

Factors hindering development of small-scale energy in Russia's East

I.Yu.Ivanova, T.F.Tuguzova, N.A.Khalgaeva, A.N.Simonenko

The paper addresses the problems of small-scale energy development in the east of Russia. The factors that affect the efficiency of projects for construction of new low-capacity energy sources are analyzed. These include mini cogeneration plants on local kinds of fuel and a variety of renewable energy sources. Connection to centralized power supply system is also considered. The value of tariff increase for ensuring payback of these projects is presented.

Key words: efficiency of the project, capital intensity, cost price of electricity, tariff increase, payback periods, state support.

1. INTRODUCTION

Above 5 thousand autonomous and backup low-capacity energy sources (up to 30 MW) are operating in the eastern regions of Russia. They are located mainly in the isolated power systems and in the area of decentralized electricity supply. Despite a rather large number of small-scale energy sources their capacity makes up 9.8% of the total capacity of power plants in the east of Russia and their annual electricity output is estimated at 5 billion kWh (Table 1).

Diesel power plants (DPP) operating on imported fuel dominate the low-capacity energy sources which are mainly located in the north-east regions. Distribution of consumers across the territory, poorly developed transport infrastructure, multistage fuel delivery and its seasonal character lead to a large increase in fuel cost. In the most remote populated areas transport component in the imported fuel cost reaches 70-80%. This results in a high cost of electricity production, which is by 5-10 times higher than that of power plants in the isolated power systems. Therefore, the annual subsidies from budgets of various levels for equalizing

tariffs are estimated at 12-15 rub./kWh. The total value of subsidies makes up 10% of budget expenditure in the northeastern regions [1, 2].

TABLE 1. CHARACTERISTIC OF ENERGY SOURCES IN THE EASTERN REGIONS OF RUSSIA

	Number	Capacity, million kW	Electricity output, billion kWh
Energy sources in interconnected power systems	51	19,0	86,6
Energy sources in isolated power systems	16	2,1	5,6
including renewable energy sources (RES)	4	0,1	0,5
Autonomous and backup energy sources	5291	2,3	5,1
including autonomous RES	7	0,02	0,01

Saving fuel and money for its purchase often limits electricity supply to consumers. Another problem is aging of equipment at energy sources. Technical state of diesel power plants is as a rule unsatisfactory. Equipment is almost beyond its service life: wear and tear of many energy sources have reached 80-90%. It is necessary to replace it by modern equipment with improved technical and economic parameters. Construction of new or restoration of old buildings is also necessary.

The Eastern regions practically do not use renewable energy sources (except for geothermal ones) despite a great potential of renewable natural energy resources available here. Only 5 small hydro power plants (SHPPs) with a total capacity of 29 MW and three wind farms (WF) with a capacity of 3.25 MW [3,4] operate in the regions.

2. PROBLEMS AND DIRECTIONS OF DEVELOPMENT

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The rational directions for development of small-scale energy in the Eastern regions to ensure the enhancement of energy supply efficiency include the following:

- reconstruction and upgrading of existing energy sources by replacing aged equipment by the modern one;
- connection to electric power system;
- construction of mini cogeneration plants on local fuels (coal and hydrocarbons from local deposits);
- construction of low-capacity nuclear power plants (LCNPP);
- involvement of renewable energy sources (RES).

However, future development of low-capacity energy sources is related to certain problems. These problems are caused by different factors – economic, technical and natural. However, the main problem is commercial unattractiveness of the projects for construction and operation of any low-capacity energy sources.

2.1. Connection to centralized power supply system

This measure is rather capital intensive, though completely excludes the problem of fuel import and considerably improves power supply reliability.

The problem consists in that with the autonomous power supply to consumers from diesel power plants at which the cost of electricity production is much higher than the tariffs established for population, the subsidies are allocated from the budgets of different levels to equalize the tariffs. After connection of consumers to centralized power supply system they pay according to the tariffs established in the system and the subsidies are lifted. This makes the project for construction of transmission lines and substations unprofitable. In order to avoid such a situation the financial support should be provided through the entire calculated payback period.

Studies on the efficiency of connecting consumers to centralized power supply system were carried out for the consumers located at a distance of 50 km from points of potential connection to the system. The findings are presented in Fig.1. The projects are paid back for less than 10 years at a

current level of cost indices of transmission lines 35 kV 100-120 thous. doll./km only if electricity tariffs are above 11-16 cent/kWh (3.3-5 rub./kWh) respectively. Hence, the tariff increase for the payback period of the project for connection to centralized power supply system is estimated at 2-3 rub./kWh.

