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Renewable Energy in Russia in the Midst of Turbulence: Focused on the Republic of Sakha (Yakutia)

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Abstract
This paper examines the development of renewable energy in Russia, with a focus on the concept of ecological modernization as an analytical framework with an aim to see the realities of green transition in the country that seems to have fallen behind other major countries in the dynamics of decarbonization. At the national level, Russia's green transition is slow and sluggish in terms of the installation of variable renewable energy (VRE) generators, despite the fact that it has a considerable amount of latent renewable sources to contribute to decarbonization. On top of this, it has become more difficult for the country to navigate the decarbonizing world as a result of the unprecedented economic sanctions that have forced Western firms to give up their operations in the field of renewables. The demonstration project on the use of wind energy in Tiksi, a northern town in the Republic of Sakha (Yakutia), has shown that wind energy production has successfully progressed as part of the Japan–Russia energy cooperation; however, due to the impact of energy and financial sanctions, it seems unlikely to start a new initiative for wind energy development in the republic with abundant wind resources. In the context of ecological modernization theory, the pathway to a decarbonizing society with innovative renewable technologies is now *shut down* rather than *closed* for Russia, partly because of malfunction of domestic institutionalization and mainly owing to Western economic sanctions. This is in contrast to China's experience, wherein ecological modernization has been *forced* as a national policy in the last two decades.

Keywords
Renewable energy, Russia, Republic of Sakha (Yakutia), economic sanctions, ecological modernization

1. Introduction
The current inventory of businesses for decarbonization or carbon neutrality, which form the core of climate change polices, is often referred to as a "promised market." This not only means that they are guaranteed as promising investment opportunities in financial markets but also implies that market opportunities have already been created, and investment areas and technologies have been narrowed down in advance (Minami, 2023).

In the wake of the Paris Agreement adopted at the United Nations Framework Convention on Climate Change (COP) 21 at the end of 2015—a new international framework specifying greenhouse gas emissions reduction after 2020—at least the advanced economies began to discuss decarbonization. While the reality of production activities and consumption behaviors may be inconsistent, it is certain that such a message—that departing from fossil resources is inevitable—is being disseminated and, at the same time, has been accepted by the international community. Furthermore, with the aim of overcoming the economic downturn that was mostly caused by the lockdowns introduced in each country to prevent the spread of Covid-19, a surging of the green transition—a fair and comprehensive transition toward decarbonization and carbon neutrality—led by Europe has spread worldwide, involving emerging countries such as China, India, and Russia; it reached its peak at COP26 held in Glasgow, UK, at the end of 2021, with a series of declarations of carbon neutrality by major countries (Harada, 2023, pp. 28–29). Just when the decarbonization movement seemed unstoppable, a grave event, the Russia-Ukraine military conflict, put the brakes on it.

The Russian Federation, whose President Putin himself declared carbon neutrality until 2060 in October 2021, has a considerable amount of "buried" potential to contribute to decarbonization. Being one of the world's leading resource-rich nations, much of its potential remains untapped. However, one instructive case that has actually been brought to light is the wind power generating facilities with a microgrid system, or a small-scale power grid with built-in distributed energy sources, located in Tiksi. In Russia's Far East and Far North regions, power systems for supplying electricity independent of the nation-wide grid system have been left in place. There have been discussions about the need to replace diesel generators that have been used for many years with liquefied natural gas (LNG) thermal power generation or solar/wind power generation, which have lower environmental impacts and can thus contribute to decarbonization. It is interesting to note that Japanese private companies and public institutions were deeply involved in the construction of the power generation facility in Tiksi and, more importantly, that the project has successfully progressed as part of the Japan–Russia energy cooperation that is likely to shed light on the oil and gas development (NEDO, 2022). This project demonstrating a wind power generation system in extremely cold regions, which peer companies in Western countries were unable to achieve, has been thoroughly evaluated (Artyushevskaya, 2021). It is also a noteworthy attempt from the perspective of Japan's business involvement in the field of decarbonization in Russia.

The rest of the paper proceeds in four parts. The literature review on decarbonization and renewable energy development in Russia is followed by a proposal of an analytical framework to examine the dynamics of renewables and the realities of the green transition in Russia that seems to have fallen behind its European counterparts, which have more than a half century of history of incorporation in energy businesses. I then examine the utilization of renewable energy sources and policy efforts toward their promotion in the country, based mainly on governmental documents and statistical data. Subsequently, I consider the significance and prospects of the renewable energy demonstration project that works out well with Japan's public support in Tiksi, a small community in the Sakha Republic, located in the Arctic region of Russia's Far East. Finally, amidst the demand for both stable energy supply and decarbonization, I attempt to ponder the significance and challenges for fossil fuel-rich nations such as Russia to advance domestic renewables and decarbonization investments. In this regard, it is observed that partnerships with foreign entities are deemed indispensable both technologically and financially for exploiting Russia's decarbonization and renewable energy potential, akin to oil and gas developments in the Russian Arctic area. Therefore, it is also of interest to examine the extent of the impact of economic sanctions against Russia after the end of February 2022.

2. Possibilities and efforts for decarbonization and renewable energy in Russia

2-1. Research trends on decarbonization and renewable energy in Russia

According to an overview of the research situation regarding decarbonization and renewable energy in Russia with the academic paper database, Web of Science, operated by Clarivate, we can observe the following characteristics.

First, as shown in **Table 1**, the number of research publications began to increase in the late 2010s and has surged since 2020. Similar tendencies can be seen in research targeting other major countries, which suggests that attention has also been drawn to the potential of renewable energy in Russia, riding the wave of global movements toward decarbonization and carbon neutrality that has advanced worldwide since the late 2010s. The sharp increase in publications in the 2020s can be related to Russia's ratification of the Paris Agreement in September 2019, which made it conducive for the country to participate in international renewable energy projects. The outbreak of armed conflict in Ukraine also globally impacted the transition process to decarbonization and carbon neutrality.[1] However, when comparing Russia with other major countries regarding

[1] To cite an example, because of the military clash, the European Union (EU) simultaneously lost Russia and Ukraine, which the EU had anticipated would be essential suppliers of mineral resources crucial for its flagship EV policy of the automotive industry

research outcomes focusing on renewable energy, which is more directly linked to business opportunities than decarbonization or carbon neutrality, as shown in **Figure 1**, even in 2023, the year with the highest number of publications, Russia only accounts for about half the number of research publications of the United States and Germany; China, which is at the forefront of the renewable energy industry,[2] outpaces Russia significantly, with a tenfold gap between the two nations. These research trends can be considered to reflect not only the research interests of the academic community but also the intentions of the political actors and business players in the world. Overall, it can be interpreted that Russia receives similar levels of interest and expectations as Japan, one of the largest energy importers, or Saudi Arabia, which has been a fossil resource-rich country.

Second, both nationally and internationally, the potential for decarbonization and renewable energy in Russia has been highly appreciated since the country got on board with the global strategic race toward a low-carbon economy with its ratification of the Protocol to the United Nations Framework Convention on Climate Change, the so-called "Kyoto Protocol," in 2004 (Øverland and Kjærnet, 2009; see also IFC, 2011; Katayama, 2012; Lombardi et al., 2016; IRENA, 2017; Omatsu, 2017, 2018; Kudelin and Kutcherov, 2021). While Russia has been acknowledged as a fossil fuel superpower, the country also possesses the world's largest decarbonization assets in the form of carbon dioxide absorption in forests, carbon dioxide capture and storage underneath, and natural gas as a low-emission fuel; in theory their commercialization or monetization could encourage carbon neutrality in the country (Harada, 2023, pp. 212–214). Therefore, some research groups argue that the transition to a decarbonized society in Russia will contribute to significant reductions in carbon dioxide emissions while fostering economic growth and employment opportunities based on their simulation analysis for the country (Laitner et al., 2020; Safonov et al., 2020). However, not all decarbonization businesses should be considered "promised markets," and there is always a certain level of investment risk.[3]

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in Europe (Tsuchida, 2022).

