

Developing Microgrid in Local Energy Systems in Russia: Barriers and Opportunities

Irina Volkova, Viktor Kolesnik
 National Research University Higher School of Economics
iovolkova@hse.ru

A Structural-innovative Model for the Development of Energy Sector in Russia

The last decade saw notable changes in the external conditions for the development of the energy sector in all countries, including Russia. The most significant of these, requiring an adjustment of the industry, included:

- decrease in the reliability of electric supply;
- changes in the electricity and power market conditions;
- the necessity to enhance the environmental safety and energy efficiency of electric power industry;
- increase of consumer demand for higher reliability and quality of electric supply;
- continuous increase of electricity prices all over the world.

Worldwide experience in power industry development and research show that the only solution is to change the paradigm of the industry, and to further a transition from the extensive development characterised by the construction of major new energy facilities to the intensive development where a sharp increase of the role and functions of management through intelligent energy technologies will ensure greater efficiency of all basic energy processes. This will significantly reduce the investment in large-scale generation and will create an optimal balance through the development of local and distributed integrated power in a single system based on microgrid technologies.

Given the specificity of Russia, it can be said that the development potential for microgrids is very high, but the level of their use will depend on the model for energy sector development. Now, there are two emerging models:

- innovative model – adopted under the “General Scheme of the Location of Energy Facilities in Russia” and the “Russian Energy Strategy until 2030” (approved by the federal government);
- structural-innovative model – proposed by the Agency for Energy Forecasting project “Development of a Concept of Energy and Electric Heat Infrastructure of Russia on the Basis of Cogeneration and Distributed Generation”.

Since the second model proposes to significantly increase the share of distributed and local power generating capacity, the implementation of this model will substantially increase the potential for microgrid development in Russia (Figure 1).



Figure 1. Microgrid development potential in Russia using various models of industry development.

However, the implementation of both models faces significant barriers at the moment. The basic barriers are as follows:

1. Market barriers: will microgrid lead to a reorganisation of the energy sector? (Figure 2)

- no policy for distributed generation (DG) development in Russia - a chaotic and unregulated development of DG;
- DG only exists at a regional level;
- the Federal Grid Company / JSC Interregional Distribution Grid Companies Holding / System Operator are not interested in DG development;
- there is no schedule or information on DG.

2. Microgrid investment and regulatory framework: barriers

- deficiency of the regulatory framework – tariff regulations should motivate innovation;
- understanding benefits is a barrier – consumer is not engaged in the discussion;
- Duma (Russian parliament) vision shows the need to increase waste-to-energy and energy storage;

- lack of typical technology and investment solutions for microgrids.

3. Education in microgrid: barriers

- inadequate skills and personnel for a new energy sector model;
- insufficient, not optimal government educational policies;
- no link between educational programmes, the standards for professional and technology innovation in the largest power companies;
- lack of sufficient skills in universities for a new energy sector model
- inadequacy of educational standards in the key areas of training required for the implementation and deployment of smart grid.



Figure 2. Market: will microgrid lead to a reorganisation of the energy sector?

In both models of energy sector development, the priority development of microgrids is necessary for isolated and island territories, first and foremost in the Far East of Russia. At present, the territory of decentralised power of the Far Eastern Federal District (FEFD) is

home to about 1,160 thousand people out of total 6,400 thousand population in FEFD.

Huge moral and physical wear and tear, high unregulated prices for diesel fuel in the logistically complex northern regions, and

high staff pay differentials in power plants and boilers all contribute to the high cost of energy in the decentralised sector - up to RUB 39/KWh and RUB 10,427/Gcal., (2009: RUB 28.02/kWh and RUB 4995/Gcal). High cost of equipment depreciation and repair imply additional burden on the energy tariff rate. In addition, in the absence of a single managing company, management of individual companies in the decentralised energy supply sector increases the managerial overhead.

In 2011, the subsidies from the regional budget to compensate for the difference in rates for people receiving energy from local generation (the total number of inhabitants of the Far East region make up less than 5 per cent of Russia's population) were RUB 1.931 billion, including thermal energy RUB 1.363 billion.

Including the cost of the modernisation and development into the local energy tariffs for electricity and heat is not feasible which makes it almost impossible to attract private investment into the modernisation and development of decentralised energy supply sector of this region. In fact, there is no money not only for the development of energy systems, but also for the necessary maintenance. All of this leads to frequent failures in the energy infrastructure and interruptions in the fuel, heat, and electricity delivery to the customers, and even the threat of bankruptcy of the supplier.

