "Energy Strategy of Russia for the Period until 2030"[2] and the "Energy Strategy of Russia until 2035"[3] project provide active development and introduction of renewable energy technologies. However, despite development goals of renewable energy being declared in a number of basic legal documents[4], until recently, the country had no real organizational and economic mechanisms of support of the industry and related sectors of power engineering. A certain dynamics of growth of RES technologies was observed only in the areas of stand-alone power supply, while a network connection of RES facilities was considered as unpromising [4].

In 2011, according to amendments to a Federal Law FZ-35, the basic renewable energy scheme (through a special rate surcharge for the electricity produced by renewable energy sources) was changed to support through a capacity market (a capacity charge). This approach is easily integrated into the architecture of the power wholesale market (similar to a power supply agreement), and makes it possible to fully harmonize the renewable energy growth rate with target indicators outlined in the basic guidelines of the state policy in the field of energy efficiency[5] and to avoid crises of surplus of power over transmission capacity. Government Decree no. 449 "On the Mechanism of Promoting the Use of Renewable Energy in the Electric Power Wholesale Market," adopted May 2013, specified particular RES support schemes and, according to international experts, was a significant step towards the creation of a regulatory framework designed to promote clean energy generation in Russia [5]. Related issues, such as renewable energy specific growth rates (Table 1) and targets for a manufacturing localization index to be achieved for gaining support (Table 2), were highlighted in an Executive Order of the Government of the Russian Federation no. 861-r. dated May 28, 2013.

ANALYSIS OF A PROMOTION MECHANISM IN THE RENEWABLE ENERGY ON A CAPACITY CHARGE BASIS

According to official data of the Administrator of the Trade System of the Wholesale Power Market of the OAO Unified Energy System, selecting construction and commissioning projects of RES facilities on a competitive basis as a result of tenders in 2013–2016, only 114 solar and wind generation projects were selected for a subsequent support, each with a capacity of not less than 5 MW and total capacity of 2.081 GW as well as five small hydropower projects with total capacity of 70 MW (Figs. 1, 2).

The largest number of applications for all the four years of competitive selection was submitted and approved in the solar energy sector (Fig. 3).

The experience in implementation of the projects approved in 2013 and 2014 showed that only approximately 30% of the planned RES facilities were commissioned on time or with a delay of not more than 1 year (Table 3).

Table 2. Production localization index (target index), %

Type of power generation facility	Year						
	2014	2015	2016	2017	2018	2019	2020
Solar PP	50	50	70	70	70	70	70
Wind PP	35	55	65	65	65	65	65
Small HPP	20	20	45	45	65	65	65

* Source: Executive Order of the Government of the Russian Federation no. 861-r of May 28, 2013.

[2] Approved by the Federal Government November 13, 2009, no. 1715-r.

[3] Currently under expert review (the Ministry of Energy follow-up instruction of the meeting of March 24, 2015, on the draft of the Energy Strategy of Russia for the period until 2035).

[4] Federal Law of November 23, 2009, no. 261-FZ "On Energy Saving and Improving Energy Efficiency."

[5] See, for example, Russian Government Executive Order of January 8, 2009, no. 1-r "On Approval of Basic Guidelines of the State Policy in the Field of Improving Energy Efficiency using Renewable Energy Sources for the Period until 2020."

From the companies implementing solar energy project, the most successful work to date was performed by OOO Avelar Solar Technology, (four solar power projects (SPP) executed on time with a total capacity of 25 MW) and OAO Orenburg Heat Generating Company, (one project executed on time with total capacity of 25 MW). It should be noted that the solar modules for the Sakmarskaya SPP of OAO Orenburg Heat Generating Company, (now a part of PAO T Plus) were also supplied by OOO Avelar Solar Technology. Since its establishment in 2011, the company has been a wholly owned subsidiary of Hevel company, which, in turn, is a joint venture between GC Renova and OAO Rosnano. Due to its own full-cycle production (a plant for the production of thin-film solar modules in Novocheboksarsk with a capacity of 97.5 MW per year) and a research center at Ioffe Institute (St. Petersburg), a localization index of the projects implemented in full or with the participation of Hevel has reached 70%. As a result of competitive selection, 34 RES projects with a total capacity of 349 MW gained support in 2013–2015 (Fig. 4).

