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The Role and Future Outlook for Renewable Energy in the Arctic Zone of Russian Federation

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Abstract:

The development of the Arctic zone of the Russian Federation (the Russian Arctic) aims to enhance the social and economic growth of the region in line with the priorities set forth by the state policy and address a range of socio-economic issues.

As the Russian Arctic offers an array of hydrocarbons and renewables available in the context of the region's unbalanced infrastructural and manufacturing development and extreme climatic environment, the conditions dictate the need for an integrated use of the Arctic's energy resources.

Energy security of a region is a primary contributor to its social and economic sustainability. Key energy users in the Russian Arctic include both large and local load consumers that have to operate against the background of economic and logistic difficulties related to power supply. The Russian Arctic can offer a wide range of energy resources, but individual areas are facing power shortage.

These challenges are particularly relevant for the Arctic regions in Siberia and the Far East, and to a lesser extent for the Murmansk and Arkhangelsk regions as the areas are covered by the capabilities of the Unified Energy System of Russia. Energy challenges and discrepant development plans for the power and manufacturing sectors create major barriers that slow down the social and economic development of the areas.

Our analysis demonstrated that the role of unconventional and renewable energy in power generation and energy mix of the Russian Arctic will remain insignificant in the short term.

Keywords: *Arctic zone, development, power, renewable energy sources, RES, wind power, solar energy, Northern Deliveries program, energy consumers, power supply.*

JEL Classification Codes: *I31, O13, Q42.*

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1. Introduction

The radical change in the state system, which took place in the 1990s, led to the gradual loss by the country's Arctic zone of its production potential built in the Soviet era – air traffic shrank, icebreaker fleet depreciated and aged, and depopulation aggravated. Today, the Arctic is Russia's most important geopolitical and geoeconomic macroregion. The increased focus on the Arctic zone is not random. The first factor is the growing shortage of multiple resources, especially fuel and energy. In the long term, the oil and gas industry (O&G) will retain its importance for the Russian economy. Today, O&G's sectors are continuing to be a backbone of the Russian economy, strengthening the country's export positions and being major contributors to the budget (36% in 2018).

According to Russia's Energy Strategy to 2035 (Russia's Energy Strategy to 2035, 2009), historic oil and gas provinces are expected to show reduced oil production. In this context, looking for new regions to substitute diminishing production volumes at existing fields is more relevant than ever. The Arctic is a huge source of resources in this regard. According to the US Geological Survey, the Arctic has considerable hydrocarbon reserves: 48.3 trillion m3 of natural gas and 90 billion barrels of oil (30% and 13% of global reserves, respectively). And the greatest part of these reserves (88%) belong to Russia, the US and Denmark (Kolpakov, 2016; Kapyshev and Kapysheva, 2017; *Albekov et al.,* 2017; Winarno and Tjahjadi, 2017). The second factor is a crucial military and strategic value of the Arctic. The accelerated industrial and transport development as well as other improvements in the Arctic zone will bring about the need to build up the defense capabilities of the area due to continuous interstate conflicts and economic claims made by other Arctic states. The existing geopolitical situation cannot offer a reliable guarantee that our possessions will be well protected by international conventions and UN regulations in the future.

The third factor is the potential of the Northern Sea Route. The Northern Sea Route ensures meridional transport communication in the Asian part of Russia, connects the European and Far Eastern parts of the Russian Federation and is the shortest transit route from Europe to Asia. By analogy with the Suez Canal, it is expected to earn as much as $ 5.2 billion of annual profits (The Russian Arctic – the strategic potential and the future of the country, 2017). Understanding of the role and importance of the Arctic region by the leadership of the Arctic countries caused a development turnaround towards high latitudes. The resource potential of the Arctic zone of the Russian Federation (the Russian Arctic) makes it possible to build a sustainable future for both the macroregion and the country. The development of the Russian Arctic will help enhance the country's national security and strengthen its international role.