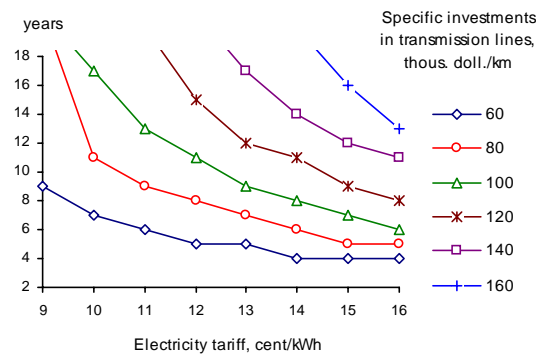


Fig.1. Payback period of projects for connection of consumers to centralized power supply system

2.2. Construction of mini cogeneration plants on local fuels

The problems related to construction of mini cogeneration plants (CP) consist not only in their high capital intensity which increases due to construction and erection works under severe climatic conditions, long distances and difficult access to the points of their allocation. They also concern the necessity of practically complete replacement of heat supply systems due to changes in their routing which will also cause a considerable rise in prices of heat supply from mini CP. Thus, construction of mini CP is a social rather than an economically efficient measure.

Besides, electricity and heat supply from mini CP is associated with increase in coal consumption as compared to boiler plants. However, due to specific features of northern climatic conditions that are characterized by significant dominance of thermal load over electric one, construction of mini CP for the populated settlements which currently import coal for boiler plants will lead to an insignificant fuel consumption increase. Based on the fact that the specific fuel consumption for production of heat at CP is lower than at boiler plants, the increase in coal volumes required for mini CP can make up 15-20% versus the amount of coal needed for boiler plants. In doing so, sup-

ply of diesel fuel to DPP for the purposes of electricity supply is completely excluded.

The efficiency of constructing mini CP on coal was estimated for 8, 4 and 1.5 MW. The findings are presented in Fig.2. The project payback period less than 10 years is only possible at electricity tariffs above 30-40 cent/kWh (9-12 rub./kWh) respectively. Tariff increase for mini CP is estimated at 7-10 rub./kWh.

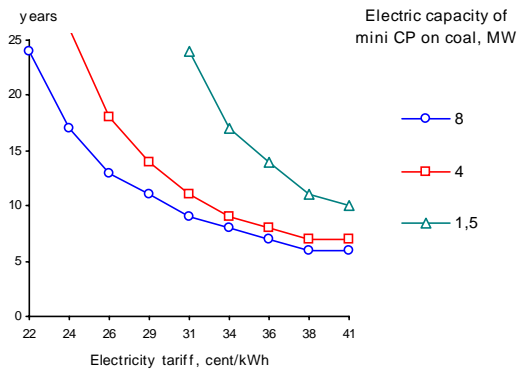


Fig.2. Payback period of mini CP construction projects

Despite the fact that the projects for mini CP construction are inefficient the cost of electricity production at these sources is on the average twice as low as the cost of electricity production at DPP. The heat production cost at CP is commensurable with the heat production cost at boiler plants. Thus, construction of coal-fired mini CP will allow decrease in the volumes of subsidies for power supply to consumers by more than 2 times.

2.3. Utilization of renewable energy sources

The natural factors causing to a greater extent problems in utilizing renewable energy sources (RES) include seasonal irregularity and instability in occurrence of renewable natural energy resources, such as energy of wind flow, small streams, solar radiation.

In the Eastern regions the maximum wind potential practically on the whole territory with its effective use during the year falls on the autumn and spring periods [5, 6, 7]. However, in some areas the maximum wind energy is observed in winters (e.g. Kuril Islands of Sakhalin region) or in summers (Chokurdakh settlement in Sakha Republic (Yakutia)) [7].

Energy of small streams has universally a spring maximum owing to floods which decreases considerably (to tens of times) in winters [8].

Solar radiation has a pronounced summer maximum along with latitudinal variation of its potential [7].

Since the energy loads of small consumers are maximal in winters, their covering by RES stipulates the problem of coincidence of the curves of energy consumption and production by RES and also choice of their optimal capacity. This factor is aggravated by isolation of small consumers from centralized electricity supply and prevalence of municipal loads, which is responsible for greater non-uniformity of energy consumption.