A Simulated Microgrid Project for a Typical Township in Russia's Far East

Overall, an analysis of the current situation in the decentralised energy sector of the Khabarovsk Territory leads to a recognition that the economic efficiency of the regional energy sector is currently at an extremely low level. A realistic and productive approach to the energy development in the region should be based on microgrids and distributed generation, which in the authors' estimates can be quite beneficial, and therefore attractive for investors. Further, the report provides an assessment of the effectiveness of a typical microgrid project for a township in FEFD. The basic scenario is assumed as follows:

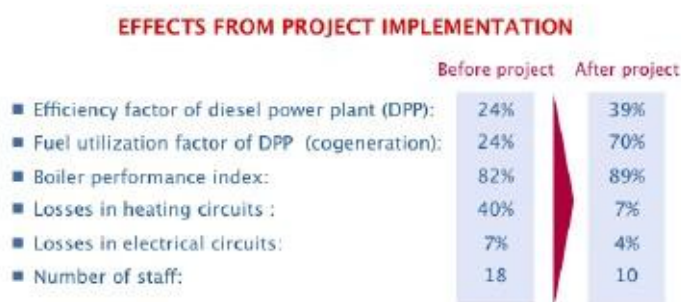


Figure 3 Typical microgrid project for a Far Eastern Federal District (FEFD) township: results

Table 1.

STRUCTURE OF CAPITAL INVESTMENTS

Description	Cost, million rubles
Equipment	
DPP	33
Wind turbine	46
Boiler	7
Other equipment	6
Automated process control system	13
Total Equipment	105
Facilities, construction and design works	
Construction and design works	67
Electric lines	1
Heat lines	6
Total construction works and facilities	74
Total capital investments	179

- Annual consumption of electric energy is 1,000 thousand KWh, electric heat – 4,000 GCal;
- Average temperature of the heating season is -20C, duration of heating season – 7-9 months. Considerable part of populated areas is characterised by an adequate wind potential (average speed - over 6 meters per second);
- The length of heating lines is 1,600 m, electrical - 9 km;
- Electrical energy tariffs for the operating organisation are approximately RUB 21 /kWh, for heat energy – RUB 5,000/GCal;
- Electric energy tariffs for the households are approximately RUB 2/kWh, for heat – RUB 1,500/GCal; the difference between the tariffs is subsidised from the regional budget or from cross-subsidising (the case of the Republic of Sakha - Yakutia);

- Financial breakdown: 50 per cent budget funding, 50 per cent credit (10 years, 11 per cent interest);
- Tariff growth rate in case of project implementation in 2012-2014 does not exceed the forecast of Russia's Ministry of Economic Development;
- Reduction of tariffs on electric energy and heat energy by 30 per cent after the credit repayment;
- Key question for the banks: guarantee of economically justified tariffs for the duration of the credit term.
- Technical: existence of system of double accounting, coordinated work of local and central generators, appropriate protection systems for all types of local and central generators, maintaining the stability of voltage and frequency in the general networks;
- Technological: there must be available equipment for local energy generation (solar panels, wind turbines, co-generation equipment);
- Organisational: there must be coordination between all participants in order to avoid overloads of generating capacities or building extra capacity, which would be underutilised;

Evaluation results are shown in Figure 3 and Table 1.

Financial results appear in Table 2 below.

The project is of considerable interest for investors, credit institutions, and FEFD sub-regions. For the implementation of the projects under consideration, various technical and policy issues should be effectively addressed:

- Legal and economic: a legal possibility of selling the excesses of self-generated energy to the end user; there must be a developed market for energy or an economically attractive environment for all participants in terms of tariffs for energy usage and transit.