2. Brief Literature Review

The development of the Russian Arctic is an overarching megaproject with a core based on a systematic approach to implementing social and economic development programs in the region. The pillars of the new state policy are detailed in a comprehensive set of basic strategic documents on the Arctic zone: "Foundations of the Russian Federation's state policy in the Arctic until 2020 and beyond" (2008) (Foundations of the Russian Federation's state policy in the Arctic until 2020 and beyond, 2008), "The development strategy of the Arctic zone of the Russian Federation and national security up to 2020" (2013) (The development strategy of the Arctic zone of the Russian Federation and national security up to 2020 (approved by the President of the Russian Federation February 8, 2013, No. Pr-232), 2013), the Russian state program "Social and economic development of the Arctic zone of the Russian Federation until 2020" (2014) (Social and economic development of the Arctic zone of the Russian Federation until 2020, 2014) and Edict of the President of the Russian Federation No. 296 "On the land territories of the Arctic zone of the Russian Federation" (2014) (Edict of the President of the Russian Federation No. 296., May 2, 2014). The development program of the Russian Arctic specifies to enhance the social and economic growth of the region in line with the priorities set forth by the state policy and based on the range of socio-economic issues. Power supply is key to any infrastructure and greatly affects the quality of life and the possibility of developing a region. Hardships and challenges related to introduction of renewable energy sources (RES) and their effect on the environment, social prosperity, economic growth and power generation efficiency are reviewed in works carried out by many Russian and foreign researchers (Smolentsev, 2012; Zabello, 2016; Zhigalov and Pakhomova, 2015; Leksin and Porfiryev, 2017; Verdolini *et al.*, 2018; Gillingham *et al.*, 2016; Fischer and Preonas, 2010; Amundsen and Bye, 2018; Leal-Arcas *et al.*, 2016; Sweeney, 2017; Jaraite *et al.*, 2018). On the other hand, the prospects for RES applications in the power sector of the Russian Arctic have only received cursory estimates, and the issues of evaluating the RES potential in the Russian Arctic require further research.

3. Research Methods

The theoretical and methodological basis of the research was provided by monographs and scholarly articles by foreign and Russian researchers, applied studies dedicated to the issues of alternative power and social and economic sustainability of the territories. Implementing the study involves the use of methods of economic analysis and management methods for sectors and industrial complexes. The regulatory and legal basis for the study is formed by the legislative and regulatory acts, as well as resolutions by the State Duma and Russian Government, which define the state regulation policies for the social and economic development of the Russian Arctic.

4. The Purpose

The social and economic progression of the Russian Arctic has been balanced over the past decades, as no integrated approaches were put into practice. Currently, suffering from inadequate social and economic development, some of the arctic areas have to drag far behind other regions with more beneficial conditions. This can be primarily seen in progressing depopulation that is not as intensive as it was the case in the 1990s, but still may become an obstacle impeding the implementation of key lines in the Russian Arctic development policy. Energy security of a region is a primary contributor to its sustainable social and economic development. As the Russian Arctic offers a range of hydrocarbons and renewables available in the context of the region's unbalanced infrastructural and manufacturing development and extreme climatic environment, the conditions dictate the need for an integrated use of the Arctic's energy resources. Addressing this challenge requires: identifying limitations and opportunities for RES applications in the Russian Arctic; providing profiles of the regions in terms of energy consumption and prospective RES consumers; analyzing the potential of using renewables in the location with decentralized power supply and reviewing prerequisites and a roadmap for wind and solar energy in the Arctic region.

4. Analysis and Results

Currently, depopulation remains one of the critical problems in the Russian Arctic. This can be confirmed both the size dynamics of both the economically active population and the resident population. In the Chukotka Autonomous Okrug, the population declined by 69%, in the Murmansk region – 35%, in other Arctic regions, the loss of population varies from 10 to 29%, as compared to figures for 1990. And it is the Yamalo-Nenets Autonomous Okrug that shows positive trends in the population growth: it increased by 11% between 2000 and 2013. The size of the resident population is now continuing to go down in the Russian Arctic, although the rate is not that fast – by 1% from 2013 to 2016. In 2013, Arctic regions had 5% (in absolute terms – 4 million people) in the total percentage of the country's economically active population. Considering the fact that Russia’s economically active population grew by 4% in 2013 as compared to 2000, the Arctic zone experienced 1% decrease (Development of the concept for the Man in the Arctic project. Analytical report, 2014). The intensity levels of migration exchange is determined by the following factors: intraregional migrations (nomadic migrations of indigenous minorities, a decreasing percentage of the rural population, moving to locations offering better life standards, etc.); youth migrations to more prosperous regions, people of retirement age look for opportunities to move to regions with a milder climate and more affordable medical services, rotation work schemes. The persisting trends in migration processes show that the population to the Russian Arctic can only be engaged in the region’s economic improvement if the appropriate living conditions are created.

