Alternative energy as a tool for the development of small and medium-sized enterprises in Russia

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Abstract. Nowadays, the level of development of small and medium-sized enterprises (SMEs) in Russia lags behind that of the states with advanced economy. Problems with connection to the power supply attributed to prohibitive costs and time-consuming procedures can be distinguished among many other reasons. The aim of this paper is to consider feasibility of applying alternative energy sources to the needs of small and medium-sized enterprises through the study of the Sverdlovsk Region. While analyzing local energy sources of the region with due regard to its geographic and climatic peculiarities, we have identified the most promising sources of energy that require state support for their efficient use. Estimation of economic efficiency of the implemented project of alternative energy supply at a small enterprise proves feasibility of using a stand-alone solar panel based energy supply system.

Keywords: small enterprises, energy supply, alternative energy sources, solar panels, economic efficiency.

1. Introduction

In democratic states with advanced economy small enterprises are the backbone of their national economy. Their contribution to GDP illustrates the welfare of the population. They generate jobs for the able-bodied population and form the so-called middle class whose core is represented by economically independent and socially active citizens. Small enterprises in the OECD member states are a powerful force for scientific and technological progress. The majority of innovation projects, patents and certificates obtained in different spheres, from medicine to IT, accrue to small and micro-sized enterprises.

The attitude towards small enterprises in Russia is slightly different. Since the existence of the USSR and Gosplan (State Planning Committee of the USSR) national economy has been showing the trend towards production consolidation irrespective of a specific industrial sector. After the collapse of the USSR, the situation changed in favour of small enterprises, but not dramatically. The share of large companies and public sector in GDP has been rising steadily. Small enterprises in our country cause problems to many entities related to entrepreneurship activities or their regulation. State government bodies must spend enormous amounts of money to monitor the activities of dozens of small companies with minimum annual turnover, manage taxes, etc. Large companies due to their clumsiness and internal bureaucracy cannot compete fairly and honestly with small enterprises at local markets and have to beg local authorities, which they fused with in the 1990s, for help. Due to public awareness formed by domestic media and the experience of the first years following the collapse of
the USSR, the population has quite a negative attitude towards the entrepreneurs considering them as people who became rich following the wrong path and who have criminal background.

The situation is aggravated by problems which, as it seems, should not occur in a market economy. SMEs have difficulties with connection to resources, such as gas distribution network, electrical grid, water supply lines, and sewerage network even on a fee-for-service basis. Prohibitive costs and time-consuming procedure required for connection are not always viable in case of entrepreneurs whose activity suggests low power consumption.

This paper examines feasibility of using alternative energy sources by small enterprises located far away from the centralized power supply networks, in the geographical and climatic conditions of the Middle Urals. Among renewable resources available in this region, the following can be identified: solar energy, wind power, small hydro power, and biomass.

2. Challenges for SMEs in Russia

Small business in the states with advanced economy plays a key role in the economy, providing fair competition, supplying new commodities and services to the market, and covering the needs of large enterprises. Development of small enterprises in the states with advanced economy is more rapid, as national authorities elaborate a lot of programs to support them and grant privileges considering this sector very important, which influences micro- and macroeconomic performance, i. e. GDP, loan interest rates, economic competitive ability, employment of population, etc. (Table 1) [1].

Table 1. Key figures reflecting the role of small business in different countries (2015)

| Value                                      | Russia | USA | Japan | Germany | England | Singapore |
|--------------------------------------------|--------|-----|-------|---------|---------|-----------|
| Share of small enterprises in GPD of the country, % | 20     | 52  | 51.6  | 57      | 52      | 53        |
| Share of small enterprises in total employment, % | 26     | 50.1 | 69.5  | 69.3    | 55.5    | 62.3      |
| Share of small enterprises with regard to total number of enterprises, % | 98.5   | 97.6 | 99.2  | 99.3    | 99.1    | 98.5      |

For example, in Germany subsidies granted to small enterprises account for about 4 billion euros annually (in comparison, in Russia in 2017 it was 7.5 billion rubles or, on the average weighted exchange rate of the Russian rouble to euro equal to 70 RUB/EUR, 107 million euros). Two committees deal with the problems of small businesses in the U.S. Congress. Their aim is to support small business at a government level. Japan, with a particularly high number of small enterprises, distinguishes those of them that cannot develop on their own under market economy conditions without any state financial aid. States with advanced economy support small business financially and give privileges, particularly tax privileges [2].