[2] China globally led renewable energy investments in 2023, and this pattern is expected to continue in the near future (*Weekly Toyo Keizai*, December 23–30, 2023). The IEA forecasts that China accounts for almost 60% of new renewable capacity expected to become operational globally by 2028 (IEA, 2024b).

[3] There is no shortage of skepticism of forest absorption and the underground storage of carbon dioxide in terms of technology, cost, management, and supervision. Some technologies often labeled as low-carbon solutions, such as carbon capture and utilization and storage (CCUS), face criticism vis-a-vis their perceived feasibility and economic viability in the context of climate change mitigation polices (Fukakusa, 2024). While the IEA views nuclear power plants as a decarbonized energy source, soaring construction costs due to strengthened safety measures, combined with recent increases in material and

Moreover, there are concerns that promoting decarbonization and enlarging renewable energy sources could potentially lower the value of the oil and gas industry, which is crucial to the Russian economy. Accordingly, the move toward carbon neutrality without conditions is not usually applauded in academic circles or in business society. Prior to the full-scale war between Russia and Ukraine, it was common to contemplate the intention and attitude of European countries, which had deep ties with Russia in the resource business, while strictly assessing the plausible impact of the decarbonization process upon the Russian economy and industries, and external economic relations as well (Berezkin and Sinyugin, 2019; Golub et al., 2019; Belov, 2020; Harada, 2020; Silnitsky and Uemura, 2021; Romanova, 2021; Crowley-Vigneau et al., 2023). The imposition of economic sanctions against Russia following the military clash in Ukraine has shifted the world's focus toward decarbonization as well as de-Russification, although these two are not necessarily synchronized in essence (Tokunaga, 2023a). We now witness a strong headwind, not only for the fossil fuel business, but also for the renewable energy sector in Russia, as we will describe later. However, since natural gas[4] and nuclear power,[5]

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labor expenses, have led to delays and cancellations of new construction projects in Japan, the USA, and Europe. As a result, the focus of nuclear power development is shifting to China and Russia (*Nikkei*, May 29, 2024, and June 2, 2024).

[4] Unlike those involving crude oil and petroleum products, transactions involving Russian natural gas are not subject to sanctions, except by the United States and Australia. Therefore, despite a sharp decrease in pipeline gas trade for artificial reasons, Europe continues to purchase Russian LNG as a substitute (Harada, 2023, pp. 83–122). Even though Europe is at the forefront of criticizing Russia, it continues to import Russian LNG at record high levels (McWilliams et al., 2023); with energy prices even stabilizing in 2023, Russia remains the second-largest LNG supplier to Europe after the United States. Criticism still persists over inconsistency, including the concern that "the pipelines have just been replaced by ships," and that "European companies are still sending billions of euros to the war fund of Putin's Russia" (*Nikkei*, September 14, 2023).

[5] In the nuclear power industry, where dependence is even higher on Russian uranium fuel than on natural gas because of Russia's overwhelming market share in the enrichment capacity of uranium, there is almost no economic leverage targeting Russia, except by the UK. Although five G7 countries (USA, UK, Japan, Canada, France) have agreed to multilateral cooperation regarding the nuclear fuel supply, in the current supply chain landscape, there are few options for Western business entities to operate without Russian uranium fuel (*Asahi Shimbun*, September 23, 2023, and May 7, 2024; *Nikkei*, January 10, 2024; see also "Russia's nuclear business: Europe's unbreakable dilemma" in *Asahi Shimbun Digital*, September 23, 24, and 25, 2023). US Public Law No. 118-62, "Prohibiting Russian Uranium Imports Act," was put in force in May 2024 (https://www.congress.gov/bill/118th-congress/house-bill/1042/text); however, this law de facto allows US business entities to import low-enriched Russian uranium until the end of 2027.

trade in which Western countries cannot completely cut off because of their high dependency on their Russian counterparts in business, are considered to fall within the category of decarbonization in line with the mainstream energy discourse in the world, Russia still retains the potential to show itself to be a clean energy superpower along with predominantly domestically oriented hydroelectric power, as Seregina (2023) argued in an enthusiastic way.

Third, there is generally less interest in researching Russia's actual policies and projects implemented in the field of decarbonization and renewable energy. Despite its significant potential, Russia lags behind other major countries in both fostering the transition to a green energy society and building the necessary institutional frameworks, mainly due to the immense resource rents generated by the fossil fuel business, which turns away from the green transition (Katayama, 2012; Suutarinen, 2015; Tynkkynen, 2020, 2021; Strielkowski et al., 2021; Yamawaki, 2020, 2022, 2023; Crowley-Vigneau et al., 2023). Moreover, the unfolding of the Russia–Ukraine conflict since the end of February 2022 has not only disrupted the political stability, from which the Arctic countries enjoyed significant benefit in the high north region, but also jeopardized international efforts to address climate change and environmental issues (Heininen, 2022; Krasnopolski, 2022; Hilde et al., 2024). Above all things, considering the significant greenhouse gas emissions resulting from the hostilities between the two countries, it is undoubted that the military assault on both Ukraine and Russia is an apparent setback for decarbonization and carbon neutrality efforts in the world community (Tokunaga, 2023a).

According to the forecast by the British magazine *The Economist*, released a year after the start of the battle, a tipping point that stemmed from the critical situation in Ukraine might accelerate the transition to decarbonization by five to ten years at the global level (Economist, 2023). Indeed, despite a resurgence in fossil fuel usage amid the energy crisis, the adoption of renewable energy sources is steadily advancing. The International Energy Agency (IEA) reports that the capacity for renewable energy generation increased rapidly in 2023 and marked a record-high annual growth rate in the past two decades (IEA, 2024a). The most serious and long-term negative impact that the Russia–Ukraine crisis has had on climate change mitigation efforts is attributable to the undermining of the foundation of international cooperation, which is essential for substantial progress of decarbonization; however, the surge in fossil fuel prices due to the full-scale conflict has relatively enhanced the cost competitiveness of renewables, prompting major countries to accelerate decarbonization investments over the last few years (Takamura, 2024).

2-2. Analytical framework: ecological modernization approach

As we have seen so far, the literature suggests that there is a major gap in the performance between Russia and other major countries such as China, among others, with regard to decarbonization efforts in general and renewable energy investment in particular. In this paper, we take the concept of ecological modernization as an analytical framework so as to examine the reason behind Russia' backwardness in the exploitation and monetization of its huge renewable energy resources for decarbonization in the country.

While the early literature of ecological modernization was primarily based on the experiences of advanced countries in Europe, the most recent literature has been more concerned with comparative perspectives, often focusing on the ways in which globalization processes would catalyze ecological modernization in developing and transitional countries (Buttel, 2000). It has been described as a social theory of modernization for ecological development, public policies and discourses for building an environmentally friendly society, private sector behavior bringing about efficiency of economic systems as well as improvement in the natural environment, and environmental technologies and standards that are often generically labelled green technologies. As I mentioned in an earlier paper (Tokunaga, 2010), we can refer to ecological modernization both quantitatively and qualitatively: first, ecological modernization is considered as industrial restructuring that leads to a more environmentally sound economy on the basis of measuring the extent of the decoupling between economic growth and environmental stress; second, it is also defined as the development of institutional capacity for an effective environmental policy, which can be analyzed by reviewing the institutions in relation to environmental governance, as well as the social groups involved in the management of these institutions.

As we will describe in the following sections, plentiful statistical data shows that Russia is far lag behind its competitors regarding the development of renewables: the share of solar and wind energy to total power generation is still less than 1% as compared to 33% in Germany, 14% in the United States, 13% in China, and 10% in Japan (see Table 3, shown later). It is worth noting that the share of variable renewable energy (VRE)—such as solar and wind power in Russia—has never been more than 1% since the country launched its development plan for renewable energy at the end of the 2000s. The latest IEA World Energy Investment Report explores a bleaker landscape: clean energy investment in Eurasia, most of which would be referred to Russia, remains 1% as a share of the global total, as compared to 33% in China and 15% in the United States (IEA, 2024b, pp. 181, 196, 208). As for the institutional capacity as a qualitative indicator of ecological modernization, most of experts in this field assess Russia's environmental governance negatively, in general, particularly as related to its involvement in the green transition with an enforceable business restructuring strategy (Yanitsky, 2001; Mol, 2009; Tokunaga, 2010; Wilson Row, 2012; Henry and Sundstrom, 2012; Skryzhevska et al., 2015; Suutarinen, 2015; Tynkkynen, 2020, 2021; Kudelin and Kutcherov, 2021; Crowley-Vigneau et al., 2023).