The Russian Arctic is characterized by extremely unbalanced population distribution, substantially differentiated industrial and natural resource potential of the territories and infrastructure quality. Various sectors play a key role in shaping the system of socio-economic interests and production relations between business enterprises in the Russian Arctic regions. This results in significant gaps between regions by the quality of life levels. More than 80% of the total population living in the Russian Arctic is based in towns and major cities, such as Arkhangelsk, Murmansk, Vorkuta and Norilsk. The Arctic zone accounts for about 25% of the area of the Russian Federation, while the Arctic population does not exceed 2% of the country's total population (Smolentsev, 2012). The gap in the industrial development of the areas, the exceptionally low population density and the varying infrastructure levels make it imperative to define growth points for the Arctic infrastructure (Leksin, 2017).

In addition to the mineral exploitation, the integrated program of the Russian Arctic enhancement also includes addressing the issues related the tapping into biological resources of land and water as well as preserving its unique ecosystem (Cherepovitsin and Sultani, 2011). The Arctic zone consists of sea, island and coastal areas. Their use entails the implementation of large-scale projects to create transport and communication networks in the region (air communication, the Northern Sea Route and meridional river corridors).

The bottleneck that limits further improvement of local settlements as well as construction of new manufacturing and infrastructure facilities is power, a vital component in the industrial infrastructure. Although the Arctic zone of the Russian Federation is a wealth of energy resources, some areas are facing power shortage. Key energy consumers in the Russian Arctic include:

- Facilities in mineral resources upstream operations: rotation camps, pumps, drilling rigs, etc.;
- Facilities operated by the fishing sector and the Northern Sea Route: shipbuilding and ship-repairing plants, port infrastructures, weather services, navigation and hydrographic logistics, etc.;
- Military facilities, such as military bases (Severny Klever (Northern Clover) and Arkticheskiy trilistnik (Arctic Trefoil)), observation bases of the Northern Fleet, and border outposts.

The above facilities include both large and local energy consumers that have to operate against the background of economic and logistic difficulties in power supply (Plotkin, 2017).

The power supply principles significantly vary depending on the specific shape that economic progression, working conditions and infrastructure facilities take across the regions of the Russian Arctic. Traditional schemes of power delivery have very limited use in the Russian Arctic. The Arctic energy system has specific features such as costly fuel import, a great number of standalone load centers and decentralized users of energy resources. Difficulties related to supplying power to isolated consumers are a major barrier constraining the economic growth of the Arctic zone. The transportation leg doubles or trebles the price of fuel for remote regions of the Arctic zone. The transportation component accounts for 70% in the fuel cost structure (10% across the country on average) (Smolentsev, 2012). This range of issues poses a very serious challenge for the Arctic regions of the Far East and Siberia, since they are supplied with power by isolated energy systems. The unified energy system of Russia partially incorporates the Arkhangelsk and Murmansk regions, and this allows the use of the traditional power supply schemes in the coverage area. The unaddressed power issues pertaining to the Russian Arctic (the inefficient energy system, significant power losses in the transmission chain to the end user, deteriorated power infrastructures, high cost of procurement under the Northern Deliveries program, etc.) and the existing discrepancy in power and industry enhancement plans significantly decelerate the socio-economic development of the territory (Gillingham, 2016).

Today, the Russian Arctic predominantly utilizes fuels for power generation, which cause a major harmful impact on the Arctic environment, exacerbating the man-induced load on the area. In power generation – fuels and lubricants are used by diesel-electric power plants. In thermal energy generation – coal, fuel oil and wood are used (Zhigalov and Pakhomova, 2015). From 6 to 8 million tonnes of fuel and up to 20-25 million tonnes of coal are delivered annually under the state Northern Deliveries program to sustain the Arctic (The Russian Arctic – the strategic potential and the future of the country, 2017). Where there is no possibility to ensure centralized power supply, local energy, including renewables, become a good alternative to conventional sources (Vertakova, 2017).