Execution of such large volumes of their own and partners' projects allows the company to achieve scale and learning curve effects in the production process, without which modern high-tech and science-based production can not be price-competitive [6, 7].

The average installed capacity utilization factor (ICUF) for 1 year of operation of the Kosh-Agach SPP, as per the authors' evaluation, made on the basis of a register of certificates issuance and redemption with respect to RES generation facilities[6], was 16.94%, which is well above the global average of 10% [8] and exceeds the target level of 14% set in Russian Government Decree no. 449. A seasonal distribution of ICUF of this SPP is represented in Fig. 5. The rest of the commissioned solar power plants have not worked more than 1 year, so it is not yet possible to estimate their ICUF.

A project of OAO Krasnoyarsk HPP for the construction of Abakan SPP has been successfully completed, although commissioning was rescheduled for almost another year. In the implementation of this project, new businesses were built, dealing with multicrystalline silicon ingots' growth in Angarsk, Irkutsk oblast, and inverters assembly plant in Divnogorsk, Krasnoyarsk krai. This made it is possible to achieve the desired level of manufacturing localization.

However, not many companies that won the competition in 2013–2014 were able to fully implement the announced projects. Thus, OOO KompleksIndustriya, and OOO MRC Energoholding, owned by the Solar Energy Holding group of companies, were to have started power supply under the projects implemented in Astrakhan oblast from December 2014, but they never

[6] Available on the official website of the Association NP Market Council.

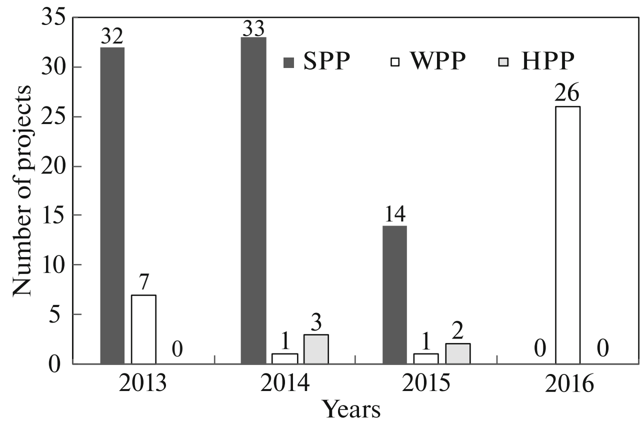

Fig. 1. Number of RES projects selected on a competitive basis.

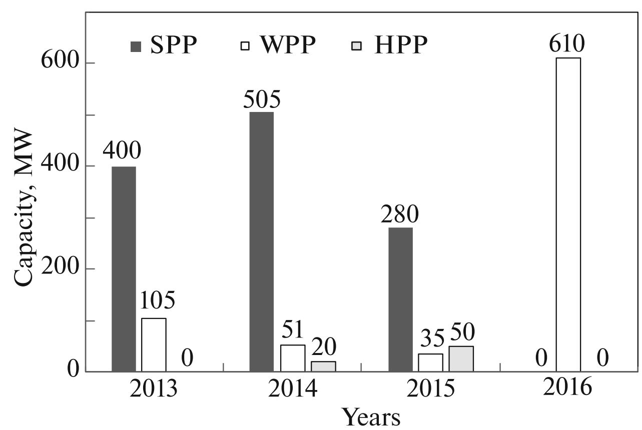

Fig. 2. Total capacity of RES facilities, selected on a competitive basis.