Fig. 3 presents an example of coincidence of energy consumption curves for the specific consumer (Chokurdakh settlement in Sakha Republic (Yakutia)) and electricity production by different types of wind turbines of approximately equal total installed capacity. The winter maximum of electricity consumption is covered by the existing diesel power plant (DPP).

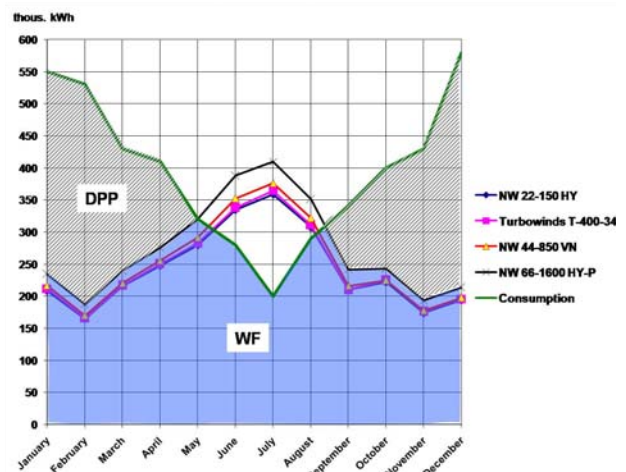


Fig. 3. Curves of electricity consumption and its production by wind turbines for Chokurdakh settlement

The example shows that because of non-coincidence of maximum loads the installed capacity of RES is used incompletely. Neglect of this factor leads to overstatement of the capacity factor at assessment of financial and economic efficiency of projects, which in turn leads to negative attitude to RES utilization,

since in practice the expected benefit is not achieved.

In this context renewable energy sources can be used only to reduce the volumes of fuel delivered, which somewhat decreases the cost price of joint electricity production by the complex DPP+RES. In this case, however, it is still necessary to receive substantial subsidies from budgets for tariff leveling [3].

Fig. 4 presents relations between the payback periods of projects on construction of WF and SHPP and the electricity tariff at different specific investments.

Acceptable payback periods are realized only at the tariffs above 12-17 cent/kWh (3.5-5 rub./kWh) at the average values of capital investments in RES.

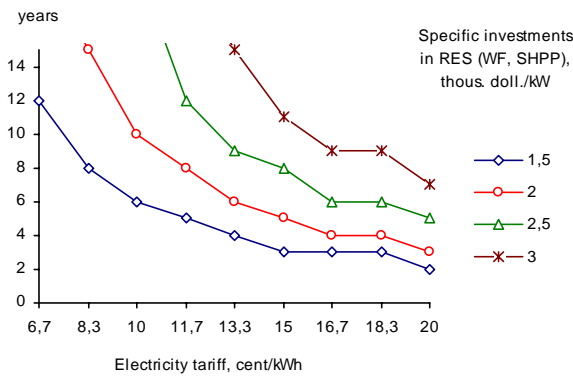


Fig. 4. Payback periods of RES construction projects

The studies performed have shown that for the conditions of the Eastern regions at the current level of RES cost the state support is needed as an increase in tariff for energy produced on the average in the amounts:

- for electricity production by WF or SHPP jointly with DPP – 3.5-5 rub./kWh, photovoltaic converters (PVC) – 15-20 rub./kWh;
- for heat production by solar heat supply systems – 1500-1800 rub./Gcal.

3. CONCLUSION

The key problem in small-scale energy development is high capital intensiveness of new energy sources of low capacity. This is the reason for inefficiency of projects on their construction. But in view of poor and point development of the territory the zone of decentral-

ized electricity supply in the Eastern regions will remain, even after the transport systems providing maximum admissibility are created in the future. The small-scale energy will be of great importance as before. The economically sound increases in tariff for electricity generated by low-capacity energy sources are given in Table 2.

ТАБЛИЦА 2. ECONOMICALLY SOUND TARIFF INCREASES FOR ELECTRICITY

Perspective project	Tariff increase, rub./kWh
Construction of renewable energy sources	
- wind farms and small hydro power plants	3,5-5
- photovoltaic converters	15-20
Construction of mini cogeneration plants on coal	7-10
Connection to centralized power supply system	2-3

The efficiency of using low-capacity energy sources can be improved on the basis of the state support, whose main directions are:

- adoption of the law on the state policy in the area of low-capacity energy sources, in particular RES;
- granting of target subsidies;
- development of a system of soft credits;
- application of a system of tax privileges to participants of the whole cycle from design of equipment to operation;
- organization and stimulation of batch production of equipment based of domestic technologies;
- creation of grounds for testing key elements of technologies.

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