A program to optimize the Northern Deliveries system is included in “The development strategy of the Arctic zone of the Russian Federation and national security up to 2020” (2013) (The development strategy of the Arctic zone of the Russian Federation and national security up to 2020 (approved by the President of the Russian Federation February 8, 2013, No. Pr-232), 2013). The program will reduce budget expenditure through increased power generation based on renewable alternative local energy sources. In this context, a powerful tool to handle local energy problems can be offered by small-scale power generation. Small generators also have their strengths and weaknesses. Small fossil-fueled power facilities require relatively small investment, but substantial operating costs (fuel component) – this type of generation is fairly common, but relies heavily on fuel supplies and has a major environmental impact. Small nuclear power plants have a long life cycle, do not have to rely heavily on fuel, have almost no environmental footprint and can operate autonomously for a long time. However, they initially require massive capital investment, and their payback period extended over about 20 years. Benefits enabled by renewable energy sources (RES) include: Small initial investment, a minor impact on the environment, and no fuel component. But RES imply considerable operating costs (maintenance), and the utilization of installed capacity strongly depends on climatic conditions (Smolentsev, 2012).

According to Global and Russian Energy Outlook to 2040 (Global and Russian Energy Outlook to 2040, 2014), harnessing unconventional and renewable energy sources (URES) in Russia will double by 2040 mainly thanks to biomass and waste. The use of all types of alternatives and renewables will achieve the 1.9-2.6 times increase, and their share in energy consumption will grow from 1.1% in 2010 to 4.2% in 2040, but still they will play a local role in the Russian energy sector. Implementing infrastructure projects and developing hard-to-recover resources in the harsh Arctic climate can only progress with efficient organizational, economic and technological solutions for power supply (Verdolini, 2018). In this regard, counting on URES in the Arctic zone is not only a viable alternative to conventional energy sources but a necessity.

The principles of the government policy regulating and supporting the wider use of RES are reflected in the following documents:

- 2003: Federal Law No. 35-FZ “On Electric Power”;
- 2008: Decree by the Russian Federation Government No. 426 “On Qualifying a RES-E Generating Facility”;
- 2009: Order by the Russian Federation Government No. 1-r “On the Main Areas of the Government Policy to Raise the Energy Efficiency of Electric Power from Renewable Energy Sources for the Period to 2020”;
- 2012: Order by the Russian Federation Government No. 1839-r “On the Approval of a Package of Measures to Stimulate Production of Power by Generating Facilities Operating on Renewable Energy Sources”;
- 2017: a government program “Energy Efficiency and Energy Development” (2012–2020) (approved by the Russian Federation Government’s Decree No. 321);
- 2017: A General Layout of Electric Power Facilities until 2035 (approved by Order of the Russian Federation Government No. 1209-r).

The packaged measures are designed to encourage and support the use of RES through subsidies, a tariff and tax regulation process, surcharges to wholesale market prices for RES-E generation, inflow of extra-budgetary funds, new infrastructure construction, etc. However, the lack of a coherent system approach to program implementation poses a barrier to alternative power. The share of renewable power in Russia's energy mix is below 1%, while the figure for EU countries exceeded 15%.

Compared to the Mexican savannas or the desert of the Arabian Peninsula, the Russian lands do not have an industrial scale potential for wind and solar power, and the availability of relatively cheaper conventional power resources is one of the factors. However, the outlook for RES in the Arctic is very good and equals to virtually 15 times power consumption by the entire country (Zabello, 2016). The Arctic zone has a broad spectrum of RES with wind and solar being most essential. Equipment manufacturing for RES facilities cannot benefit from the size effect, and this means their worse competitiveness, as compared to conventional power capacities. Nevertheless, deploying RES facilities in the Russian Arctic can be feasible as centralized power supply cannot be achieved for remote polar regions (Plotkin, 2017). In addition, even with surplus installed power capacities (for example, in the Murmansk region), the exploitation of RES in the Russian Arctic is a forward-looking and ambitious direction for future power.

Table 1 contains the characteristics of the Russian Arctic areas and the prospects for the alternative power scenario.