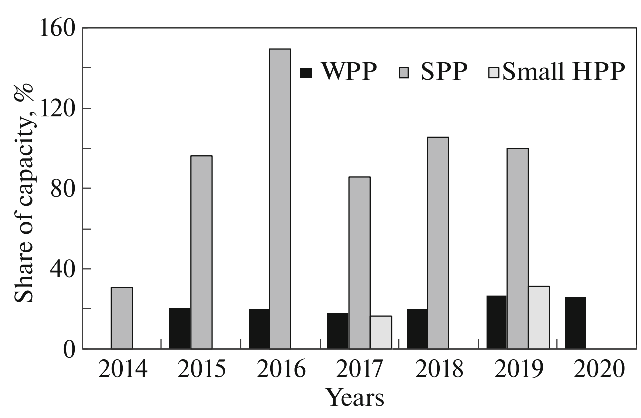

Fig. 3. Share capacity of RES facilities scheduled for the commissioning on a competitive basis in 2013–2016, within the limits of installed capacity specified in the Executive Order of the Government of the Russian Federation no. 861-r of May 28, 2013.

Table 3. Progress of the RES project implementation*

Project and company name	Location	Planned capacity, MW	Production start year	State of the project
SPP in Abakan, OAO Krasnoyarsk HPP	The Republic of Khakassia	5.198	2014	Launched December 2015
Rezinovaya SPP OOO MRC Energoro-sholding	Astrakhan oblast	15	2014	Power Supply Agreement was terminated December 2015
Volodarovka SPP OOO KompleksIndustriya	Astrakhan oblast	15	2014	A request for the technological connection to the grid of Apr. 8, 2014. No supply
Baimak SPP, OOO Avelar Solar Technology	The Republic of Bashkortostan	10	2015	Launched Oct. 30, 2015
Kosh-Agach SPP, OOO Avelar Solar Technology	Altai Republic	5	2015	Launched Sept. 4, 2014
Kosh-Agach SPP-2, OOO Avelar Solar Technology	Altai Republic	5	2015	Launched Apr. 1, 2016
Perevolotskaya SPP, OOO Avelar Solar Technology	Orenburg oblast	5	2015	Launched May 20, 2015
Matraevskaya SPP, OOO Avelar Solar Technology	The Republic of Bashkortostan	5	2015	Launched December 2015 (first stage of the Bugulchanskaya SPP)
Enotaevka SPP, OOO MRC Energoholding	Astrakhan oblast	15	2015	Power Supply Agreement was terminated December 2015
Sakmarskaya SPP, OAO Orenburg Heat Generating Company	Orenburg oblast	25	2015	Dec. 21, 2015
Promstroymaterialy SPP, OOO MRC Energoholding	Astrakhan oblast	15	2015	Delayed
Zavodskaya SPP, OOO MRC Energoholding	Astrakhan oblast	5	2015	N/A**
Volodarovka-2 SPP, OOO MRC Energoholding	Astrakhan oblast	15	2015	Delayed
Kaspiiskaya SPP, OOO MEK-Engineering	The Republic of Dagestan	5	2015	N/A
Khunzakh-1 SPP, OOO MEK-Engineering	The Republic of Dagestan	5	2015	N/A
Rudnik SPP, OOO KompleksIndustriya	Belgorod oblast	15	2015	N/A
Priyutinskaya WPP, OOO ALTEN	The Republic of Kalmykia	51	2015	Two 1.2 MW wind turbines were connected to the grid in a test mode July 2014
Fortum-Simbirskaya WPP, OAO Fortum	Ul'yanovsk oblast	5.198	2014	Under survey of a foundation
Bugulchanskaya SPP, OOO Avelar Solar Technology	The Republic of Bashkortostan	15	2014	Launched Oct. 21, 2016

Here and hereinafter, company names are listed according to their constituent documents.
* Compiled by the authors as per data of NP Market Council Association and reports of the companies-initiators of the projects.
** Not available.