All in all, even before the outbreak of war, it was difficult to say that Western-style ecological modernization was proceeding in Russia, in spite of some evidence that its environmental discourse was changing to or converging with a more environmentally friendly rhetoric, and the policy response in some spheres had high affinity with the European environmental policy (Tokunaga, 2018). Under the current circumstances, it seems that a country upon which unprecedented energy and financial sanctions have been imposed has no chance to navigate the decarbonizing world and pursue the path to ecological modernization described above. In the following sections, therefore, we attempt to frame the discussion of this concept and elaborate why and how Russia diverted itself from the wave of decarbonization despite its official engagement with the Paris Agreement and the declaration of carbon neutrality.

3. Planning and performance of renewable energy development in Russia

As described at the beginning of this paper, if the low-carbon and zero-carbon fields are considered to be promising markets, then will the resource business of high and medium hydrocarbons such as coal, oil, and natural gas[6] eventually become an unpromising or unable-to-promise market? Some movements that can be seen as precursors to this have been observed even before the Russia–Ukraine war; one factor contributing to skyrocketing resource prices in the middle of an energy crisis should be attributed to the worsening predictability of fossil resource development amidst increasing pressure to decarbonize, leading to underinvestment as a result of uncertainty.[7] Furthermore, as

[6] Carbon dioxide emissions per unit of heat generation vary depending on the fuel; when compared using the CO_2 emission coefficients, natural gas emits more than 40% less than coal (anthracite) and around one quarter less than petroleum (crude oil). For this reason, natural gas is sometimes regarded as a low-carbon fuel. However, the concept of low-carbon or decarbonization should be understood fundamentally as a policy goal or a direction for transformation. Given the current lack of objective standards for classifying carbon content as high, medium, or low, such labeling is inevitably susceptible to accusations of being arbitrary. Incidentally, the IEA classifies natural gas as a fossil fuel and lists low-emission fuels as hydrogen or biofuels (IEA, 2023b).

[7] For example, Amin Nasser, President and CEO of Saudi Aramco, the state-owned oil company of Saudi Arabia, stated that “the sharp decline in investment in oil and gas has led to an energy crisis” (*Nikkei*, November 10, 2022). According to Ryohei Masumoto, a

transactions in energy markets, including the electricity market, proceed to liberalize, it becomes difficult to foresee long-term business prospects, which creates a potential inconsistency between the need for large-scale investments over the long term for decarbonization policies and the energy market mechanism for short-term efficiency. This discrepancy simultaneously exposes vulnerabilities in the energy market system and a lack of investment in renewable energy, which requires the redesign of the power system as a whole (Takeuchi, 2023a, 2023b).[8] The surge in global energy prices triggered by the military clash in Ukraine is also related to the promotion of energy market liberalization and decarbonization policies in the major European countries, with rising energy prices becoming apparent even before the outbreak of war. Therefore, President Putin's criticism of Europe at the end of 2021—the excessive liberalization of energy markets and the hasty introduction of renewable energy—was not entirely off the mark (Matsuo, 2023).[9] It should be noted here that Russian government senior officials, including President Putin, are not entrenched in climate change denial or skepticism, and they have often advocated for the necessity of liberalization in the energy business (Tokunaga, 2018; Romanova, 2021). This fact suggests that Russia's negative reaction should have been seen as a

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petroleum industry analyst at INPEX Solutions in Japan, even before the OPEC+ group, including Russia, announced production cuts in September 2022, the growth of oil production had slowed due to stagnant investments, and the available capacity for increased production is now limited to some oil-producing countries (*Nikkei*, September 13, 2022). However, divestment from fossil resource development does not necessarily mean only negative consequences for oil and gas-producing nations. In the short term, it may lead to soaring market prices due to supply–demand constraints, and in the long term, it may increase business opportunities for secondary energies derived from fossil resources such as hydrogen and ammonia (Harada, 2023, pp. 219–224). In fact, oil-producing countries in the Middle East, anticipating the arrival of peak oil demand, are actively working to introduce renewable energy and develop clean energy. In the United Arab Emirates (UAE), among others, several foreign companies are participating in various projects in this field (see Toichi (2023) for Japan's involvement in the development of non-fossil fuels in the Middle East).

[8] See Joskow (2022) and Keppler et al. (2022) for a theoretical background of this argument.

[9] For example, in a speech at the plenary session of the Russian Energy Week held in October 2021, President Putin criticized European energy policies: "Over the past 10 years, the share of renewable energy sources in the European energy balance has skyrocketed, which, on the face of it, appears to be a good thing…However, this sector is notorious for erratic power generation… In the event of major generation failures, primarily due to bad weather, this reserve is simply not large enough to cover the demand. This is exactly what happened this year…, there was a shortage of electricity on the European market. Prices soared, which triggered a spike in natural gas prices on the spot market" (President of Russia, 2021, http://en.kremlin.ru/events/president/news/66916).

backlash against the EU's measures and behaviors that contradict Russian national interests rather than viewing it as a rejection of decarbonization goals or policies per se. The European Green Deal announced at the end of 2019 aims to achieve carbon neutrality while also calling for a structural transformation in the direction of green economic growth detached from the use of fossil resources (Hasumi, 2023), which is totally aligned with the main argumentation of ecological modernization theory, i.e., the decoupling of economic growth and environmental stress.[10] As symbolized by the electrification of the automotive industry, the blow to the existing energy market and industry relying on fossil fuels seemed inevitable, which Russia could not overlook or withstand. Now, while "watching developments in Europe from the sidelines with trepidation and fear" (Harada, 2023, p. 188), how has Russia progressed with their renewable energy projects as a key part of their decarbonization businesses?

The foundational official document regarding the development plan for renewable energy in Russia dates back to January 8, 2009, with the Russian government directive titled "The Main Areas of Government Policy to Raise the Energy Efficiency of Electric Power from Renewable Energy Sources for the Period to 2020" (Government of the Russian Federation, 2009). Signed by then-Prime Minister Vladimir Putin, the document states at the outset that the enhancement of energy efficiency in the power supply system based on the expansion of renewable energy is part of the national energy policy. Consisting of three sections—(1) purpose, (2) current situation, and (3) measures—this government document garnered attention around the world regarding the establishment of goals for increasing the share of renewable energy generation in the country. Specifically, it set numerical targets for increasing the share of renewable energy generation capacity, including small-scale hydropower with a capacity of less than 25 MW,[11] from less than 1% to 1.5% by 2010, to 2.5% by 2015, and to 4.5% by 2020. These

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[10] According to the final version of the document, the European Green Deal is "a new growth strategy that aims to transform the EU into a fair and prosperous society, with a modern, resource-efficient, and competitive economy where there are no net emissions of greenhouse gases in 2050 and where economic growth is decoupled from resource use." (European Commission, 2019, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=celex:52019DC0640)

[11] In general, hydropower is considered one of the renewable energy sources (see Table 3 below). However, large-scale hydropower facilities have historically been regarded as symbols of environmental destruction. As a result, in recent years, the role of small-scale, low-output hydropower has been reassessed. At the same time, the criteria and definitions for what constitutes "small-scale" or "low-output" vary significantly across countries and regions, and the terminology used—such as small, mini, or micro—is equally diverse. When discussing government subsidies for power generation facilities utilizing

targets all remain unmet. The share of renewable energy generation has not reached 1% of the total production of electricity; the Federal State Statistics Service indicates that its share still remained at 0.66% in 2023 (Federal State Statistics Service, 2024).[12] It is noteworthy that this figure includes data from the Republic of Crimea, which was abruptly annexed by Russia in 2014. Solar and wind power generation from the Crimean Peninsula, which is rich in both solar and wind resources, has accounted for approximately 5.4% of Russia's total renewable power production (Russia Renewable Energy Development Association, 2025).