Table 1. *Conventional and alternative power in the Russian Arctic* [4]

Russian Arctic region	Power supply	Energy generation based on local resources and RES	Potential of unconventional energy, local resources
Murmansk region	Centralized power supply is well established. The most crucial role is played by hydro and nuclear power: Cascade of the Niva HPPs, Cascade of the Paz HPPs, Cascade of the Tuloma HPPs, Cascade of the Serebryansky HPPs, Apatity CHPP, subsidiaries of Murmansk CHPP. Part of the surplus power is transferred to the power system of the Republic of Karelia	Kislaya Guba Tidal Power Station (TES); Hybrid solar-wind-diesel power plant (Pyalitsa)	High wind potential. Calculation of technical wind power resources for the Kola Peninsula: total installed capacity of the wind power can amount to about 120 million kW, and the annual power generation – about 360 billion kW-h.
Arhangelsk region	TGC-2 power plants: Arkhangelsk CHPP, Severodvinsk CHPP-1, Severodvinsk CHPP-2, power facilities of Solombala Pulp and Paper Plant, Arkhangelsk Pulp and Paper Plant	Wind-diesel power plants	Prospects for improved thermal power using local resources, in particular those of forest operations
Nenets Autonomous Okrug	The power sector consists of local facilities. Cities are provided by Naryan-Mar Power Plant GUP NAO, rural locations – by autonomous diesel power generators		Use of associated petroleum gas (APG); Wind power offers a promising outlook – hybrid (wind diesel) power plants; Potential for creating small hydro power plants (seasonal operation)

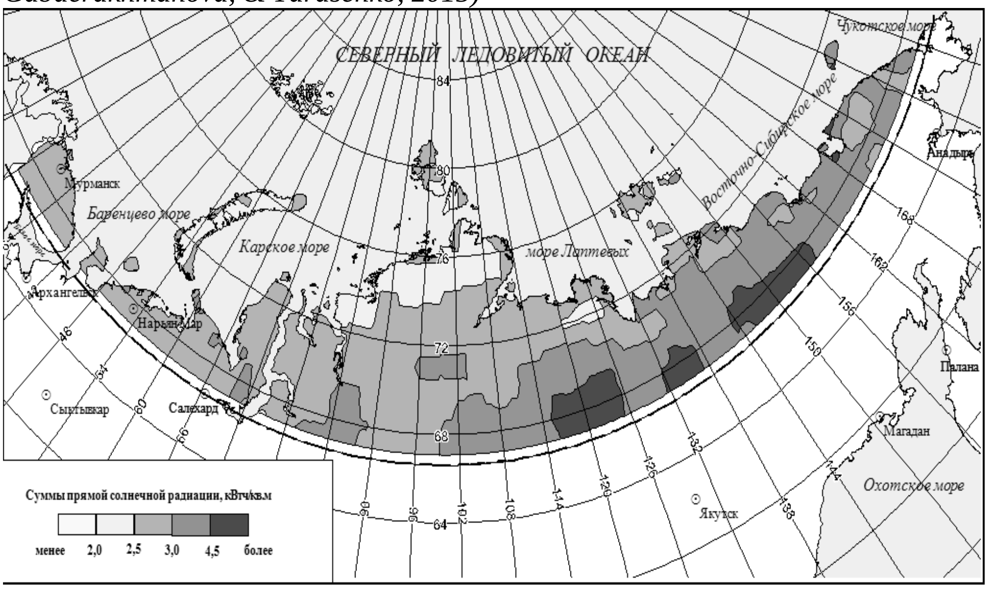
[4]*Compiled by the authors on the basis of: Selin, V.S., Skufina, T.P., Bashmakova, E.P., & Toropushina, E.E. (Eds.). 2016. The North and the Arctic in the new paradigm of global development: challenges, trends, prospects. Analytical research report. Apatity: KSC RAS. Retrieved from http://www.iep.kolasc.net.ru/news/iepdoklad2016.pdf (in Russ.)*