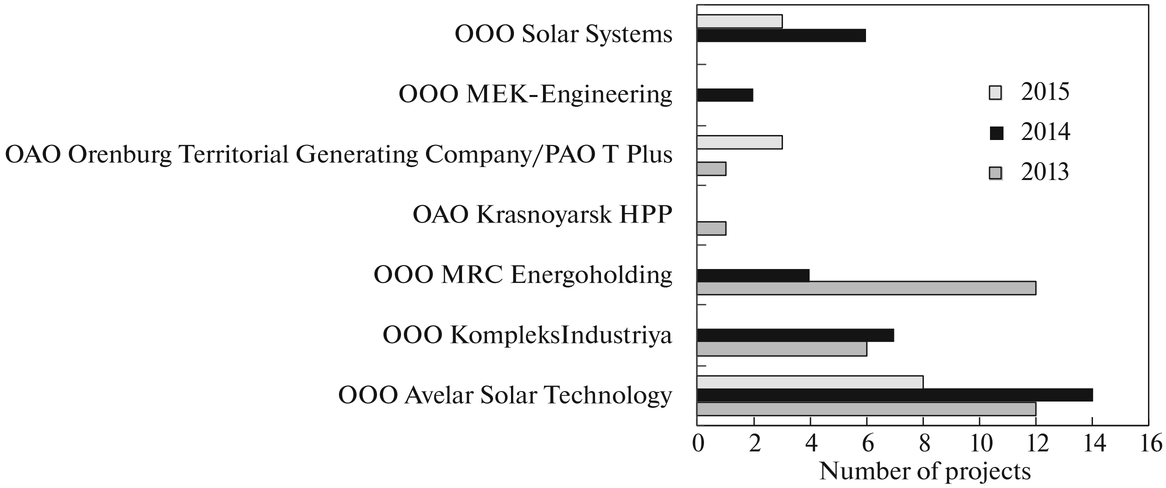

Fig. 4. Companies-winners of the tenders for the selection of RES projects in 2013–2015 in the solar energy sector.

completed the construction of solar plants due to the devaluation of the ruble and a significant rise in price for imported materials and components. The main investor and advisor of Solar Energy Holding is the Bright Capital venture capital fund, specializing in high-tech projects in the field of renewable energy and cost-effective use of resources as well as digital technologies [9]. Launching of their own production of photovoltaic modules as a part of the winning projects was not supposed [10], and the projects became unprofitable since 50–70% of their costs was a foreign currency component. In 2015, the owners of the unfinished projects were forced to pay a fine of 5% of the price for power, and the power supply agreements were terminated in December 2015 [11].

Thus, the main success factor in the implementation of solar energy projects initiated in 2013–2014 was the launch of a widespread end-to-end domestic production of photovoltaic modules. The reliance on foreign partners and creation of only assembly plants fell short of expectations.

The Russian Government Decree of January 23, 2015, no. 47 "On Amendments to Certain Acts of the Russian Government Related to Promoting the Use of Renewable Energy Sources in the Retail Power Market" came into effect in February 2015, which took into account both the positive and negative experience of implementing solar energy projects. According to the updated requirements, an RES facility at the qualification stage must be included in a regional development power plan of the corresponding subject of the Russian Federation. This will align plans of investors and development trends of regional energy systems, as well as eliminate barriers related to the lack of project support from regional authorities. Integration into the regional development power plan is carried out on a competitive basis, on the assumption of general criteria of electricity price growth minimization for the end consumers. There is a demand for the territories integrated into the United Energy System of Russia not to exceed an expected total electricity production by all RES facilities 5% of the total expected electricity losses of territorial grid companies operating in the Federal region. This relates to both existing operating facilities in the retail power market as well as scheduled ones. This requirement makes it possible to eliminate negative effects of power system reliability degradation in view of a growth in the level of penetration of RES electricity into the system [12, 13].

