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Off-grid renewable energy in remote Arctic areas: An analysis of the Russian Far East ☆

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ABSTRACT

Electricity supply in remote areas of the Russian territory is heavily dependent on diesel sources. Diesel generation imposes an important economic and social burden on the local population, besides the environmental impact of greenhouse gas emissions, black carbon and oil spills. Switching to renewable energy could reduce the current economic, social and environmental cost of electricity supply in Russia's remote areas. The objective of this paper is to review Russia's off-grid renewable energy policy by focusing on the promotion of wind- and solar-diesel hybrid energy in the Russian Arctic. Taking a mainly regulatory perspective, this paper identifies existing barriers to the development of hybrid renewable-diesel investments. Building further on the international experience with the promotion of renewable energy in Arctic climates (*e.g.*, in Alaska and Canada), this paper tests the feasibility of alternative 'best practice' mechanisms to support off-grid renewable energy in Russia.

Contents

1. Introduction

Energy supply in remote areas – *i.e.*, in regions isolated from the centralised network – is characterised by important economic, social and environmental challenges [1]. International experience demonstrates that off-grid RES systems provide a technically feasible and economically sound solution to the energy challenges that remote areas face [2,3]. As highlighted by the literature, harnessing the RES potential of remote areas requires the adoption and implementation of specific policy and regulatory support

Abbreviations: RES, Renewable Energy Sources

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mechanisms that differ from the mechanisms existing for the promotion of RES installations connected to the centralised network [4,5]. A specific approach to the support of off-grid RES is needed to address the specific technical, financial and regulatory challenges that off-grid RES projects face [6–8]. Moreover, taking into account the specific characteristics of national energy policy and regulation, off-grid RES support mechanisms must be adapted to national and even local conditions [9–11]. So far, most attention in the literature has been dedicated to the promotion of off-grid RES in Canada [11–16], Alaska [17], India [18–21], Nepal [22] and the African continent [*e.g.*, 5], with very little interest in the Russian Federation and the former Soviet Union. This article aims at contributing to the RES policy literature by reviewing the policy and regulation that Russia has adopted to promote the development of off-grid RES investments in remote Arctic areas, with a focus on the specific case of the Russian Far East.

The Russian Arctic presents a most interesting case study for examining the challenges and opportunities relating to the deployment of off-grid RES. Besides its centralised electricity infrastructure – the Unified Energy System of Russia (the world's fourth largest electricity system) – the Russian Federation is characterised by a large number of island energy systems and remote settlements. These isolated systems and remote settlements, to an important extent, rely on diesel sources for energy production. In the Far East, 70% of electricity generation comes from so-called 'dirty fuels', according to the Russian Government, including 12–15% diesel-based generation [23]. Besides the relative inefficiency of the production process, electricity generation from diesel is very expensive because the fuel needs to be shipped over long distances. In the Arctic, weather conditions complicate access to remote areas – a problem that becomes increasingly difficult to manage in the context of climate change and its impact on weather predictability. This not only increases costs [24] but also creates environmental problems given the risks associated with the transportation and storage of diesel, particularly fuel spills and leaks in pristine rural areas [1,11]. In Russia, the economic, social and environmental impact associated with the transportation of diesel to remote areas in the north of the country ('*severnyi zavoz*') is particularly acute given the size of the country and its severe climatic conditions.

Moreover, diesel-based electricity production is a carbon-intensive mode of electricity generation and, thus, contributes to climate change. In remote Arctic areas, the black-carbon impact of diesel accelerates the effects of global warming by increasing the rate of melting and causing additional warming [25–27]. At the same time, guaranteeing a reliable electricity supply is of great social importance given the severe climatic conditions that characterise remote Arctic areas [1]. The difficulty of ensuring a reliable electricity supply at affordable prices can also be a barrier to economic growth in these regions. The social and economic development of remote areas is affected by the high cost of electricity production.

Switching from diesel generation to wind- or solar-diesel hybrid energy can contribute to securing an energy supply in an environmentally-friendly way and at more affordable prices in these regions [1–5]. Off-grid hybrid energy systems reduce the use of diesel and, thus, its high cost and environmental impact. At the same time, off-grid RES can avoid the high cost of grid extension [22,28–30]. Off-grid RES also mitigates the energy security risks associated with dependence on long transmission lines (*e.g.*, disruption of transmission) [11].

Alaska and Canada have had some success in the deployment of off-grid RES systems in the northern latitudes [11–17]. Based on this experience, the International Energy Agency (IEA) [1] has identified RES policy and regulatory approaches that are adapted to the specific characteristics of remote areas in extreme weather conditions. The International Renewable Energy Agency [31] and the World Bank [32] have also proposed 'best practice' regulatory tools to promote off-grid energy production, including measures to promote a fuel switch from diesel to RES.

The Russian Government has announced policy mechanisms to stimulate energy producers in the Far East to gradually switch from diesel to hybrid diesel-solar/wind generation and so achieve the economic, social and environmental benefits of off-grid RES in the region [23]. On 23 January 2015, the Russian Government adopted Decree no. 47 on the Promotion of RES on Russia's Retail Markets [33]. One of the objectives of this Decree is to extend Russia's support mechanism to the use of RES in remote areas. Investments are slowly starting to be implemented on this basis [34–36] but progress remains limited. Important regulatory, policy and financial barriers stand in the way of the development of Russia's huge RES potential in remote areas [37–40].

Adopting a mainly regulatory – and thus qualitative – perspective (legal method), this article critically reviews the existing regulatory framework governing the support for off-grid RES investments in the Russian Far East. Having identified the regulatory barriers that currently prevent the deployment of off-grid RES in the Russian Far East, this article discusses alternative support mechanisms (including 'avoided cost' tariffs, subsidies and funds) in the light of international 'best practices' with the promotion of off-grid RES in cold and isolated regions (*see* [1,31,32]).

2. Methods: regulatory analysis of existing support for off-grid RES in Russia

Important technical, financial and economic challenges complicate the realisation of wind- and solar-diesel hybrid energy investments in remote Arctic areas (see *e.g.*, [1]) – in particular in Russia where limited and often outdated infrastructure, uncertain economic outlook and a difficult business climate exacerbate the risks characterising off-grid RES projects. The objective of this article is not to contribute to the RES literature in a quantitative way by directly engaging with the technical, financial and economic aspects of off-grid RES. Instead, this article builds on legal – and, thus, mainly qualitative – research methodologies to examine how the law could contribute to addressing the obstacles facing the implementation of off-grid RES investments. A regulatory analysis of off-grid RES is of great importance because, in the absence of the internalisation of the externalities of energy supply, the development of RES depends on the creation of a functioning legal framework 'levelling the playing field' between alternative and traditional energy sources. Legal research methodologies, thus, have a crucial role to play in identifying – and designing solutions to – existing barriers to the deployment of RES [41,42]. Given the importance of the national legal system in which RES investments operate, it is necessary to focus on national, legal rules that govern the promotion of RES. The focus of this paper is on the Russian RES regulation.

However, the law of RES – and of off-grid RES in particular – cannot be examined in isolation from the technical, financial and economic characteristics of these technologies. Studying the regulation of off-grid RES is impossible without taking into account the existing analyses of this topic by energy policy experts, economists and engineers. Most studies regarding the development of off-grid RES have been produced in the field of energy policy, economics and engineering. The legal analysis at the centre of the present study builds on these existing works in order to propose regulatory mechanisms that are adapted to the economic, social and technical characteristics of off-grid RES investments.