The phrase "raise the energy efficiency," used in the above-mentioned government directive, was one of the key slogans of energy-saving measures promoted by the Medvedev administration at the time. The expansion of renewable energy was part of environmental policies and also constituted a development strategy with an attempt to revive the Russian economy from the blow of the global financial crisis that had struck the world economy the previous year. This is demonstrated by the fact that in 2009, when this directive was issued, Federal Law No. 261-FZ—"On Energy Saving and Improvement of Energy Efficiency"—went into force, the "Climate Doctrine of the Russian Federation" was approved by the federal government and signed by the president, and the "Energy Strategy until 2030" was announced by the Ministry of Energy. Early strategies that sought to link measures to reduce environmental burdens, such as energy conservation, to economic growth were led by the EU, with other major countries initially hesitant and skeptical, but then beginning to follow suit. The reasons vary by country; in the case of Russia, it is believed to be attributable to the strong recognition of the need for structural reforms in the domestic economy following the decline in oil prices and economic downturn after the summer of 2008 (Tokunaga, 2013, pp. 114–117). Although the idea of integrating environmental policy with domestic economic recovery for the purpose of overcoming exogenous economic crises has things in common with the European Green Deal that the EU prioritized as economic recovery pillars after being

renewable energy, the Russian government decided to include hydropower facilities with a generation capacity of less than 25 MW as renewable energy sources ("Rules on Qualifying a Renewable Energy Generating Facility" adopted by the Russian Government Resolution No. 426 of June 3, 2008). Alongside this definition, there is also a standard that classifies hydropower facilities with a generation capacity of less than 50 MW as renewable energy sources, highlighting the ambiguity in defining renewable energy sources in the country (Ignat'eva, 2023, pp. 35–50).

[12] Russian media conveys some preliminary figures of electricity production in 2024, according to which the share of solar power and wind power amount to 0.3% and 0.7% of the total power production, respectively (*TASS*, January 14, 2025).

struck by the COVID-19 pandemic (Hasumi, 2023; Harada, 2023, pp. 184–188), a crucial difference lies in the fact that sensitive issues concerning the handling of fossil resources, which were vital to the Russian economy and industry, were not put on the agenda in government negotiations on climate change at that time.[13] The promotion of energy conservation and the improvement of energy efficiency, goals that align with the argument for green innovation, was a slogan that seems to be accepted with no condition. Therefore, it can be said that environmental discourse under the Medvedev administration approached international standards. We need to keep in mind that the aforementioned "Climate Doctrine of the Russian Federation" and "Energy Strategy until 2030"[14] released under his presidency completely lacked the concepts or phrases of mitigating the adverse effects of climate change through the restraint of fossil fuel development and the reduction of its use. This is in contrast to the discussion at the moment. Considering that renewable energy could potentially serve as a substitute for fossil fuels, when viewed in hindsight, it seems natural that Russia's ambitious plans for the development of renewable energy derailed and got stuck in the end.

As of 2010, when renewables were put on business the agenda, small-scale hydroelectric power plants with a generating capacity of less than 25 MW were the main source of renewable energy in Russia, accounting for 70% of total renewable energy usage; the remaining 30% was derived from biomass heat utilization which was introduced mainly for heating buildings. Renewable energy generation began in the early 2010s, with about 53.5 GW—equivalent to around 20% of the newly introduced capacity of 253 GW during that period—coming from renewable sources. Small-scale hydroelectric power (51.5 GW) remained the primary source, but biomass power (1.35 GW), solar power (460 MW), and wind power (111 MW) also saw the early development stage (IRENA, 2017, pp. 11–15). The boosted investment in solar and wind power generation projects, the flagship of renewable energy generation, was supported by the renewable energy capacity auction scheme that the Russian government institutionalized in 2013.[15] This system was approved in the 2011 electricity law amendment and then

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[13] The progression of discussions leading up to COP15, held in Copenhagen at the end of 2009, as well as the remaining challenges, is outlined in Morotomi and Asaoka (2010, pp. 57–115).

[14] The original Russian text of both documents is available at the official site of the President of Russia (http://special.kremlin.ru/acts/news/6365) and the Government of Russia (http://www.scrf.gov.ru/security/economic/document122/). See Charap and Safonov (2010), Katayama (2010), and Motomura (2010) for overviews and analyses of these two documents.

[15] Unless otherwise noted, the descriptions in this paragraph are based on Omatsu (2018).

specifically presented in the Russian government decree on May 28, 2013, “On the Mechanism for the Promotion of Renewable Energy on the Wholesale Electricity and Capacity Market” (Government of the Russian Federation, 2013). Similar schemes had already been formulized for thermal and nuclear power generation, but as for solar and wind power generation, which have significant output variations depending on weather conditions, there is a visible difference in requiring compliance with output control requests for entry to an auction.[16] Moreover, while business entities could receive capacity payments based on CAPEX (capital expenditures for purchasing, maintaining, and renovating fixed assets) set for the long term (up to 15 years) from a fund consisting of burden fees paid by buyers participating in the wholesale electricity market, the system also strongly emphasized the development of renewable energy industries by setting stringent local procurement standards to establish equipment and component production bases. Although the auction process initially skewed toward solar power generation, the relaxation of local procurement standards led to a gradual increase in wind power generation, resulting in a rapid increase in the capacity and performance of renewable energy generation at the end of the 2010s (see Table 2).[17]

However, as mentioned earlier, the target for renewable energy generation has not yet been achieved. Although the proportion of thermal power generation using fossil fuels has gradually decreased from 67.3% in 2010 to 63.7% in 2023, when compared with the trends in the world’s electricity market and the dynamics of renewable energy projects

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[16] In Japan, for example, output control—the temporary halting of solar and wind power generation—surged in 2023 and has been criticized for essentially wasting the clean energy generated by renewable sources (*Asahi Shimbun Digital*, February 10, 2024). It is argued that failing to constantly match electricity generation with consumption can lead to frequency disturbances and the risk of major blackouts. Recently in Japan, such an event occurred all across the Hokkaido region for half a day following the Hokkaido Eastern Iburi Earthquake on September 6, 2018. To promote the expansion of renewable energy generation while restraining output control, it is essential to reinforce the transmission network. Thus, there are plans to increase the capacity of the transmission network connecting Hokkaido and Kyushu, the main regions for renewable energy generation, with the Honshu region, or Japan’s mainland, which is a major consumer of electricity (*Nikkei*, March 12, 2024).

[17] In addition, increased institutional support, mainly for small-scale renewable energy producers (less than 5 MW), was implemented so as to establish a framework whereby transmission companies should prioritize purchasing electricity generated from renewable sources when compensating for transmission losses. However, due to both systemic design defects and operational challenges, this scheme did not function effectively as a mechanism for promoting local renewable energy initiatives (Omatsu, 2017).