In addition, according to the introduced amendments, in order to protect investors from currency fluctuations, a special index K_{cur} reflecting a situation

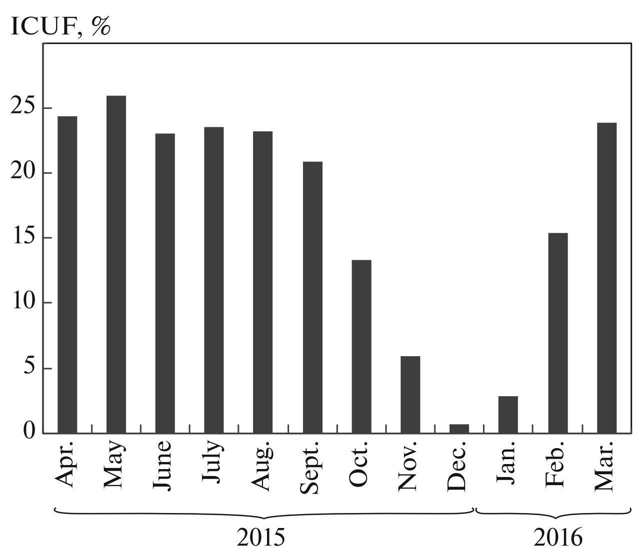

Fig. 5. Installed capacity utilization factor of the Kosh-Agach SPP, Altai Republic.

on the currency market will be used in planned capital costs, calculated by the formula

$$K_{\text{cur}} = K_{\text{loc}} + (1 - K_{\text{loc}})\frac{0.5(KP_{\text{PM}}^{\text{usd}} + KP_{\text{PM}}^{\text{eur}})}{43.262},$$

where K_{loc} is an index of project localization, $KP_{\text{PM}}^{\text{usd}}, KP_{\text{PM}}^{\text{eur}}$ are average (arithmetic mean) USD and Euro rates to Ruble in the month preceding the beginning of the competitive selection, respectively.

Thus, this index reflects the average rate over the investment period of the ruble against the currency basket, and it takes into account the share of foreign currency costs in the project. The rate of return on the invested capital to RES projects prior to January 1, 2017, was supposed to be 14% and thereafter 12%. The rate of return is administrated by the executive authorities of subjects of the Russian Federation when establishing long-term prices (tariffs) or marginal (minimum and/or maximum) prices (tariffs) for the electric energy (power) generated by RES facilities.

It is not yet possible to judge the success of implementation of wind and small hydropower projects, since none of the winning projects of the first competitive selection have yet been implemented. However, an analysis of the implementation of the projects makes it possible to get some ideas about possible root causes of their success and failure. In 2016, commissioning of the Priyutenskaya wind power plant (WPP) with a capacity 51 MW in Kalmykia (an applicant is OOO Alten) and the Fortum-Simbirsk WPP with a capacity of 35 MW in Ulyanovsk oblast (the applicant is OAO Fortum, more than 90% of whose shares are owned by the Finnish state-owned Fortum Corporation) were expected. According to public information, in April 2016, the Fortum company held a tender and signed a contract for the surveying of a wind turbine foundation on a wind farm site of the Fortum-Simbirsk WPP, assuming at least a schedule delay of the project.

Prospects for the successful development of the Priyutenskaya WPP project are even more vague. An original agreement between the Government of the Republic of Kalmykia and the investor (the Czech company Falcon Capital a.s.) was signed in 2007 at the XI St. Petersburg International Economic Forum. In 2009, two wind turbines produced by Vensys, Germany, with a capacity of 1.2 MW each, were installed for testing purposes on the WPP site. However, the attitude of the regional authorities to the project later changed: the local press expressed doubts in the profitability of the investment and expediency of the project. By a Resolution of the Government of the Republic of Kalmykia of January 17, 2014, the basic rent rate for the WPP sites was increased 50 times: from 0.5 to 25% of the cadastral value for 1 ha, which provoked a court trial between the company executing the project and the regional authorities. In June 2014, the Arbitration Court of Kalmykia sustained a claim of the OOO Alten Company for invalidation of the Resolution of the Government of the Republic of Kalmykia. In July 2014, there was a technological connection of the wind generation capacity of 2.4 MW to the grid of IDGC of the OAO South–Kalmenergo [14], but the data on the operating WPP is still absent in the Register of certificates, confirming volumes of generated energy by qualified RES generation facilities.