Komi Republic	Centralized power supply is well established. Vorkutinskaya CHPP-1, Vorkutinskaya CHPP-2, Central Water Boiler Plant of Vorkutinsky CHPPs	Zapolyarny Wind Farm	High wind potential.
Yamalo-Nenets Autonomous Okrug	Centralized power supply zones – Middle Ob power plants by HV overhead lines: Urengoi GRES Power Plant, Noyabrskaya CCPP Decentralized power supply zones: stationary diesel generators	The construction of a wind farm in progress on Yamal (Labytnangi)	Use of associated (natural) gas Wind power offers a good outlook if developed based on medium wind-diesel power plants
Krasnoyarsk region	Power plants in the Norilsk power system: CHPP-1, CHPP-2, CHPP-3, Kureyskaya HPP, Ust-Khantaiskaya HPP Decentralized power supply zones: stationary diesel generators		Associated petroleum gas, construction of wind power plants, small hydro power plants
Republic of Sakha (Yakutia)	Decentralized power: Sakhaenergo OAO	mini-CHPP (Deputatsky)	Small CHPP (fueled by coal delivered from the nearest deposits); Construction of small floating nuclear heat and power plant; Potential for constructing wind power plants; Potential for creating small hydro power plants (seasonal operation) Solar power plants
Chukotsky Autonomous Okrug	Greater power generation: Bilibino NPP, Anadyr CHPP, Egvekinot GRES Power Plant, Chaunskaya CHPP, Anadyr Gas CHPP Small power generation: state-owned and municipal facilities (43 diesel power plants, 48 boiler plants and one wind power plant)	Wind power plant; Wind-diesel power plant	High wind potential; Geothermal resources

With consumers located at high latitudes, solar energy in the Russian Arctic can be utilized only by seasons, in periods of sunshine. Some experts believe that the industrial use of solar energy is not an expedient power project for the Arctic because of its meager resources. Figure 1 shows a map of the daily average amounts (kWh/m2 per day) of direct solar radiation received in the Russian Arctic during a year. The map is based on the data obtained from satellite observations (NASA SSE project) (Popel *et al.*, 2015). The NASA data indicates a significant amount of solar energy, which is suitable for practical applications. The Russian Arctic's figure lies within the range from 2 to 5 kWh/m2 per day or from 0.7 to 1.8 MWh/m2 per year, which corresponds to 60–150 kg of fuel equivalent /m2 per year. In summer, cloudless days in the Arctic ensure as big incoming amounts of direct solar radiation as 6–8 kWh/m2 per day, which is comparable to solar radiation received in the country's southern regions. For example, Germany, which generates around 32% of all consumed power from renewable sources (2016), and enjoys solar energy percentage of more than 12%, has the average daily receipt of solar energy only around 3.4 kWh/m2 per day in its southern regions (Popel *et al.*, 2015).

An essential objective is the verification of NASA data. There are different error estimates and calculations. But it is obvious that solar energy is a promising area. The Russian Arctic can open possibilities for the seasonal use of solar energy to energize consumers located outside the coverage zone of local or centralized power grids (geologists, reindeer breeders, etc.). In these cases, the most efficient solution can be the use of solar installations of various types, including hybrid plants.

Figure 1. *Average daily amounts of direct solar radiation in the Russian Arctic, received during a year (kWh/m2 per day) (Popel, Kiseleva, Mogrunova, Gabderakhmanova, & Tarasenko, 2015)*



Developing wind power will create value for the coastal northern regions of the Russian Arctic. The average wind speeds reach 6–7 m/sec in these territories, and this makes sense of wind power plants. For example, a 2.5 MW wind power plant has been operating in the Chukotka AO since 2003 (Observation Cape). The Chukotka Support Zone stretches over the most remote areas of the Arctic zone with more than 50% of the territory located beyond the Arctic Circle with extreme natural and climatic conditions. These special qualities explain power supply difficulties, considering also the absence of road access from neighboring Russian regions and the complete absence of railway connection, a number of settlements inaccessible for year-round transportation and a short navigation period. Therefore, creating an efficient power infrastructure is key for the socio-economic development of the region.

The Kola Support Zone has a broad range of RES. These include not only wind power, but also tide and oceanic biomass energy. Through fuel economy, the large-scale introduction of wind power in the Kola power system will help reduce electricity rates by 25-35% over the plant's life cycle (over 20 years) in the wind conditions of the White Sea coast and by 50-60% on the Barents Sea coast (Selin *et al.,* 2016).