in other major countries, there is undoubtedly a significant shortfall in Russia. According to the latest IEA assessment, as shown in Table 3, Russia's renewable energy generation remains heavily biased toward hydroelectric power, with the integration of VRE such as solar and wind power classified as being in the most delayed Phase 1, where VRE deployment has no immediate impact on power system generation.[18] Currently, both Saudi Arabia, where renewable energy generation is almost nonexistent, and South Korea, which falls behind in the introduction of renewable energy, are also classified as being in Phase 1. However, generation in both countries is expected to grow in the future, whereas Russia's actual achievement in 2023 is mostly congruent with its future prediction for 2030. In other words, the future of renewable energy projects in the country is deemed to be hopeless under the current circumstances. Similar to the LNG projects that have struggled amid intensified economic sanctions against Russia (Tokunaga, 2023b), renewable energy generation in the country is also a business that cannot work unless foreign companies are involved in the capital supply and the provision of technology (Omatsu, 2018; Crowley-Vigneau et al., 2023; Sakaguchi, 2024). Consequently, in the absence of participation from Western companies in new projects, the aforementioned renewable energy capacity auction scheme has seen repeated delays in implementation and has effectively been frozen (Volobuev, 2022; Geroeva, 2022).[19] Its impact is clearly reflected in the launch of renewable energy generation following a series of sanctions against Russia. Russia Renewable Energy Development Association (2025) reported that the introduction of solar power generation capacity peaked at 596.9 MW in 2019 and has been decreasing annually, reaching only 44.1 MW in 2023 and then recovering to 360.3 MW in 2024. In the case of wind power generation, after significant expansion in capacity from 2020 to 2021 (843.40 MW in 2020 and 1008.9 MW in 2021), there has been a sharp decline through 2022 and 2024 (230.4 MW in 2022, 252.0 MW in 2023, and 35.3MW in 2024), amounting to only a few percentages of the peak recorded in 2021. Furthermore, despite the continued increase in the installed capacity of renewable energy generation, its output decreased from 8.6 billion kWh in 2022 to 7.8 billion kWh in 2023 (see Table 2). Based on various reports on energy, Russia appears to be the only major country in the world where renewable energy generation has declined during this period. Nonetheless, the current Putin administration has not wavered in its bullish stance and, without lowering the banner of renewable energy expansion, decided on March 24, 2022,

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[18] In accordance with the integration level and operational performance of VRE in the electricity supply system in each country, major countries are classified into Phases 1 to 6. As of 2023, Denmark's Phase 5 is the highest ranking (IEA, 2024c).

[19] The auction was held only once in the spring of 2023 (Sakaguchi, 2024).

shortly after the start of the military clash in Ukraine, to establish a framework for financial support to be applied from 2024 to 2035, with some crucial parameters that are indispensable for auction enforcement, such as a cap on capital expenditures and development costs (Government of the Russian Federation, 2022). The Ministry of Energy, the government body responsible for planning the development of renewable energy in Russia, has set a target of 2.0% (281 billion kWh) as the share of renewable energy generation by 2030 (Geroeva, 2022). It took steps to amend the electricity law in mid-2023 to encourage the use of low-carbon electricity sources by users.[20]

4. Development of renewable energy projects in the Republic of Sakha (Yakutia)

The operation of a renewable energy capacity auction, which has, to some extent, contributed to the development of solar and wind power generation in Russia, has serious gaps in its geographical coverage.[21] Some areas in the Far East and Far North regions, where wholesale electricity markets do not exist, are referred to as "non-price zones" or "isolated zones." In these areas, there is no competitive market because there are few power generation operators; also, there is no possibility of trading electricity since they are not physically connected to other networks through electric power transmission lines. As a result, government-regulated electricity tariffs are applied to these areas, and public subsidies are provided to power generation operators to make up for the difference between the generation cost and the power-supply price. This imposes a heavy financial burden on local governments, in some cases. As mentioned later, some parts of the Sakha Republic have been connected to the Unified Energy System of Russia or the national-level power transmission and distribution system operator since the beginning of 2019, and the infrastructure development necessary for electricity trading through market mechanisms has been underway.[22] However, the territories of the Sakha Republic were not included in the auction system led by the Ministry of Energy at the national level. Therefore, the Republic's government has embarked on its own support measures for renewable energy and, in 2014, enacted a regional version of the renewable energy

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[20] The amendment to the federal law "On Electric Power Industry" was approved by the lower house on July 20, 2023, endorsed by the upper house on July 28, and signed by the president on August 4 of the same year, after which it was put into force (Russian Federation, 2023).

[21] Unless otherwise noted, the descriptions in this paragraph are based on Omatsu (2017).

[22] For an overview of Russia's electricity industry and the history of its restructuring, see Chubais (2018) and Urinson et al. (2020). The Federation of Electric Power Companies of Japan (2018) provides short descriptions of Russia's electric industry and market.

promotion law (YASIA, 2023),[23] preceding other regions or constituent entities of the federal state. It has focused on promoting renewable energy generation, which not only directly contributes to reducing greenhouse gas emissions but also helps to reduce the use of high-cost diesel fuel that has been cited as a main reason it is one of the regions with the highest electricity tariffs in Russia. Unlike the federal-level support system, no local procurement standards were set in the support program of the Sakha Republic; this lowered institutional hurdles for foreign companies to provide their own technology and equipment. As a consequence of this local initiative, between 2011 and 2015, 13 small-scale solar power plants with capacities of 10kW to 60kW were installed in the region. Furthermore, in 2015, the world's first megawatt-class solar power plant for the polar region was opened in Bagatai of the Verkhoyansk District (Kudryavtseva, 2015), leading to a significant reduction in diesel fuel consumption throughout the Sakha Republic. As for wind power generation, which had been expected to reduce fuel consumption for electricity,[24] since the mid-2010s, Japan's national research and development agency, the New Energy and Industrial Technology Development Organization (NEDO), has been collaborating with the Sakha Republic government and RusHydro, Russia's state-owned hydropower company, to work on a demonstration project for a microgrid system using wind power generation facilities newly established in Tiksi of the Bulunsky District. This project concluded at the end of February 2022, shortly after the start of the military clash in Ukraine (NEDO, 2022).

4-1. Electricity situation and renewable energy in the Republic of Sakha (Yakutia)

The Russian Far East, including the Sakha Republic, is endowed with abundant wind and solar resources, along with hydroelectric potential in the Amur River basin. In consideration of vast territories not integrated into the Unified Energy System of Russia, the significance of utilizing renewable energy resources to improve electricity conditions in remote areas has been emphasized both domestically and internationally (Voropai et al., 2012; Lombardi et al., 2016; Omatsu, 2017, 2018; Artyushevskaya, 2021; Bushukina, 2021). As shown in Figure 2, the interconnected national-level power grid does not cover the entire Russian territory but is limited to deployment in certain regions. Consequently,

[23] The Republic of Sakha (Yakutia) Law N 1380-Z N 313-V on November 27, 2014, "On Renewable Energy Sources of the Republic of Sakha (Yakutia)" (revised in 2017)

[24] For the Bagatai solar power plant, with a generation capacity of 1 MW, an annual fuel savings of 300 tons was planned, while the Tiksi wind power plant (0.9 MW) was expected to save 534 tons of fuel annually (Artyushevskaya, 2021). Across the Sakha Republic, approximately 70,000 tons of diesel fuel was procured annually for power generation during the 2010s (Fujiwara and Yamamoto, 2020).

the majority of the northern communities have their own power generation and supply networks. In total, the areas that are neither covered by the nation-wide unified power system nor regional power centers serving some specific industrial and residential zones (shaded in Figure 2) constitute around 60% of the national territory, mainly in the Far East and Far North regions (Toyoda and Hosomi, 2012; Voropai et al., 2012). Many of these isolated power districts have their own power plants; however, without interconnection via transmission lines, there is a high risk of power supply disruptions. Also, diesel electric generation predominates in these areas, which leads to significant financial burdens on both corporate and government finances due to the high cost of procuring heavy oil fuel (IRENA, 2017, p. 23). The Sakha Republic, covering an area equivalent to that of India (approximately 3.08 million km^2), has power supply systems in its western, central, and southern power districts that allow interconnection and power transfer, with some areas having been connected to the Unified Energy System of Russia since January 2019. At the same time, approximately 2.2 million km^2, nearly two-thirds of the republic's territory, constitutes the non-centralized power supply zone commonly known as the northern power district. This sphere hosts small-scale power plants (indicated by circles in Figure 3) scattered throughout the region, accounting for about a quarter of the republic's total generating capacity, or approximately 200 MW, based on 2017 data. Bagatai and Tiksi, mentioned earlier, also fall within the non-centralized power supply zone. AO Sakhaenergo,[25] which is primarily responsible for managing power plants in this zone, operates mostly diesel generators with capacities below 5 MW (Republic of Sakha (Yakutia), 2019, pp. 16–79).