The emerging serious lag between the actual development of the wind energy and the originally planned one in the Executive Order of the Government of the Russian Federation no. 861-r, judging by results of the competitive RES project selection in 2016, is going to be overcome through an active involvement of large, state-owned corporations. All 26 selected wind power projects with total capacity of 610 MW, three of which will be implemented in the Republic of Adygea in 2018 and 23 in Krasnodar krai in 2019–2020, have been bid by the same company AO VetroOGK. The latter is a subsidiary of OAO Atomenergomash, a part of the Rosatom group of companies. Commissioning of the pioneering AO VetroOGK's wind farms is scheduled for 2018. Planned capital expenditures for 1 kW of the wind farms' installed capacity as per the project, which is scheduled for completion in 2018 is 141472 rubles and 134272 rubles for the projects scheduled for 2020, while the index of projects' localization should be not less than 65%. Solar and small hydropower projects were not selected in the tender of 2016.

The nearest launch of small hydroelectric projects (small HPP) is expected within 2017 [15]. This includes PAO RusHydro's projects in Stavropol krai (the Sengileevskaya and Barsuchkovskaya HPPs) and one project in the Karachay-Cherkess Republic (the Ust-Dzhegutinskaya small HPP), selected in the tender in 2014. However, RusHydro readjusted its 2016–2019 investment program already in the fourth quarter of 2014, having reduced the amount of planned investment by 31.8 billion rubles (–8%). As a part of the investment program optimization, there was a reduction of funding of small hydroelectric power plants on the territory of the North Caucasus Federal District to the extent necessary for the completion of the project documentation in 2016.

By 2019, two other small hydropower facilities of NordHydro, ZAO, are scheduled for commissioning in the Republic of Karelia. The projects are actively supported by the Government of the Republic of Karelia. They have also received support from a new Bank of Development of the BRICS countries. Upcoming investment in the projects are estimated at 8787 billion rubles, of which 80% are credit funds, 10% are investments from China and a Russian Private Investment Fund, and the remaining 10% are funds of the project initiators.

On December 9, 2014, the NordHydro Company signed an agreement with OAO Tyazhmash, for the design, manufacturing, delivery, and adjustment supervision of four water turbines for the Beloporozhskaya-1 and -2 small HPPs with a total capacity of 24.9 MW each [16]. OAO Tyazhmash, in turn, signed a deal on February 26, 2015, with ČKD Blansko Holding, a.s. (Czech Republic) for the design of water turbine components for the Beloporozhskaya small HPP (300000 Euros), manufacture of water turbine components (1100000 Euros), manufacture of water turbine components for small HPP (1250000 Euros), installation and adjustment supervision, and consulting services (280000 Euros), i.e., for almost the entire range of works and services. This calls into question the possibility to achieve the required localization index for the qualification of the RES facility.

Thus, it may be concluded that, unlike solar energy projects, the production of wind energy and small HPP equipment has not been established yet in Russia.

ANALYSIS OF THE DEVELOPMENT BARRIERS OF THE RENEWABLE ENERGY PROGRAMS USING A LEARNING CURVES METHODOLOGY

In the authors' opinion, the current situation can be partially explained by objective laws of development of the renewable energy subsectors in the framework of a learning curves theory, which has become very popular in the scientific literature on energy economy in recent decades. Economic parameters of various energy technologies, both traditional and new ones are studied and forecasted using learning curves. This approach involves endogeneity of technological development and dependence of its rate on such factors as the volume of investment in research and development, the intensity of promoting measures, etc. [17]. Energy researches usually consider the unit power cost as a degree of technological development.

