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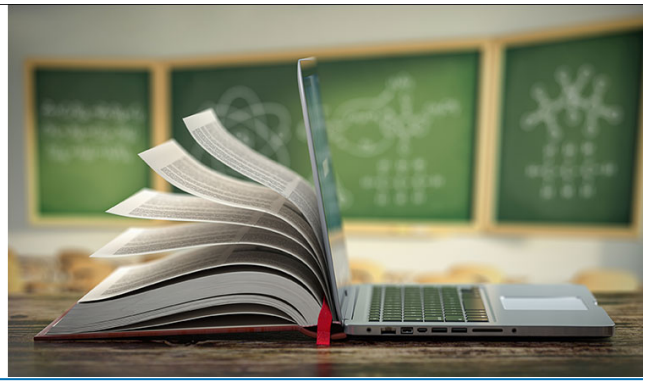

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The potential for the development of renewable energy generation in Russian territories where the power supply system is decentralized

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Abstract. The problem of conservation of energy sources is actual in many countries. The energy strategies of developed countries are aimed at renewable energy sources. For instance, European Union has already developed a long-term strategy ENERGYSTRATEGY 2050 aimed to reduce greenhouse gas emission by more than 80-95% from 1990 levels. Russian Federation has also developed the national program "Energy saving and improvement of energy efficiency for the period until 2030". The distinctive feature of Russian energy system development is decentralized energy supply on large territories. Therefore, the renewable energy development is urgent. This article describes prospective directions of development of renewable energy generation systems in underpopulated and isolated territories of the Russian Federation where energy supply is decentralized.

1. Introduction

The saving of energy resources is one of the most trending topics today. In order to address this problem developed countries focus on the reduction of specific power consumption levels and effort to increase the use of renewable power sources.

There are more than one billion of different buildings being serviced and constructed around the world and consuming more than 40% of the world's material resources and energy [1-4]. The concept of sustainable development is being actively discussed, implemented, and popularized worldwide. The concept involves the assurance of the safe environment, the conservation of resources for future generations, the limitation of negative impact on the environment, and the rational use of all types of natural resources in all urban construction activities. The world energy consumption has increased twice for the last 50 years (figure 1) [5].

Many developed countries around the world are taking urgent measures for the development of energy conservation policies. For example, the members of the European Union developed the energy conservation strategy named ENERGYSTRATEGY 2020 aimed to reduce greenhouse gas emission by more than 20%, increase the share of renewable energy sources by more than 20%, and achieve energy savings of 20% or more by the year 2020 [6]. Energy efficiency in European industry is increased due to such factors as: investments in sustainable construction, the creation of a regulatory framework for stimulating the use of renewable energy, the development and implementation of renewable energy application technologies, etc. At present, the European Union has already developed

a long-term strategy ENERGYSTRATEGY 2050 aimed to reduce greenhouse gas emission by more than 80-95% from 1990 levels [7].

