EXPLORING THE NORTHERN DIMENSION

Northern Dimension

Northern Dimension Institute | Policy Brief 12 - December 2020

Wind Energy is a key solution for remote area energy supply in the High North of Russia

The energy supply in the Russian Federation is characterized by a large number of remote northern settlements which are powered by imported fossil fuel, mostly diesel fuel. Therefore, sustainable development of remote northern territories is a major challenge. One solution to this challenge is to increase the use of wind energy. The replacement of majority of diesel power plants with wind power plants would reduce economic costs and environmental risks, and thus contribute to the sustainable development in the High North.

- **Recommendation 1**. To invest in the construction of wind power plants in the High North with the plant capacity corresponding the demand of electrical capacity of the settlement. Initial investments represent the largest part of the wind power plant costs. These investments are paid off by using a natural renewable energy source.
- **Recommendation 2.** To support research on icing of wind power plants and the development of de-icing systems. Solving the icing problem is the key to the sustainable operation of wind turbines in the north.
- **Recommendation 3**. To integrate wind power plants to existing power supply networks to create a smart grid system. This system would eliminate the risk of energy shortages caused by possible wind instability.
- **Recommendation 4**. To raise public awareness about the benefits of clean and renewable energy through distributing information on television, organizing training courses for companies, and providing education in schools and universities.

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Why does remote area energy supply matter?

About 60 % of the Russian territory is not covered by centralized electricity supply. Figure 1 shows that these are mainly areas of the High North. Power supply of these regions is most commonly carried out by **low-capacity power plants operating on fossil fuel**, usually diesel fuel.

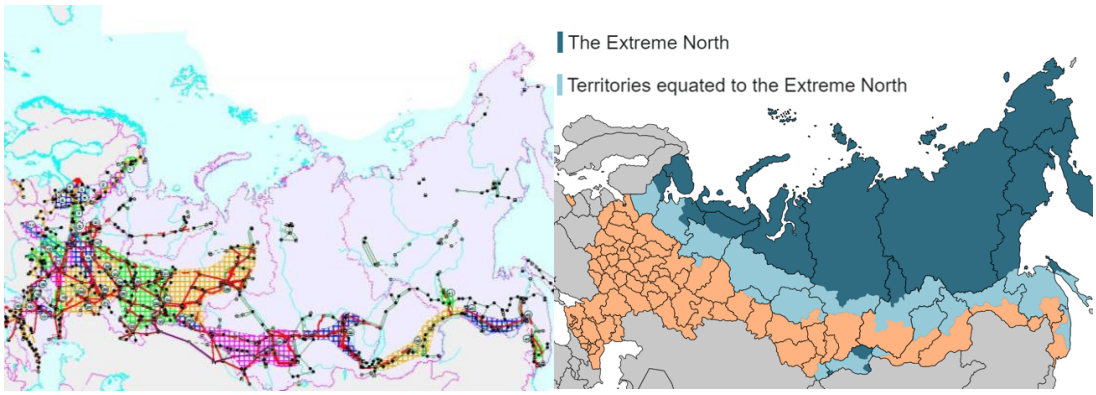

Figure 1: Centralized power supply networks in Russia (left) and in High North territories (right).

The total capacity of diesel power plants operating in the High North of Russia is more than 3 million kW. Approximately 5–6 million tons of diesel fuel are transported for power supply of remote northern territories annually[i], which is about 15 % of the total amount of diesel fuel produced for the domestic market of the country[ii].

The remoteness from centralized power supply systems and the use of diesel fuel cause the following problems:

- Electricity generation is very **expensive,** because the fuel needs to be transported over long distances. This increases the cost of energy production for several times.
- Transportation and use of fossil fuel create environmental problems due to the increased **risk of fuel spills and leaks**. Oil products spilled into water or soil remain there for many years. Pollutants contaminate air and drinking water.
- Diesel power plants have a negative impact on the environment due to **pollution emissions**[iii]. They are harmful to human health and the environment.
- Many diesel power stations have physically **old equipment**. As a result, they have high fuel consumption and high cost of energy production. In this regard, it is necessary to improve the existing power supply systems of remote northern territories by using modern and efficient technologies.

Wind energy – a sustainable solution

Electricity generation by remote diesel power plants in Russia is 15 billion kWh per year on average. At the same time, according to the Ministry of Energy of Russia, total wind power generation in Russia was only 0.3 billion kWh in 2019. As Figure 2 shows, territories of the Russian High North have **substantial wind resources**, which are currently not used.