The simplest mathematical model reflecting the main points of the learning theory applied to energy technologies is as follows [18]:

$$SC = a \times CC^{-b};\quad \log(SC) = \log(a) + (-b) \times \log(CC);$$
$$TC = \int_0^{CC} a \times CC^{-b} \mathrm{d}CC = \frac{a}{1-b} CC^{1-b}; \qquad (1)$$
$$PR = 1 - LR = 2^{-b},$$

where SC is specific unit of capacity cost, CC is cumulative capacity, TC is cumulative cost, PR is technological progress rate, LR is learning rate per specific unit cost (unit cost when the capacity reaches the value divisible by a unit of capacity), a factor a is a specific unit cost (a specific cost, when a capacity rate reaches divisible units), and factor b is learning flexibility. A logarithmic base in formula (1) is not specified explicitly, since the represented model describes a general form of the development of new technologies. Quantitative model parameters, including the logarithmic base, are specified on the basis of statistical data. However, it should be noted that the majority of studies carried out on the learning curve methodology use the logarithm to the base 2.

The specific cost in model (1) is a one-variable function—the cumulative capacity, representing the entire experience gained in the technology development in this case. Some studies, for example, [19] consider cumulative generated energy in model (1) as an exogenous variable CC.

According to findings of numerous studies carried out in the framework of the learning curves methodology, the average learning rate in the process of solar energy production is 23% [19], which is much higher than the average learning rate in the land-based wind energy sector (12%) and hydropower (1.4%) [18]. This means that a doubling of the cumulative installed capacity reduces solar projects cost by 23%, while the cost of wind projects is reduced by only 12% and hydropower projects by only 1.4%. Therefore, in order to achieve the production profitability in the wind energy sector, comparable with the one in the production of photovoltaic equipment, the doubling of a cumulative installed wind capacity should be approximately two times more often than the solar one, which is not observed in the development plans of the industry (see Table 1). The doubling of the cumulative installed capacity of a small HPP with comparable values of a production localization index should occur 16 times more often, which also contradicts the government's plans for the development of RES facilities. Therefore, it is possible to promote the development of wind and small hydraulic energy henceforth in two ways:

(1) Decreasing the index of production localization, attracting foreign companies looking for opportunities to expand their markets, for the implementation of WPP and small HPP construction projects.

(2) Increasing installed capacity limits of WPP and small HPP generating facilities, applying for state support in the framework of the power supply agreements.

Obviously, the second way for RES development promotion is preferable for the Russian economy, since it provides an opportunity to create multiplicative effects, spreading to adjacent sectors, the labor market and the scientific sphere. However, it implies an increase in the volume of state support, which is unlikely in the current budget deficit. Thus, the selection of the first way for the development promotion of wind and small hydraulic energy is economically feasible, especially considering the creation of appropriate conditions for the accelerated introduction of technologies and training of engineering personnel.

In addition, a hybrid stimulation is possible: an increase in the limits of installed capacity for generating facilities of the same type (for example, WPP) by reducing the limits of installed capacity for generating facilities of another type (for example, small HPP). Such a support makes possible to initiate the development of at least one new energy technology in the country, and to put off the development of another one for a long term perspective. The choice of the technology should be carried out on the basis of a thorough analysis of the existing technological reserve of the power engineering industry, as well as organizational readiness for the development of a new type of generation. This matter will be the subject of the authors' further research.

CONCLUSIONS

(1) Achievement of technological maturity and economic efficiency of the state-supported forms of renewable energy (solar and wind generation, small hydropower) today is constrained by limits on putting facilities into operation and their connection to the power grid.

(2) An attempt to develop innovative technologies and create new competitive high-tech production on a limited scale, without the enhanced expansion on the domestic or foreign markets, according to the main provisions of the economic theory of innovative development, has a very low probability of successful implementation, as evidenced by the experience of RES projects in Russia.

(3) In the present context, the most promising way to correct the existing mechanism of state support of renewable energy seems to be increasing the installed capacity limits of generating facilities of the same kind (with the most prepared production base for the development of new technologies) by reducing the installed capacity limits of generating facilities of another kind (with the least prepared production base and technological strength).

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