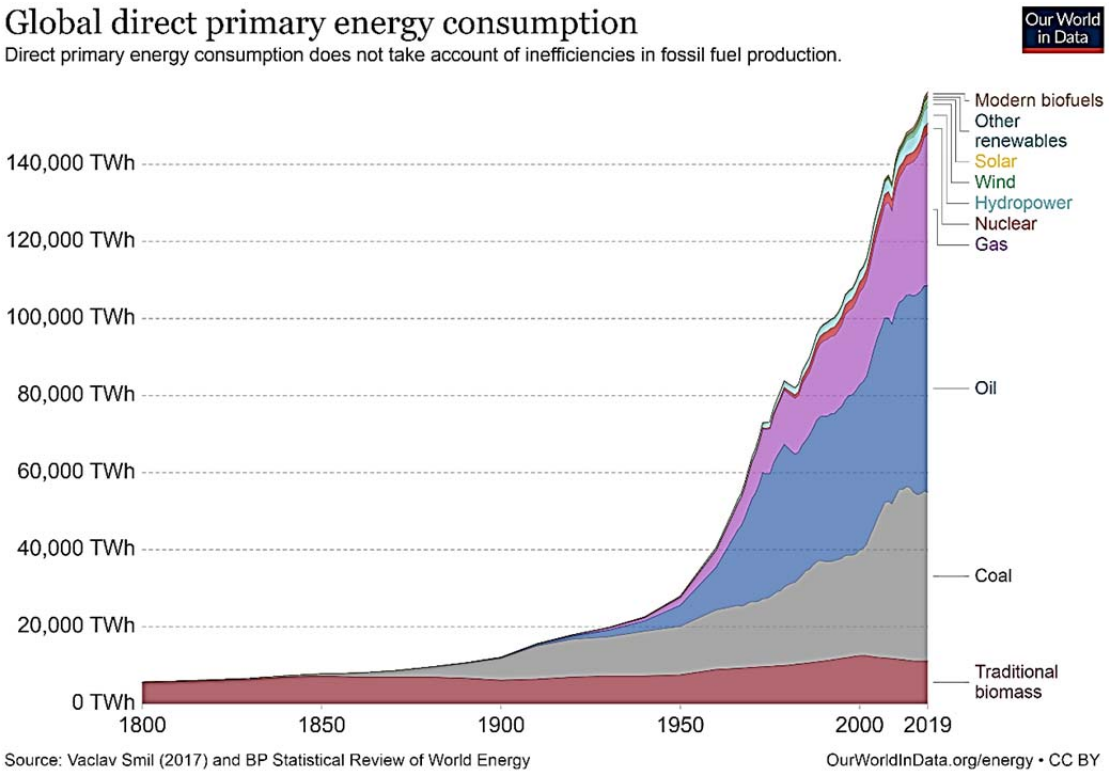

Figure 1. Global direct primary energy consumption.

A national program "Energy saving and improvement of energy efficiency for the period until 2030" developed in Russian Federation and put in force by the Government of RF in the year 2009 aims to modernize the regulatory framework and implement mechanisms for increasing energy efficiency, improving environmental safety, and reducing the energy intensity of the gross domestic product by half or more (as compared with 2005 level) [8].

2. The potential for the development of renewable power generation in Russian territories where the power supply system is decentralized.

Russia's agriculture power industry sector is characterized by: the dispersion of consumers in rural areas; low power consumption; lengthy electricity, heat, and gas distribution networks; and low population density of agricultural territories where there is no centralized power distribution system. These factors define additional reliability requirements to energy supply systems due to the wear of power lines, low quality of power supply, as well as persistent failures and loss of power in the lines. Rural territories provide great potential for the development of renewable energy industry since it will solve many problems related to the power supply of such areas [9-11].

Most of rural settlements in the Russian Federation are located in areas where the energy supply is decentralized. The energy supply strongly influences population living conditions, demographic situation, and the development of agricultural industry in these territories. A substantial percentage of settlements having no access to the electrical grid get their power supply from fuel-fired generators. Up to 8 million tons of liquid fuel and up to 30 million tons of coal are delivered annually to Far North, Far East, and Siberia regions, and the price of the fuel in some hard-to-reach areas is higher than its price on the global market [12].

In some cases the lack of fuel can endanger people's lives. According to the latest agricultural census, less than 35% of large and medium agricultural companies have access to a centralized gas supply system, and only 20% of these companies are connected to centralized heating systems [13].

Isolated townships located in the Arctic territory may be used for starting the large-scale implementation of renewable energy projects in the Russian Federation. The Arctic regions of Russia have great potential for the development of renewable energy production. Areas with average wind speeds of 6-7 m/s and higher can be used for the development of wind-power engineering applications. The conditions in these regions are also beneficial for the development of solar power engineering: average annual direct solar radiation energy level in the Arctic varies from 2 to 5 kW*h/(m2*day). Regions in Kamchatka and Chukchi Peninsula offer favorable conditions for the development geothermal energy production. The southern part of the eastern regions of Russia is suitable for the development of biofuel engineering using wood residue and low quality wood as a raw materials. Development of tidal power engineering may be of interest in the future.

