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Isolated power system in Russia: A chance for renewable energies?

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ABSTRACT

The Russian power system is diversified regionally and consists of one Unified Power System (UPS) and multiple isolated power systems. In the Russian Federation the policy on the use of renewable energies has been one of the most debated topics in recent years. In 2010, the Russian Renewable Energy Program was launched which aims to generate 4.5% of the entire electricity demand from renewable energy sources by 2020. These energy resources can significantly contribute to both the reduction of electricity generation costs in the Isolated Power Systems (IPS) and to the creation of new job opportunities. In this study an innovative methodology for the planning of isolated power systems is presented. The methodology is based on the Analytic Hierarchy Process (AHP) and on the software program HOMER Energy®. It considers the economic, social and environmental criteria for the optimal planning of isolated systems. A case study related to a small Siberian isolated power system is analyzed.

1. Introduction

In recent years, the policy related to increasing the use of renewable energy sources, to reducing the anthropogenic impact on climate change as well as to enhancing the security of supply through decentralized generation systems has been one of the most debated topic worldwide [1–3], and this is especially true within the Russian Federation [4–7]. Around 220 GW of power are installed in Russia at present. Conventional power plants burning fossil fuels generate roughly 68% of all electricity. Nuclear power plants cover 11% and renewable energies (hydro, geothermal, wind and solar) the remaining 21%. 99% of the latter is generated by large hydropower plants, 0.6% by biomass plants, 0.3% by small hydropower units and 0.1% by wind and solar power systems [8,9].

In 2010, the Russian Renewable Energy Program up to 2030 was launched. According to this program, by 2020, 4.5% of the entire electricity demand should be generated using renewable energy sources (the generation from large hydro systems is not considered within this target) [4]. To reach this aim, it is estimated that about 14.7 GW of new renewable capacity should be installed within the Russian Federation [9].

Wind energy is the most dynamically developing renewable energy sector in Russia [10]. In recent years, it has even surpassed hydropower in terms of the number of newly installed power facilities. At present, approximately 10 big and 1600 small wind parks are installed in Russia. The country has excellent potential for wind power generation. An attempt to utilize only 25 percent of its total potential would yield some 175,000 MW of power. The highest wind energy potential is concentrated along the seacoasts, in the vast territories of the steppes and in the mountains. Russia has a long history of small-scale wind turbines located in agricultural areas with low population density. Since connection to the main energy grid is difficult there, small energy suppliers are in high demand. Large-scale commercial wind energy production has, however, been experiencing difficulty establishing itself in Russia so far.

Parallel to these reforms, the Russian electricity sector [11] was also reformed in 2010. One of the most important aspects of this reform is the creation of a wholesale market for electricity and for power capacity. However, due to the large distances between isolated regions, which are mostly located into the far eastern and northern parts of the Russian Federation (see Fig. 1), they are not included in the wholesale market. This means that the approx. 10–15 million people who live in these regions [12] must get their electricity from outside the UPS energy market.

These regions represent an extremely high potential market for introducing renewable energy technologies such as wind turbines, photovoltaic modules, power generators which burn biomass/

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Fig. 1. Isolated power system within the Russian Federation.

biogas and geothermal plants (see Fig. 2).

Government order 1715 [4] calls for stepped up utilization of renewable energy technologies and the development of multifunctional energy complexes in isolated power systems by 2030. This entails replacing diesel generators with more efficient technologies that supply combined electric power and heat on the basis of renewable energy. Besides it, it will be also supported the development of technologies that compensate for variations in the power output of wind and tide generating units, e.g. energy storage systems based on advanced materials.

However to date, only a few tens of kW of power based on renewables is installed in the isolated power system. Different studies have been conducted to estimate the economic and environmental benefits that the introduction of renewable energy sources may bring to the Russian isolated power systems [13–21]. However, few studies have examined how to upgrade the existing Russian isolated power systems.

The aim of this study is not to develop a new methodology for planning/upgrading isolated power systems, but rather to implement a new framework to assist the decision making/stakeholders in the planning phase (new plan or upgrade of isolated power systems). The framework is based on the Analytic Hierarchy Process (AHP) and on the software program HOMER Energy® [22]. A case study, which is not based on any real project but reflects real situations for the Siberian IPS, will be analysed as an example to show how the methodology works. The case study faces the problem related to the upgrade of an isolated power grid located in Siberia (in the district of Irkutsk) in which the costs of power generation are very high and the power generators are old and inefficient. A Multi Criteria Decision Analysis (MCDA) approach will be used,

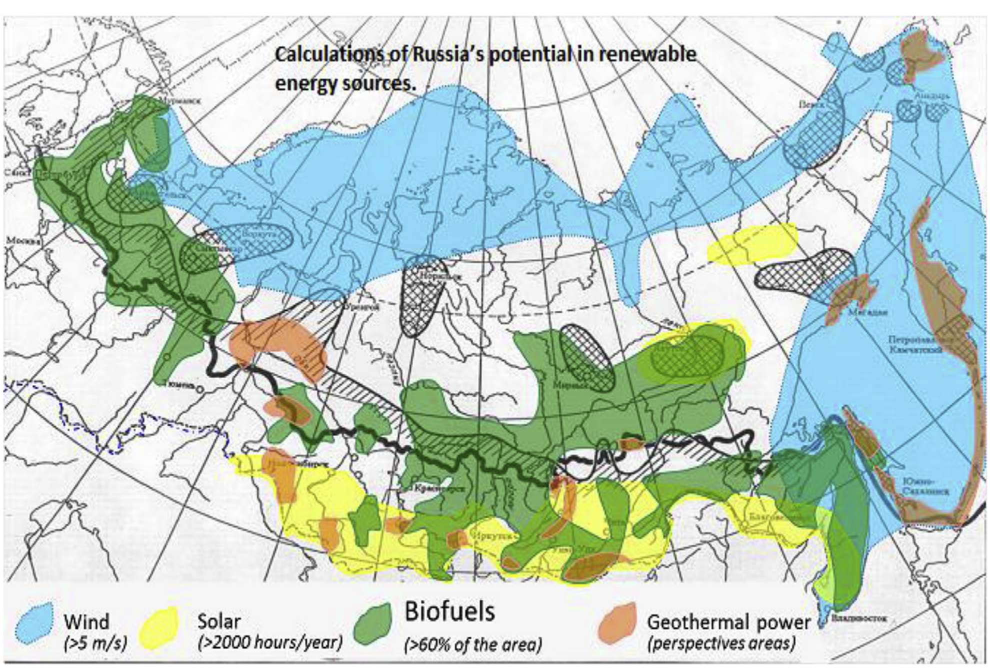

Fig. 2. Renewable energy sources potential in Russia [21].