In the developed countries, the main problems related to government interference into business are the complexity of the tax system and government overregulation of certain business spheres. However, if in Russia bureaucracy and excessive activity of inspection authorities are the main reasons hindering the development of small businesses, in the advanced economies it happens primarily due to economic and external factors. Small businesses in the West are very sensitive to contraction of domestic demand. The second largest problem affecting western small enterprises is a tremendous amount of pirated items coming from Asian countries. Fraudulent use of brand names and low quality of pirated goods inflict substantial damage to reputation of American and European trademarks. The third challenge for small enterprises in the developed countries is high standards of living assured not only by their economic strength, but also by government regulation. The OECD member states provide high minimum wage level; contributions to medical insurance funds and pension contributions are mandatory. This makes western companies spend substantial funds for job compensation, which increases the production cost of goods and decreases their competitive ability [3].
In Russia, due to insignificant influence of small businesses on GDP, analysts, experts and state officials, as a rule, distinguish and describe small and medium-sized enterprises (SMEs) rather than small business to increase the effect of their analytical efforts, development forecasts, and elaboration of SMEs' support programs. The total number of operating SMEs in Russia as of 2017 was about 5.5 million (according to data from the Federal State Statistics Service).

Federal support includes federal SME support programs, initiated by the Ministry of Economic Development of the Russian Federation, Ministry of Agriculture of the Russian Federation and other ministries and agencies. The following government agencies were established: Federal Corporation for the Development of Small and Medium Enterprises (SME Corporation, AO), Russian Bank for Small and Medium Enterprises Support (SME Bank). SME Corporation is responsible for monitoring support granted to SMEs as per Federal law No. 209-FZ dated July 24, 2007 On the SMEs’ development in the Russian Federation. SME Bank is responsible for government financial aid program (bank loans, microloans, receipt of assets under the finance lease agreement, accounts receivable financing) [4].

However, despite SME support on the federal, regional and municipal levels, small and medium-sized enterprises face a lot of problems. As per the data provided for by the analysts of the Center for Macroeconomic Analysis and Short-Term Forecasting [4], 3,227 companies have gone bankrupt in Russia in different spheres since the beginning of 2017 due to the following reasons: lack of stability, inflation and economic disenfranchisement, weakening of the Russian currency, and increase in rates of the Bank of Russia. Other experts declare that SME problems are attributed to the critical number of different inspectors who strangle business by their inspections. SMEs find it difficult to get government financing funds, face problems during tenders and auctions pertaining to state procurement. These problems are fundamentally different from the difficulties faced by SMEs in the USA, Japan, and EU countries.

In the 2000s, SMEs, in our opinion, encountered a very unexpected problem that substantially inhibits SME development and remains a problem even today, i.e. arbitrary behaviour of such natural monopolies as RAO Unified Energy System of Russia (after reformation of energy industry Federal Grid Company of the Unified Energy System of Russia and regional grid companies), Gasprom (PAO). Even large industrial companies had difficulties in connection to electrical grid and gas supply network, not to mention SMEs.

All the regions in Russia find themselves in a similar situation. Key economic indicators show that the Sverdlovsk Region is one of the most developed major industrial territorial entities of the Russian Federation (according to data from the Federal State Statistics Service). The Government of the Sverdlovsk Region also makes efforts to support SMEs. Subprogram Development of small and medium-sized entrepreneurship has been approved and is being implemented (within the framework of the 2013–2020 State Program of the Russian Federation Economic Development and Innovative Economy). The analysis of different ratings and research works pertaining to the analysis of entrepreneurial and investment climate in the regions of the Russian Federation showed that the Sverdlovsk Region is not the leader in this sphere and holds middle positions among the territorial entities of the country [5]. The Sverdlovsk Region is one of the regions with a very low level of SME state support, i.e. only 293.4 rub of federal financing per capita. As many entrepreneurs remark, the most time-consuming procedure when connecting to the power supply system in the Sverdlovsk Region is elaboration and approval of the project for external electricity and gas supply.

3. Analysis of alternative energy sources in the Sverdlovsk Region
In the Urals, in general, and in the Sverdlovsk Region in particular, the main sources of electrical energy for large companies, small and medium-sized enterprises, and for housing and community amenities are heat power, hydropower, and nuclear power (the Beloyarsk Nuclear Power Station with the fast neutron reactors).