Analysis of the official document titled "Development Scheme and Program of Electric Power Energy of the Republic of Sakha (Yakutia) for 2019–2023," approved by the head of the Sakha Republic at the end of April 2019, reveals challenges related to the electricity situation in the non-concentrated power supply zone. These challenges stem from the increasing electricity demand related to the advancement of developing resources such as coal, oil, natural gas, diamonds, and gold, as well as the need to ensure a stable power supply to remote residential areas primarily located in the northern part of the republic. The resource industries supporting the regional economy, including

[25] The company primarily charges with power and thermal supply in the non-centralized power supply zone as a subsidiary of Yakutskenergo PAO, the largest power production and distribution company in the Sakha Republic. As of the beginning of 2022, Sakhaenergo oversaw 169 power plants, of which 137 are diesel-powered, and served approximately 130 thousand residents across 17 districts within the republic (Republic of Sakha (Yakutia), 2022, p. 28).

companies such as Yakutugol (coal production), Alrosa (diamond production), Surgutneftegas (crude oil production), and Transneft (crude oil transportation), have their own management and operation entities for the necessary power production and transmission facilities; new construction and updates to power facilities are being carried out as part of the investment activities for their core businesses. On the other hand, the transmission lines and transformation facilities established during the Soviet era are reaching the end of their service lives, and some entirely depreciated facilities are still in use, which makes their replacement and renewal an urgent social issue. In this context, policies to replace diesel power plants, which are high cost and environmentally burdensome, with gas-fired or renewable energy-based power plants are reasonable. Such transitions are actually being seen in the Sakha Republic. This locally initiated movement is in line with the argument for ecological modernization, in that it apparently shows the bottom-up development of institutional capacity both for the alleviation of environmental stress and the reduction of energy costs in the region.

Upon review, it is apparent that the performance of renewable energy generation in the Sakha Republic over the past decade has steadily expanded, albeit on a small scale (see Table 4). As of 2023, there were 29 operational renewable energy generation facilities, reaching 1% of the total electricity production in the republic for the first time ever (RIA Novosti, 2023). Except for the large-scale power plant constructed in Bagatai, solar-based renewable energy generation facilities are small-scale and operating in conjunction with diesel power plants in existence (Artyushevskaya, 2021). Of particular interest is the significant expansion of capacity in 2022, which can be attributable to the introduction of five hybrid power facilities in the Moma and Verkhoyansk Districts (Yakutia Daily, 2024). According to media reporting within Russia, Sakhaenergo, a group-affiliated company of RusHydro, is engaged in various projects to install solar panels on existing diesel power plants and to enhance the rate of renewable energy generation through similar hybridization across the region (RIA Novosti, 2023; GTRK "Sakha," 2024). Chinese companies were reported to have supplied equipment to solar power projects implemented in the early 2010s in the republic (Omatsu, 2017), which suggests that the installment of a solar power system proceeded smoothly without disruption by the recent economic sanctions against Russia. In contrast, as for the generation of wind power, because the renewable energy business is highly dependent on Western foreign firms (Omatsu, 2018), the only successful example so far is the Tiksi wind power plant, which was realized under Japan–Russia energy cooperation. As indicated in Table 4, there has been no establishment of a wind power system in the Sakha Republic in the post-sanction period. In extremely cold regions such as Tiksi, the only operational wind turbines for power generation were Japanese manufactured; a European rival was hesitant to be involved in this project. Also, as of 2020 or so, wind turbines produced by Chinese companies had consistently failed in such cold climates and faced significant maintenance issues.[26] In the mid-2010s, RAO ES East, a power company in the Far East region, reported that the republic had an optimistic scenario, in which 132 solar power installations (43.1 MW) and 9 wind power installations (8.3 MW) were projected to expand through 2020 (Kudryavtseva, 2015). Although both actual figures fall significantly short of these projections, it is expected that the number of solar power installations will continue to grow, whereas the outlook for wind power installation, following the project in Tiksi, remains bleak, given the current circumstances.

4-2. "Polar Microgrid System" in Tiksi

During the May 2016 Japan–Russia summit held in Sochi, the Japanese government under Shinzo Abe's administration proposed the "Eight-Point Cooperation Plan," to which President Putin expressed positive feedback and approval (Ministry of Foreign Affairs of Japan, 2018).[27] However, many of the projects included in this plan were not financially viable, leading to several projects being left in limbo (Hokkaido Shimbun Press, 2021, pp. 244–246). Among them, the "Cooperation on the Introduction and Expansion of Wind Power Generation," which is part of "Plan 4: Cooperation in Energy Development, Expansion of Production Capacity for Oil, Gas, and Other Energy Sources," can be considered a relatively successful example of Japanese–Russian energy cooperation. In February 2018, a document on cooperation in demonstration projects for energy infrastructure, including wind power systems, was concluded by NEDO and three Japanese companies (Takaoka Toko Co., Mitsui & Co., and Komaihaltec Inc.) from the Japanese side, and the government of the Sakha Republic and two aforementioned power companies (RusHydro and Sakhaenergo) from the Russian side (JETRO, 2018).

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[26] Personal communication from businesspeople from Komaihaltec Inc. (mentioned later), the Japanese windmill maker that has been involved in the project renovating the thermal electric power station in Tiksi (September 26, 2024)

[27] The eight items are: (1) extending healthy life expectancy, (2) developing comfortable and clean cities easy to reside and live in, (3) fundamentally expanding exchange and cooperation among medium-sized and small companies, (4) enhancing energy cooperation, (5) promoting industrial diversification and enhancing productivity in Russia, (6) developing industries and promoting the role as export bases in the Far East, (7) cooperating on cutting-edge technologies, and (8) fundamentally expanding people-to-people interaction (Ministry of Foreign Affairs of Japan, 2018).

As evident from Figure 2 shown earlier, the potential for natural energy, particularly wind energy, is significantly high in Russia's Far East and Far North regions. As mentioned before, while solar power has steadily risen in the Sakha Republic, it falls far short in terms of installed capacity and actual power generation as compared to Russia's southern regions.[28] On the other hand, as suggested by the sharp decline in installed capacity after the imposition of sanctions (see the previous section), wind power projects in Russia relied heavily on products and technology from Western companies; European companies such as Fortum (Finland), Enel (Italy), and Lagerwey (Netherlands) had initially entered the renewable energy sector in cooperation with Rosatom, Russia's state-owned nuclear energy corporation, but abandoned new projects in Russia after the start of the military conflict in Ukraine. In this context, the demonstration project on wind power generation systems constructed in an Arctic community, Tiksi, along with the "Polar Microgrid System" that integrates them into an independent power grid, is a valuable case for study because this project demonstrates the successful operation of wind power production in extremely cold climates, which is to say an innovative practice of renewable energy (see Figure 4 for the outline).[29] There are three component themes for verifying and assessing the effectiveness of the entire demonstration project in Tiksi: (1) renewable energy control coordination systems and mixed-burn diesel generators; (2) wind power generation systems designed for extremely cold climates; (3) the validity of the business model and its potential for widespread adoption. The three Japanese private companies described above, under contract with NEDO, handled all aspects from project planning to the manufacturing and installation of power generation facilities, while Sakhaenergo was responsible for operating and maintaining the power plant at the demonstration site. Japan's share of the project cost was 1.96 billion JPY for the three tasks above. Russian counterparts contributed 2.17 billion JPY, mainly for the domestic transportation of equipment, preliminary work such as foundation work, building construction, and piping networks, as well as on-site equipment operation and

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[28] The southern part of Russia, such as Orenburg Oblast of Volga Federal District and Astrakhan Oblast and the Republic of Kalmykia of Southern Federal District, dominates in terms of solar power generation capacity and actual electricity generation (Russia Renewable Energy Development Association, 2025). The industrial infrastructure for solar power generation was developed primarily by the Russian state-owned investment company Rusnano, which has achieved certain results through initiatives such as the construction of mega solar power plants (Katayama, 2012).