The low specific capacity of power-generating facilities and their dispersion over vast territories ensure the maximum efficiency of the implementation of renewable-energy-based solutions. These features make it possible to reduce the payback time and substantiate the feasibility of their use.

Moreover, such energy supply systems make it possible to maintain the modern level of availability of electricity in underpopulated areas, and in most cases the implementation of such projects is the only way to achieve this goal.

For many Russian regions the implementation of autonomous and integrated energy supply systems using renewable energy sources is the most practical. In general, such integrated systems working on renewable energy sources shall be designed to maximize the utilization of their effective working time. In these systems renewable energy sources shall be used as primary energy sources, and other energy sources shall be used as back-up in case of a failure of the primary system (or when the output of the primary system is low).

The use of renewable power sources makes it possible to avoid some of the expenses and potential problems related to traditional power supply means [14-16]:

- electrical grid erection works;
- line losses: from 20% to 30% in electrical networks, up to 60% in heat networks;
- wear and necessary refurbishment of grid equipment: up to 80%;
- higher connection costs;
- power failures, low quality of power supply causing losses and damages;
- fuel delivery costs;
- fuel transportation costs;
- increase in the energy supply cost due to the traditional fuel prices going up;
- environmental problems: pollution, CO2 emissions, overall deterioration of living conditions, etc.

Also, it shall be noted that due to the active development of solar power technologies the availability of solar panels is improved. For example, today the price of third generation thin-film photoelectric cells starts from 0.25 USD per 1 kW. The diagram given on the figure 2 shows the solar panel module price variation curve starting from 1976 where we can see the steady decline of the prices [17-20].

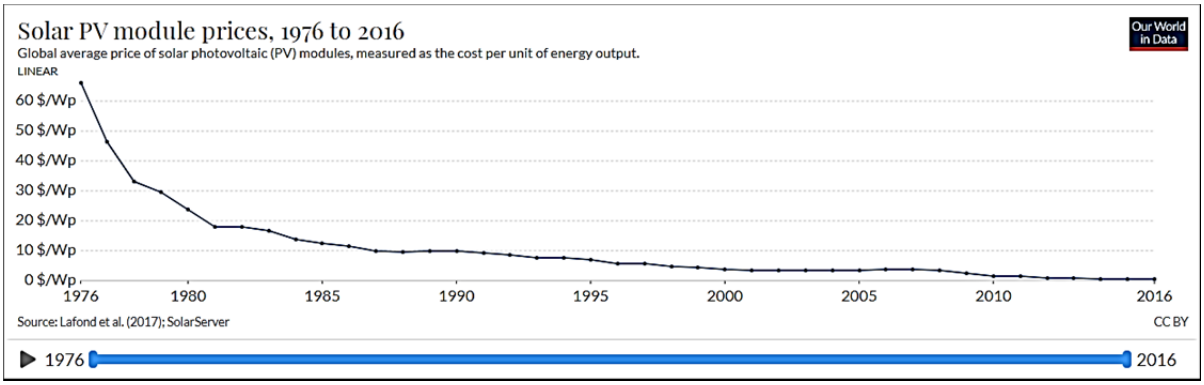

Figure 2. Solar module price variation from 1976 to 2016.

3. Conclusions

An amendment addressing the development of microgeneration was made to the Federal law No. 35-FZ "On power industry" in December, 2019. This amendment introduced the concept of microgeneration into the legislation.

The Federal law prescribes large energy providers to procure energy generated by microgeneration facilities (excessive energy) at the wholesale rate set for the respective territory. If a power plant is owned by an individual person, the income from the sale of electrical energy shall not be considered as business income and shall be exempt from the private income tax (PIT) until the first of January 2029. The manufacturers of equipment for renewable power industry shall be entitled to incentives in the field of environmental legislation. In recent years the use of renewable power sources in Russia gets more and more attention, but technology is not yet reached the widespread use. Stimulating measures taken by the Russian government will lead to the increase in the volume of energy generated with the use of renewable sources. The development of new technologies and production of equipment will allow increasing workload on the production capacities which have been underused before.

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