Renewable sources of energy, such as solar energy, wind power, and biomass also find their application, though it happens very rarely. This is due to several reasons. First of all, low specific
power necessitates large sizes of electric power stations, which leads to the increase in capital investment in comparison with conventional power stations. Second, climate variability influences certain kinds of energy, for example, solar energy and wind power depend on the season and meteorological conditions. Third, the obtained energy has to be immediately used (which is not always efficient) or accumulated. Accumulation of energy in large quantities is an unsolved technical challenge. Finally, procurement and maintenance of special equipment incur high costs, which makes such sources of energy uncompetitive in comparison with conventional sources.

In view of the reasons stated above, it is clear that large companies do not see any benefits in application of renewable sources of energy on a large scale, but it is different in case of SMEs. In the Urals alternative sources of energy are often adopted in SMEs in the Chelyabinsk and Kurgan Regions. The following can be identified among renewable resources available in the Sverdlovsk Region: solar energy, wind power, small hydro power, and biomass [6, 7].

3.1. Solar energy
In 2014 RealSolar performed research pertaining to the amount of solar energy in different regions of Russia. The data on daily solar radiation is given in Table 2 for several Russian cities.

| City              | Jan | Feb | March | Apr | May | June | July | Aug | Sept | Oct | Nov | Dec | Average per year |
|-------------------|-----|-----|-------|-----|-----|------|------|-----|------|-----|-----|-----|------------------|
| St. Petersburg    | 0.35| 1.08| 2.36  | 3.98| 5.46| 5.78 | 5.61 | 4.31| 2.6  | 1.23| 0.5 | 0.2 | 2.8              |
| Moscow            | 0.5 | 0.94| 2.63  | 3.07| 4.69| 5.44 | 5.51 | 4.26| 2.34 | 1.08| 0.56| 0.36| 2.63             |
| Kazan             | 0.68| 1.44| 2.82  | 4.29| 5.52| 5.93 | 5.72 | 4.49| 2.86| 1.51| 0.83| 0.54| 3.06             |
| Rostov-na-Donu    | 1.27| 2.09| 2.98  | 4.09| 5.53| 5.76 | 5.86 | 5.17| 3.85 | 2.38| 1.31| 1   | 3.45             |
| Nizhny Novgorod   | 0.64| 1.45| 2.75  | 3.95| 5.34| 5.6  | 5.5  | 4.27| 2.69| 1.45| 0.75| 0.45| 2.91             |
| Yekaterinburg     | 0.64| 1.5 | 2.94  | 4.11| 5.11| 5.72 | 5.22 | 4.06| 2.56| 1.36| 0.72| 0.44| 2.87             |
| Novosibirsk      | 0.69| 1.37| 3.02  | 4.08| 5.05| 5.48 | 5.01 | 4.29| 2.93| 1.44| 0.8 | 0.62| 2.91             |
| Khabarovsk        | 1.64| 2.72| 4.11  | 4.61| 5.39| 5.86 | 5.42 | 4.53| 3.81| 2.56| 1.72| 1.28| 3.64             |

The research showed that solar energy in the Sverdlovsk Region has small potential. However, as domestic and foreign experience shows [8–10], even such a moderate irradiation makes it possible to use solar panels in separate remote objects with the aim of cost reduction of diesel power generation (for 1 kWh) and building of a stand-alone power supply system with low power consumption.

In our opinion, the climate in the Urals makes it feasible to apply solar energy to power SMEs if there are no other sources of energy.

3.2. Wind power
Annual average wind speed is a very important indicator for application of wind power plants.

The Sverdlovsk Region is characterized by quite a nonuniform distribution of wind current within its territory. As per the data provided by Meteoblue, annual average wind speed in the south and east of the Sverdlovsk Region reaches 1–2 m/sec, while in the west and in its central part, 2–4 m/sec, and in the north, 3–6 m/sec. The highest annual average wind speed (5.5–10 m/sec) can be found at the tops of the Ural mountains' spurs (Blagodat, Kachkanar, Magnitnaya, etc.) and in the North Sosvinsky height where annual average wind speed reaches 6–12 m/sec [10].

Application of wind power plants to power large companies in the Sverdlovsk Region is not efficient. First of all, wind is unstable, it can rise and slacken. Second, the speed of wind in the Sverdlovsk Region is quite low. Third, wind turbines of good quality are very expensive. In the fourth place, wind power plants are characterized by high level of acoustic pollution. Finally, they cause interference to TV and different communication systems. However, wind turbines can be used as a source of electrical energy together with solar panels, diesel-, petrol- and gas generators for country houses, auxiliary premises and farm enterprises, small houses, small-scale producers in remote regions.
where there is no central power supply network or the parameters of the available electric power are not appropriate for the consumer.