The Russian Arctic power enhancement should not rely solely on RES, but take into account the possibility of using local resources. For example, the Arkhangelsk Support Zone is an untapped source of thermal power with a potential of using biofuel. The taiga development took place without adequate reforestation efforts, which resulted into felling sites colonized by birch, aspen and alder. These tree species are not very valuable but can suit pellet production applications as a fuel or raw material. The use of biofuel will partially meet the needs of the region for raw materials required for thermal power generation and help support jobs.

5. Conclusions

Enhancing and leveraging the economy of the Russian Arctic has not only economic value but also geopolitical significance for Russia. For this reason, improving the region’s economic and social conditions becomes a strategic goal for the Russian Federation. The continuing depopulation makes the challenge of building in the Russian Arctic the workforce and population in the sizes, needed by the region to ensure its sustainable future, as urgent as never before. Today, the social and economic aspects of the Russian Arctic are strongly influenced by the power infrastructure and power sector growth as providing dependable power supply is a top priority for the Arctic. The analysis demonstrated that the role of unconventional and renewable energy sources in power generation and energy mix of the Russian Arctic will remain insignificant in the short term. The reason is that remote areas cannot completely stop using conventional capabilities, and diesel generator units will continue to be main power sources for remote consumers. However, decentralized power supply with a focus on efficiency and sustainability based on unconventional and renewable energy sources offers a promising growth potential for the Russian Arctic. The availability of hydrocarbons and renewables in the area provides a platform for an optional scenario of the region's power engineering.

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References:

Albekov, U.A., Parkhomenko, V.T., Polubotko, A.A. 2017. Green Logistics in Russia: The Phenomenon of Progress, Economic and Environmental Security. European Research Studies Journal, 20(1), 13-21.

Amundsen, E.S., Bye, T. 2018. Simultaneous Use of Black, Green, and White Certificate Systems. The Energy Journal, 39(4), 103–120. doi: https://doi.org/10.5547/01956574.39.4.eamu.

Cherepovitsin, A.E., Sultani, A.N. 2011. Principles and prerequisites of forming oil and gas cluster in development of Shtokman Gas-Condensate Field. Journal of Mining Institute (Zapiski Gornogo instituta), 191, 218-222, Retrieved from http://pmi.spmi.ru/index.php/pmi/article/view/1361/1408 (in Russ.)

Development of the concept for the Man in the Arctic project. Analytical report. 2014. Center for Strategic Studies of the Republic of Sakha (Yakutia). Retrieved from https://narfu.ru/aan/Encyclopedia_Arctic/Chelovek-v-Arktike.pdf (in Russ.)

Edict of the President of the Russian Federation No. 296. May 2, 2014. On the land territories of the Arctic zone of the Russian Federation. Retrieved from http://www.kremlin.ru/acts/bank/38377 (in Russ.)

Fischer, C., Preonas, L. 2010. Combining Policies for Renewable Energy: Is the Whole Less Than the Sum of Its Parts? International Review of Environmental and Resource Economics, 4(1), 51-92, doi: http://dx.doi.org/10.1561/101.00000030

Foundations of the Russian Federation's state policy in the Arctic until 2020 and beyond. 2008. Retrieved from http://government.ru/info/18359/ (in Russ.)

Gillingham, K., Rapson, D., Wagner, G. 2016. The rebound effect and energy efficiency policy. Review of Environmental Economics and Policy, 10(1), 68-88, doi: https://doi.org/10.1093/reep/rev017

Global and Russian Energy Outlook to 2040. 2014. ERI RAS – Analytical Centre for the Government of the Russian Federation. Retrieved from https://www.eriras.ru/files/forecast_2040.pdf (in Russ.)

Jaraite, J., Karimu, A., Kazukauskas, A. 2018. Policy-Induced Expansion of Solar and Wind Power Capacity: Economic Growth and Employment in EU Countries. The Energy Journal, 38(5), 197–222, doi: https://doi.org/10.5547/01956574.38.5.jjar

Kapyshev, A., Kapysheva, S. 2017. Economic and Energy Factors on the Formation of USA Foreign Policy. International Journal of Economics & Business Administration, 5(4), 56-77.

Kolpakov, A.A. 2016. The oil polar horizon Retrieved from Http://expert.ru/northwest/2016/40/neftyanoj-polyarnyij-gorizont/ (in Russ.)