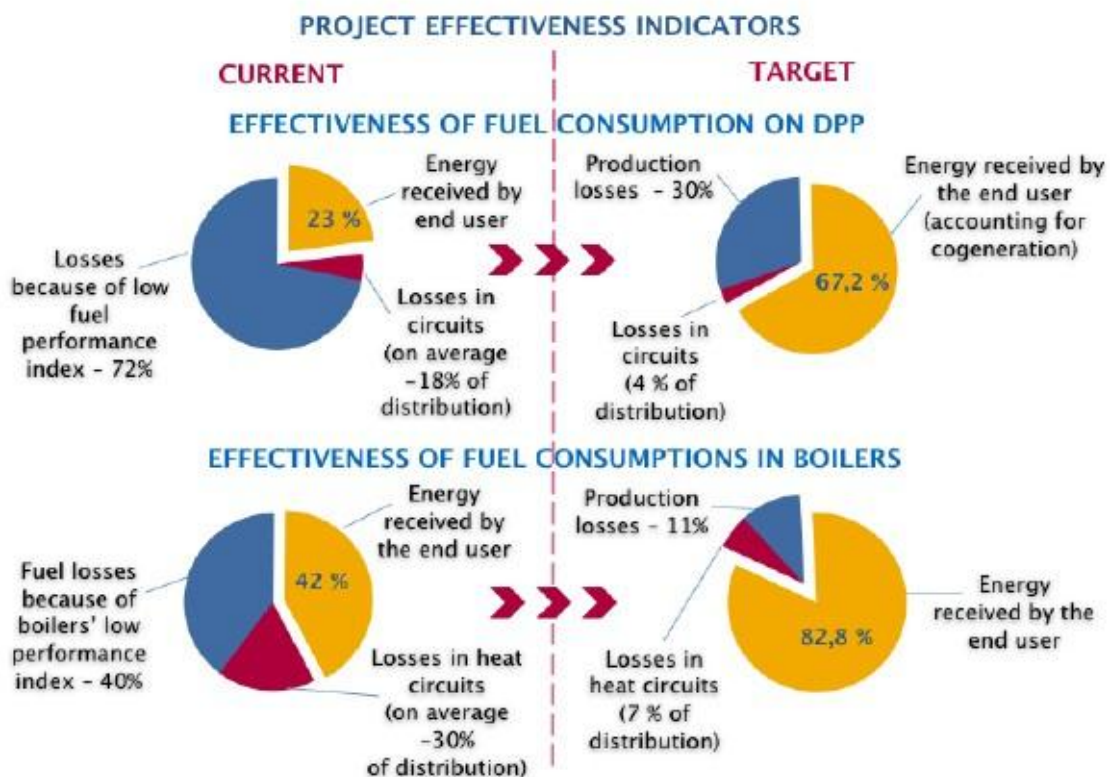
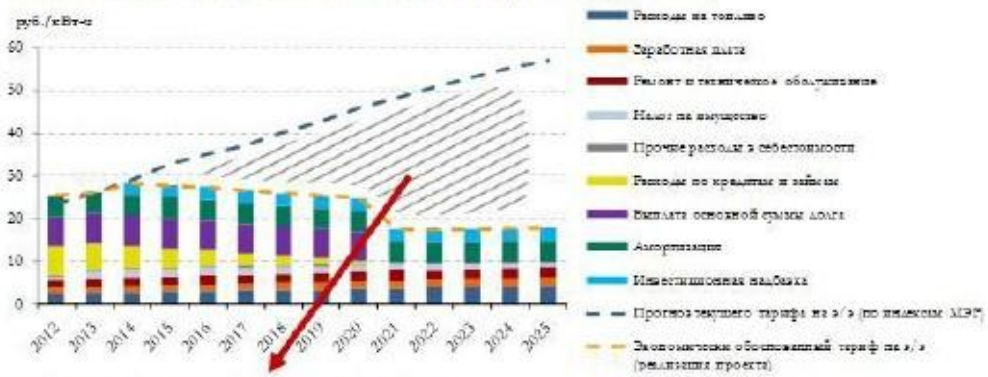


Figure 4 Typical project Microgrids for Far Eastern Federal District (FEFD): project effectiveness indicators

ELECTRIC ENERGY TARIFFS (FORECAST)



Reduction of subsidies and cross-subsidies:
RUB 922 mln – RUB 417 mln = RUB 505 mln
 in 14 years

HEAT ENERGY TARIFFS (FORECAST)

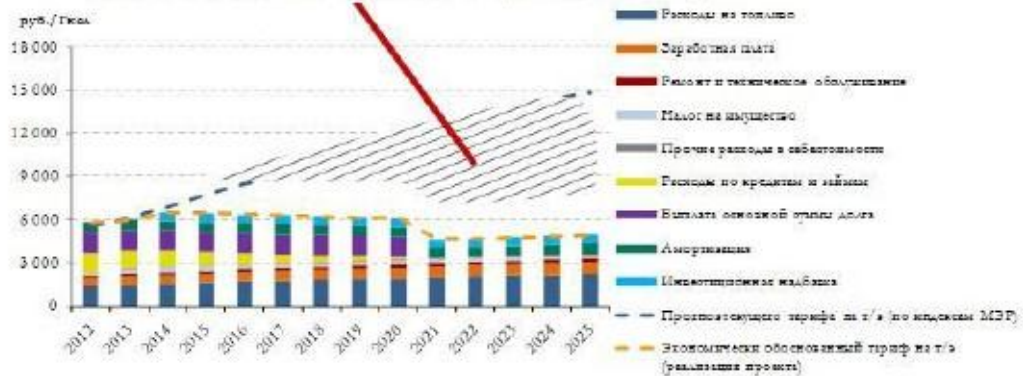


Figure 4 Typical project Microgrids for Far Eastern Federal District (FEFD): tariff forecast

Table 2.

FINANCIAL RESULTS

Indicator	Result
Project financing, RUB million including:	217
Financing of the project on account of borrowed funds, mln RUB	111
Financing of the project from the budget funds, mln RUB	106
Payback period (simple), years	9.6
Payback period (discounted), years	12.6
Net present value for the period (NPV) 2011–2025 years, mln RUB	14
Internal cost of capital, per cent	5
Borrowed cost of capital, per cent	11
Internal rate of return for the period (IRR) 2011–2025, per cent	71

Specific conditions for introduction of microgrids and DG in remote localities and island communities, i.e. state support of

projects, aimed at modernising and developing of isolated regions, must include:

- Providing long-term tariff rates for the introduced energy facilities for the entire payback period;
- Providing budget support on a payback or payback-free basis (subsidies, favorable budget financing, other mechanisms);
- Subsidies from the budget of the difference between the economically justified tariff rates and the actual rates;
- Elimination of cross-subsidising transition to direct budget subsidies; and
- Co-financing from the federal budget funds, including Federal Target Programmes, based on the public-private partnership;
- Mechanism of financial injections from the investment funds and other sources.