3.3. Biopower
There is quite a long list of possible sources of raw materials for biopower, for example, oil crops, sugar and starch crops, their waste products, animal fat, timber, wood wastes, peat, biodegradable solid municipal wastes, sewage sludge, manure, etc. But peat, wood wastes and wastes from farm enterprises are the most promising sources from this list for the Sverdlovsk Region. Nevertheless, these resources remain untapped, and the development of this trend in the near future is unlikely.

3.4. Mini hydro power plants
There are a lot of river water resources in the Sverdlovsk Region. There are 18,414 rivers with total length of 68,000 km, besides 135 water-collecting areas, more than 1,200 ponds, and 2,500 lakes (according to data from the Ministry of Natural Resources and Environment of the Sverdlovsk Region).

Mini hydro power plant is one of the most promising ways for the development of the alternative energy. The companies located in remote and hard-to-reach areas, far away from power lines can use small hydro power plants. They can operate using current energy of small rivers and even creeks. Modern plants are easy to operate and fully automatic. They can operate both standalone, and as part of an electrical grid. What is more important, the quality of current produced by small hydro power plants complies with the requirements of state standards (GOST) with regard to voltage and frequency.

All the enumerated alternative sources of energy are currently important for SMEs. The choice of this or that source for a SME is determined by its economic efficiency in comparison with other sources, including connection to public networks despite high capital investment.

Several examples of successful implementation of alternative sources of energy application despite the difficulties of connection to public electric power and (or) gas distribution networks can be found in the Middle Urals. One of such examples is described below.

4. Stand-alone power supply of a small enterprise
An enterprise registered in Yekaterinburg as a legal entity X is engaged in distribution of tools and components of technical production goods, including those of own production, within the territory of the Urals and Russia. In compliance with the criteria stipulated in regulations of the Russian Federation, this enterprise falls within the category of small business. Nowadays, the main territory of this enterprise includes production areas and warehouses, but also there are two additional sites for shipping of the goods with convenient approaching roads.

One of the sites that was launched in 2013 is 30 km away from Yekaterinburg. When the site was under construction, the entrepreneurs faced a serious problem, i.e. absence of power supply. The total length of power lines required for connection to the centralized power supply was 1.7 km, which necessitated capital investment equal to 1,500,000 RUB (or 47,100 EUR). The owners of the enterprise found such a connection economically inefficient due to high nonrecurring expenditures and time-consuming procedure of connection for a relatively low power consumption. Eventually, they chose a project of alternative power supply which was successfully implemented.

Warehouses, an office building and an accommodation building are located within the premises of this site.

The choice of the room lighting devices, household and office equipment was based on their power consumption bearing in mind the capacity of installed solar panels, i.e. 3 kWh/24 h or 1,095 kWh/year. LED lighting devices were installed in the office, while mercury lamps mounted in the warehouses. To save electric power consumption, PCs were replaced with laptops, and ink-jet multifunction printer was used. Radio connection was adjusted through a channel with 5 Mbit/s. Expenses associated with electric power in the accommodation building included lighting, a fridge, a
TV set, and a phone. The rooms were heated with radiant convector gas heaters; LPG delivered in balloons was used as fuel. This site was less operated during winters.

To generate electric power, a stand-alone solar panel based energy supply system was used. The equipment was installed by the in-house personnel (Figure 1 and 2).

Calculations of capital investments for installation of this system is given in Table 3. Funding of the project was carried out by the enterprise itself.

### Table 3. Capital Investment

| Items for capital investment                                      | Sum, RUB  | Sum, EUR<sup>a</sup> |
|-------------------------------------------------------------------|-----------|-----------------------|
| 1. Solar panels, 200 W, 24 V, 9 pcs                              | 87,000    | 2,730                 |
| 2. MPPT controller for solar panels                              | 20,000    | 620                   |
| 3. *Docke*r accumulator batteries 12 V, 200 A/h, 3 pcs           | 17,000    | 530                   |
| 4. Inverter, 2,500 W                                            | 8,500     | 270                   |
| 5. Installation materials, commutation and other equipment       | 10,000    | 310                   |
| 6. *Hitachi* generator, 2 kW (for emergency recharging)          | 17,000    | 530                   |
| 7. LED lighting                                                  | 12,000    | 380                   |
| 8. *Alpine* radiant convector gas heater, 4.5 kW (heating of the office and accommodation building), 2 pcs | 12,000    | 380                   |

Total: 183,500 RUB = 5,760 EUR

<sup>a</sup> Official average ruble-euro exchange rate of 2013: 31.85 RUB/EUR.