Leal-Arcas, R., Grasso, C., Ríos, J.A. 2016. Energy Security, Trade, and the EU: Regional and International Perspective. Northampton, MA: Edward Elgar Publishing, 488.

Leksin, V.N., Porfiryev, B.N. 2017. Socio-economic priorities of sustainable development of Russian Arctic macro-region. Ekonomika regiona (Economy of Region), 13(4), 985-1004, doi: 10.17059/2017-4-2 (in Russ.)

Plotkin, B.K., Khaikin, M.M. 2017. Formation and development of theoretical principles for mineral resources logistics. Journal of Mining Institute (Zapiski Gornogo instituta), 223, 139-146, doi: http://dx.doi.org/10.18454/pmi.2017.1.139 (in Russ.)

Popel, O.S., Kiseleva, S.V., Mogrunova, M.O., Gabderakhmanova, T.S., Tarasenko, A.B. 2015. The use of renewable energy sources for power supply to consumers in the Arctic zone of the Russian Federation (Ispolzovaniye vozobnovlyayemykh istochnikov energii dlya energosnabzheniya potrebiteley v Arkticheskoy zone Rossiyskoy Federatsii), Arctic: Ecology and Economy (Arktika: ekologiya i ekonomika) 1(17), 64–69 (In Russ.)

Russia's Energy Strategy to 2035. 2009. Retrieved from https://minenergo.gov.ru/node/1026 (in Russ.)

Selin, V.S., Skufina, T.P., Bashmakova, E.P., Toropushina, E.E. (Eds.) 2016. The North and the Arctic in the new paradigm of global development: challenges, trends, prospects. Analytical research report. Apatity: KSC RAS. Retrieved from http://www.iep.kolasc.net.ru/news/iepdoklad2016.pdf (in Russ.)

Smolentsev, D.O. 2012. Development of the Arctic energy sector: problems and opportunities of small generation. The Arctic: ecology and economy (Arktika: ekologiya i ekonomika), 3(7), 22-23, Retrieved from http://www.ibrae.ac.ru/docs/3(7)/22-29.pdf (in Russ.)

Social and economic development of the Arctic zone of the Russian Federation until 2020. 2014. Retrieved from http://government.ru/docs/11967/ (in Russ.)

Sweeney, J.L. 2016. Energy Efficiency: Building a Clean, Secure Economy. Hoover Institution Press, Stanford University, 196.

The development strategy of the Arctic zone of the Russian Federation and national security up to 2020 (approved by the President of the Russian Federation February 8, 2013, No. Pr-232). 2013. Retrieved from http://government.ru/info/18360/ (in Russ.)

The Russian Arctic – the strategic potential and the future of the country.2017. Retrieved from http://abiu.ru/articles/406-rossiiskaja-arktika-strategicheskii-potencial-i-buduschee-strany.html (in Russ.)

Verdolini, E., Anadón, L., Baker, E., Bosetti, V., Reis, L. 2018. Future prospects for energy technologies: Insights from expert elicitations. Review of Environmental Economics and Policy, 12(10), 133-153, doi: https://doi.org/10.1093/reep/rex028

Vertakova, Yu., Plotnikov, V. 2017. Problems of sustainable development worldwide and public policies for green economy. Ekonomichny Chasopis-XXI (conomic Annals-XXI), 166(7-8), 4-10, doi: https://doi.org/10.21003/ea.V166-01 (in Russ.)

Winarno, A.W., Tjahjadi, B. 2017. The Moderating Effect of Industry Environments on the Relationship between IT Asset Portfolios, Efficiency and Innovation in the ERP Context. European Research Studies Journal, 20(2A), 3-15.

Zabello, E. 2016. Alternative energy of the Arctic. Center for information and legal support of development of the Arctic. Retrieved from http://arctic-centre.com/ru/analitika/item/197-alternativnaya-energiya-arktiki (in Russ.)

Zhigalov, V.M., Pakhomova, N.V. 2015. Contemporary system of strategic planning in energy saving and increase of energy efficacy in Russia in the context of the new climate politics. Problems of Modern Economics (Problemy sovremennoy ekonomiki), 3(55), 62-72, Retrieved from http://www.m-economy.ru/art.php?nArtId=5478 (in Russ.)