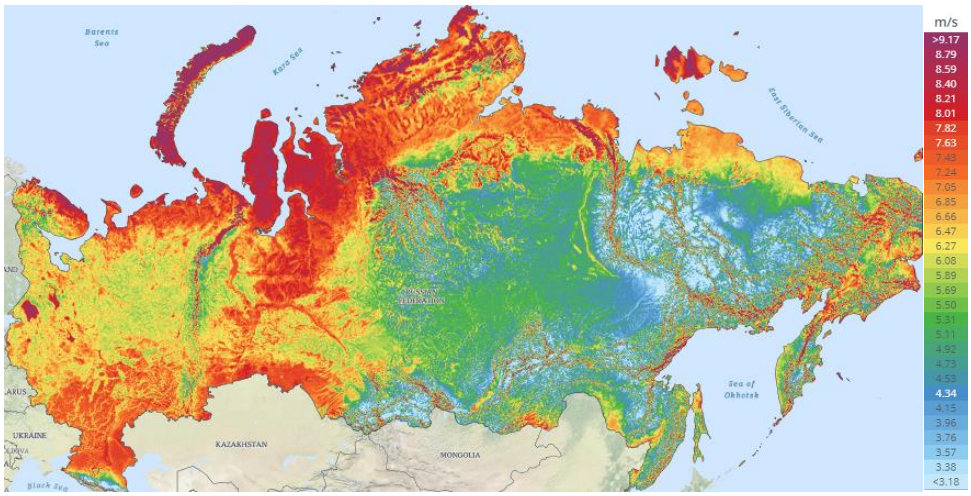

Figure 2: Map of mean wind speeds in Russia[iv]

A sustainable solution for energy supply in remote northern territories is to increase the use of wind turbines to partially replace diesel fuel. This would contribute to the creation of **a reliable and efficient power supply system for remote territories** that takes advantage of local renewable energy sources. Modern equipment, methods and software available for forecasting and calculating wind resources of the territory allow to use these resources to the maximum (Fig. 3)[v].

The carbon footprint of wind energy is concentrated in the construction phase and is negligible compared to fossil fuel exposure. The impact of wind energy on the environment does not contradict the sustainable development of society. Negative aspects most commonly associated to wind energy are noise, impact on birds and visual impact. Modern methods of wind park construction, research of bird migration routes, and numerical simulation of wind turbine operations allow **controlling and reducing these risks**[vi].

A challenge specific for wind energy in the **northern climate** conditions is **icing**. One of the negative consequences of ice formation is the disturbance of blade aerodynamics, which leads to a decrease in annual energy production of a wind park and **economic losses**. In addition, ice accretion disturbs the structural balance and causes vibration. As a result, it leads either to a reduction in the lifetime of a wind turbine or to its **mechanical destruction**.

There are, however, means to address the icing problem. The most effective methods to investigate ice formation and its prevention are experimental studies in icing wind tunnels and numerical simulations in software. **New scientific data can improve efficiency and safety** of wind power plants in the High North.

Figure 3: Modeling of designed wind park on the site in the software.

Did you know that…?

- Wind power generation potential for northern territories is in winter higher than in summer due to higher wind speeds. This highly correlates with the electrical load diagram of any northern territory when the energy consumption in winter is higher (Fig. 4)[v].

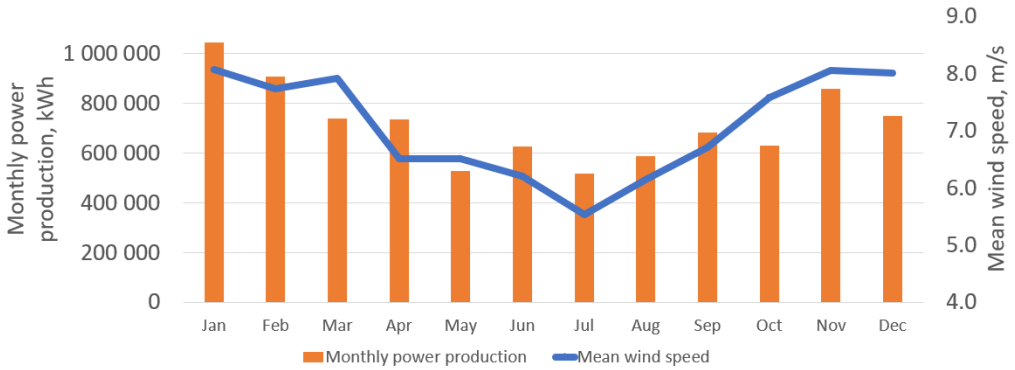

Figure 4: Distribution of wind speeds and power production. The Case of the Solovetsky Archipelago.

- It is possible to increase the energy production of a wind park only by optimizing the location of wind turbines. Wind resources may vary even within a small area depending on the terrain, and wind turbines affect each other due to the aerodynamics of the airflow. Our case study on simulation of wind park operation in the Solovetsky archipelago shows that optimization allows to increase the energy production of a wind park by 16%[v].

Who benefits from wind energy?

- **The government**: Annual energy costs will be reduced due to the reduction of diesel fuel consumption. The risk of environmental disasters will be reduced. Compliance of northern regions with the Federal policy and energy strategy will be ensured, as according to the Energy Strategy of the Russian Federation until 2035: "The priority of the state energy policy of the Russian Federation is the transition to the environmentally friendly and resource-saving energy industry".
- **Companies:** The construction, operating and maintenance of wind parks will bring local firms new business opportunities, and thereby create new jobs including those for highly-qualified specialists.
- **Local people**. Hybrid (combined) energy system will increase the stability of energy supply and reduce pollutant emissions.

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Co-funded by the European Union