The stand-alone energy supply system demonstrated stable operation for more than two years. There were practically no failures, and if any, it was mainly attributed to human errors. The system did not require activation of an emergency petrol generator for 9-10 months a year. The least efficient months were October, November, and December due to low luminous flux and short length of light days. With low recharging of the solar panels during the day and with a 24-hour operation of the accommodation building, accumulator capacity was reduced to zero within a week time.

To evaluate economic efficiency of application of a stand-alone solar panel based energy supply system, we can compare expenses incurred for three variants of generation of power that can be divided into two kinds, i.e., electric power (for lighting, communication, operation of the household and office equipment) and heating energy. We consider the following as sources of energy:

- Variant 1: the system on the basis of solar panels and gas convectors.
- Variant 2: *Hitachi* generator (fueled with petrol) and gas convectors.
- Variant 3: centralized power supply network. This variant implies heating of the rooms with electricity.

Calculations of operating energy costs for three variants of energy generation is given in Table 4.
Table 4. Calculation of energy costs.

| Parameter                                      | Variant 1       | Variant 2       | Variant 3       |
|------------------------------------------------|-----------------|-----------------|-----------------|
| 1. Capital investment, RUB/EUR               | 183,500/5,761   | 116,000/3,642   | 1,500,000/47,096 |
| 2. Annual energy and fuel consumption, including |                 |                 |                 |
| 2.1. electric power, kWh                     | 1,095           |                 | 7,420           |
| 2.2. petrol, l                               |                 | 1,003           |                 |
| 2.2. LPG, l                                  | 794             | 794             |                 |
| 3. Annual operating costs, RUB, including    |                 |                 |                 |
| 3.1. electric power                           | 33,992          | 59,593          | 191,552         |
| 3.2. petrol                                  |                 | 33,701          |                 |
| 3.3. gas                                     | 14,292          | 14,292          |                 |
| 3.4. depreciation                            | 19,700          | 11,600          | 150,000         |
| 4. Present Value\(^a\), RUB                  | -213,744        | -290,240        | -1,447,499      |
| 5. Prime cost of 1 kWh, RUB/EUR\(^b\)        | 16.89/0.53      | 37.29/1.17      | 25.82/0.81      |

\(^a\)Official average ruble-euro exchange rate of 2013: 31.85 RUB/EUR.
\(^b\)This parameter takes into consideration capital investment and operating cash outflow. It is calculated for a 10-year period with a discount rate of 17%.

Our analysis showed that the first variant, i.e. application of a stand-alone solar panel based energy supply system, is the most cost efficient for the enterprise. However, the comparison of the costs of 1 kWh shows that solar energy is more expensive, limited and unstable source of electric power in the Middle Urals.

High energy costs in case of a centralized power supply network are attributed to high expenses for connection to the electrical grid, which is an obstacle for the small business development both in the Urals, and within the territory of Russia. Even if technological connection of power receiving appliances of electrical energy consumers to the available power lines is possible (generally, not further than 300 m), nonrecurrent costs amount for 750 thousand rubles. Therefore, it is very important to consider means of small business support that can be provided by state government with regard to power supply. Application of a stand-alone solar panel based system is efficient as a backup electric power supply for communication systems, alarms, heating pumps, and the server of the enterprise.

5. Conclusion
1. Small and medium-sized enterprises are the backbone of the economic growth in the developed states, and account for more than half of the gross domestic product. According to the plans of the Government of the Russian Federation, this figure will be reached in Russia by 2040.
2. SMEs throughout the world require special treatment and support. Global experience show that despite state support the number of new small businesses registered every year equals approximately the number of the companies shut down every year. Without state support existing imbalance with regard to companies-bankrupts and companies that successfully continue their activity would dramatically change in favor of the former.
3. Besides conventional problems related to corruption, bureaucracy, and frequent changes of legal framework, SMEs in Russia face specific challenges, such as connection to public networks (electric power supply, gas and water supply, sewerage).
4. One of the solutions of these specific problems can be application of alternative sources of energy. Feasibility of applying some alternative sources has been analyzed through the example of the Sverdlovsk Region. The most efficient kinds of alternative energy appropriate for this region have been identified.
5. Calculations for adoption of alternative sources of energy have been given for a specific enterprise located in the Sverdlovsk Region, including a respective feasibility report.
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