[29] See Fujiwara and Yamamoto (2020) and Muto et al. (2020) for an overview of the installation work of wind turbines in Tiksi and the various challenges endemic to the extremely cold weather conditions.

maintenance with various inspections during the demonstration operation period, with which RusHydro was primarily charged (NEDO, 2022). The demonstration test results for each theme were generally positive, and as shown in Table 4 above, power generation performance has been maintained after all of the facilities were handed over to Sakhaenergo with the completion of this Japan–Russia joint project at the end of February 2022. At the same time, as a result of the escalation of economic sanctions against Russia, it has become more difficult to continue operation in a normal way or engage in new initiatives in Tiksi. Regarding the "Polar Microgrid System," while follow-up tasks related to daily operations—such as responding to inquiries and providing advice—are still being carried out remotely, it remains uncertain how issues will be handled if mechanical equipment malfunctions occur or consumable parts need to be replaced for maintenance.[30]

It seems that there is little dissent regarding the usefulness and future potential of such initiatives, as demonstrated through the operation of the "Polar Microgrid System" installed in Tiksi, since renewable energy projects utilizing local natural energy sources are, in theory, able to bring excellent results both environmentally, by reducing greenhouse gas emissions, and economically, by saving on costly diesel fuel in the Russian Far East and Far North regions. This reflects a significant practice of promoting ecological modernization in remote areas with the help of local renewable sources. Prior to the project in Tiksi, on-the-ground surveys regarding the possibility of a microgrid system utilizing wind power in Sakhalin Oblast and wind turbine construction operations in Kamchatka Krai were conducted by Komaihaltec with NEDO's financial support for these demonstration projects in cold climates (Toyoda and Hosomi, 2012; Yamamoto and Iwai, 2017). These efforts have provided evidence of the benefits of introducing renewable energy into isolated power districts with the harsh natural environment. Hence, despite the increasing business challenges to renewable energy projects in Russia, both the federal and republic governments have not altered their destinations, although they have been forced to change their course toward expanding renewable energy. However, as suggested by the fact that Komaihaltec, the Japanese company responsible for manufacturing and installing the core wind power facilities in the three regions (Sakhalin Oblast, Kamchatka Krai, and Sakha Republic), has shifted its business focus to reconstruction for war-torn Ukraine.[31] It is rather plausible that Russia's attempts to

[30] An informant from Komaihaltec described such situations as unknown territory for the company (see note 25).

[31] During the Japan–Ukraine Conference for the Promotion of Economic Growth and Reconstruction held in Tokyo on February 19, 2024, numerous cooperation agreements

expand renewable energy will face significant obstacles in the near future, even though there are a number of reports that strongly endorse the positive perspective for renewable energy business in the Arctic territory of Russia's Far East.[32] This would give further impetus to the country's derailing from a track of primary ecological modernization goals. Anticipating such challenges, a plan for the construction of the first nuclear power plant with low-output capacity in the Sakha Republic is circulating around the region as part of the proactive support for renewable energy initiatives that should be embraced by local communities.[33]

5. Concluding remarks

The COP28 held in Dubai, United Arab Emirates, in December 2023, reached some historical agreements on the transition away from fossil fuels in energy systems and a tripling of renewable energy capacity (UN Climate Change, 2023). While the latter set specific numerical targets, the former's wording of *transition* instead of *abolition* or *reduction* carries a nuanced impression, probably reflecting the interests of oil- and gas-producing countries. Nonetheless, this phrasing correctly depicts the current discourse surrounding fossil fuels and renewables. Even though natural gas has a relatively lower environmental impact, it faces criticism due to its status as a fossil fuel. On top of this, Russian gas is scrutinized under social norms that call for reducing energy dependence on the country. In the discourse regarding environment and energy, therefore, renewables are apparently positioned ahead of fossil fuels. While the gap between the two may

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were signed by government agencies and private organizations from both countries. Among them, it was announced that Komaihaltec had exchanged a memorandum of understanding regarding collaboration on infrastructure reconstruction projects in Ukraine with the Naftogaz Group, TM CKS, and DOGUS Construction Ukraine (Ministry of Foreign Affairs of Japan, 2024). It has been reported in Japan that they are considering the introduction of wind power generation facilities and the development of materials for bridges (*Nikkei*, February 15, 2024, and February 20, 2024). In June 2024, the governments of Japan and Ukraine held a reconstruction support conference in Berlin again and signed a new cooperation document. However, according to sources, as long as attacks on Ukraine's power facilities go on, the commercialization of wind power projects remains quite challenging (*Asahi Shimbun*, June 12, 2024).

[32] Komaihaltec conducted on-site surveys for wind power generation and infrastructure development in the Russian Arctic region, including the Sakha Republic (Komaihaltec and Nomura Research Institute, 2020; Komaihaltec et al., 2022).

[33] Personal communication from three experts who live in the Sakha Republic (January 17, 2024). There is a plan for a small-scale nuke in Ust'-Kuyga, an estuarine locality in the Ust'-Yansk District of the republic against the backdrop of a rapid increase in electricity consumption in the republic (EnergyLand.info, 2024).

narrow due to global political and economic dynamics, a reversal of their positions is highly unlikely. Prior to COP28, in September 2023, IEA emphasized the necessity of tripling renewables in order to meet the goals of the Paris Agreement (IEA, 2024a); shortly before the conference, in November 2023, the organization also published a report advocating for halving oil and gas investments by 2030 (IEA, 2023c). Given the strong influence of the IEA's views upon major countries' agreements on decarbonization and de-Russification (Harada, 2023, pp. 132–138), it is highly likely that energy investment will continue to shift from unpromising or unable-to-promise markets to promising markets with firm commitments from the public authorities. The ongoing contrarian investments in fossil fuel development, mainly by US resource majors, stand out now, as a result of the growing trend toward decarbonization.[34] In other words, such movements would not even be conceptualized without corresponding conformist investments in renewable energy development across the globe.

Russia, a resource-rich nation and potentially a major player in renewable energy, was expected to pursue both avenues under the leadership of Medvedev and the following Putin regime. However, Russia's brutality toward its neighboring country has not only jeopardized its fossil fuel business but also cast doubts on the prospects of renewable energy projects still in the early developmental stage. Considering that the flagship project of energy cooperation between Japan and Russia, the Arctic LNG 2 project, has been derailed by targeted economic sanctions from the United States (Tokunaga, 2023b), pursuing even one goal has become increasingly challenging, let alone chasing both. Especially regarding renewable energy development, a paradoxical situation has emerged. While Russia's military campaign has served as a catalyst for major countries' green transitions,[35] it has also created a situation where Russia is at risk of being left behind in this movement. In the race to decarbonize, Russia has been somewhat lagging behind in the 2010s since the country issued its 2009 government directive, suggesting that it would

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[34] For example, ExxonMobil, a major player in the resources sector in the United States, has continued its contrarian investment by steadily advancing the development of fossil fuels, even as the tailwind for decarbonization strengthens, and has not ventured into renewable energy projects (*Nikkei*, November 26, 2022, and June 16, 2023).

[35] According to business columnist Pilita Clark, authorities of the major countries began to seriously tackle climate change measures starting in 2022 (*Nikkei*, November 7, 2022). Similar observations were made in a statement released by the IEA one year after the start of the conflict of arms between Russia and Ukraine, which noted that "sweeping government interventions" with the aim of the transition to clean energy began in response to the economic turmoil following the outbreak of war. The statement highlights key initiatives, such as Europe's "Repower EU," the United States' "Inflation Reduction Act," and Japan's "GX Promotion Act" (IEA, 2023a).

enter the competition. At the moment, it is undeniable that the current world circumstances may lead the country toward dropping out or retiring from this global race. In the context of ecological modernization theory, the pathway to a decarbonizing society with innovative renewable technologies is now *shut down* rather than *closed* for Russia, partly because of malfunctioning domestic institutionalization and mainly owing to the Western economic sanctions; this case study for renewable energy generation in the Sakha Republic reinforces this point. This is in contrast to China's experience, wherein ecological modernization has been *forced* as a national policy in the last two decades.[36] The period up to 2030, which will be a pivotal year for evaluating the success or failure of a series of measures for realizing carbon neutrality, coincides with President Putin's fifth term, secured in the March 2024 elections. Given this overlap, it is becoming increasingly apparent how Russia, under the leadership of someone described as "unable to walk toward the future,"[37] envisions the future of environment and energy.

References

Artyushevskaya, E.Y. (2021): *Артюшевская Е.Ю.* Анализ потенциала альтернативных источников энергии в Республике Саха (Якутия) // Вестник Амурского государственного университета. Серия: естественные и экономические науки. Выпуск 93, С. 72–75.

Belov, V.B. (2019): *Белов В.Б.* Новые водородные стратегии ФРГ И ЕС: перспективы кооперации с Россией // Современная Европа. № 5. С. 65–76.

Berezkin, M.Yu. and O.A. Sinyugin (2019): *Берёзкин М.Ю., Синюгин О.А.* Перспективы низкоуглеродного развития энергетики России // Окружающая среда и энерговедение. № 2, С. 4–13.

Bushukina, V.I. (2021): *Бушукина В.И.,* Особенности развития возобновляемой энергетики в мире и в России // Финансовый журнал. № 5, С. 93–107.

Buttel, F. (2000), Ecological modernization as social theory, *Geoforum*, 31, pp. 57–65.

Charap, S. and G. Safonov (2010): Climate change and role of energy efficiency, in Åslund, A. et al. (eds.), *Russia after the Global Economic Crisis*, Peterson Institute for International Economics, pp. 125–150.

[36] See Tokunaga (2010) for the implications of *closed* and *forced* pathways to ecological modernization in both countries.

[37] Svetlana Alexievich, the Nobel Prize-winning writer born in Ukraine and raised in Belarus, said of President Putin in an interview following Russia's military campaign: "This is a man who could not go into the future. And he is trying to pull all of us into the past—it is the only thing he understands" (Machida and Yamashita, 2022).

Chubais, A.B. (2018): *Чубайс А.Б.* Реформа российской электроэнергетики: десять лет спустя // Вопросы экономики. № 8, С. 39–56.

Crowley-Vigneau, A., Y. Kalyuzhnova and N. Ketenci (2023): What motivates the ‘green’ transition: Russian and European perspectives, *Resources Policy*, 81, pp. 1–10.

Economist (2023): War and subsidies have turbocharged the green transition, February 13, 2023, [https://www.economist.com/finance-and-economics/2023/02/13/war-and-subsidies-have-turbocharged-the-green-transition] (accessed February 18, 2023)

EnergyLand.info (2024): В 2023 году Якутия увеличила выработку электроэнергии на 10,8%, 13 февраля 2024 [https://energyland.info/news-show--electro-253301] (accessed May 2, 2024)

Federation of Electric Power Companies of Japan (2018): 電気事業連合会「ロシアの電気事業」2018 年 9 月 30 日 [https://www.fepc.or.jp/library/kaigai/kaigai_jigyo/russia/index.html] (accessed March 20, 2024)

Federal State Statistics Service (2017): *Федеральная служба государственной статистики.* Российский статистический ежегодник. М.

Federal State Statistics Service (2018): *Федеральная служба государственной статистики.* Российский статистический ежегодник. М.

Federal State Statistics Service (2022): *Федеральная служба государственной статистики.* Российский статистический ежегодник. М.

Federal State Statistics Service (2023): *Федеральная служба государственной статистики.* Российский статистический ежегодник. М.

Federal State Statistics Service (2024): *Федеральная служба государственной статистики.* Динамика промышленного производства в 2023 году. [https://rosstat.gov.ru/folder/313/document/231621] (accessed March 12, 2024)

Fukakusa, A. (2024): 深草亜悠美（2024）「COP28　化石燃料からの脱却に『合意』できたのか？」『世界』2024 年 2 月号，pp. 92–96.

Fujiwara, A. and Y. Yamamoto (2020): 藤原惇嗣・山本佳宏「オーロラと風車（寒冷地における風車建設工事）」『日本風力エネルギー学会誌』Vol. 44, No. 3, pp. 451–454.

Geroeva, A. (2022): *Героева А.* ВИЭ в России: медленный рост. Ведомости. 29 апреля 2022. [https://www.vedomosti.ru/business/articles/2022/04/05/916805-minenergo-zelenoi-generatsii] (accessed November 17, 2023)

Golub, A., O. Lugovoy and V. Potashnikov (2020): Quantifying barriers to decarbonization of the Russian economy: real options analysis of investment risks

in low-carbon technologies, *Climate Policy*, 19, pp. 716–724.
Government of Russian Federation (2009): *Правительство Российской Федерации.* Распоряжение от 8 января 2009 г. № 1-р. «Об основных направлениях государственной политики в сфере повышения энергетической эффективности электроэнергетики на основе использования возобновляемых источников энергии»
Government of Russian Federation (2013): *Правительство Российской Федерации.* Постановление от 28 мая 2013 г. № 449. «О механизме стимулирования использования возобновляемых источников энергии на оптовом рынке электрической энергии и мощности»
Government of Russian Federation (2022): *Правительство Российской Федерации.* Правительство создаёт дополнительные стимулы для развития ВИЭ-генерации на территории России. Новость от 24 марта 2022 г. [http://government.ru/news/44924/] (accessed March 20, 2024)
GTRK "Sakha" (2024): *ГТРК «Саха».* Гибридные энергокомплексы в Якутии сэкономили 1802 тонн топлива за 2023 год. 22 марта 2024. [https://gtrksakha.ru/news/2024/03/22/gibridnye-energokompleksy-v-yakutii-sekonomili-1802-tonn-topliva-za-2023-god/] (accessed March 22, 2024)
Harada, D. (2020): 原田大輔「ロシア・欧州：石油ガス収入上のドル箱・欧州が進める脱炭素化（水素戦略及び国境炭素税導入）の動きとロシアの対応（発表された 2035 年までの長期エネルギー戦略を中心に）」石油・天然ガス資源情報（JOGMEC），2020 年 9 月 2 日，pp. 1–21.
Harada, D. (2023): 『エネルギー危機の深層：ロシア・ウクライナ戦争と石油ガス資源の未来』ちくま新書
Hasumi, Y. (2023): 蓮見雄「欧州グリーンディールの射程」蓮見雄・高屋定美〔編著〕『欧州グリーンディールと EU 経済の復興』文眞堂，pp. 1–55.
Heininen, L. (2022): Climate change and the great power rivalry in the Arctic, *Insight Turkey*, 24, pp. 25–38.
Henry, L. and L. Sundstrom (2012): Russia’s climate policy: international bargaining and domestic modernization, *Europe-Asia Studies*, 64, pp. 1297–1322.
Hilde, P., F. Ohnishi and M. Petersson (2024): Cold winds in the north: three perspectives on the impact of Russia’s war in Ukraine on security and international relations in the Arctic, *Polar Science*, 41, pp. 1–8.
Hokkaido Shimbun Press (2021): 北海道新聞社〔編〕『消えた「四島返還」：安倍政権　日ロ交渉 2800 日を追う』北海道新聞社
IEA (2023a): Russia’s war on Ukraine [https://www.iea.org/topics/russias-war-on-

ukraine] (accessed September 17, 2023)
IEA (2023b): Low-emission fuels [https://www.iea.org/energy-system/low-emission-fuels] (accessed March 12, 2024)
IEA (2023c): The oil and gas industry in net zero transitions [https://www.iea.org/reports/the-oil-and-gas-industry-in-net-zero-transitions/executive-summary] (accessed April 30, 2024)
IEA (2024a) Renewables 2023: Analysis and Forecast to 2028 [https://www.iea.org/reports/renewables-2023] (accessed February 17, 2025)
IEA (2024b): World Energy Investment 2024 [https://www.iea.org/reports/world-energy-investment-2024] (accessed January 14, 2025)
IEA (2024c): Renewable energy progress tracker [https://www.iea.org/data-and-statistics/data-tools/renewable-energy-progress-tracker] (accessed April 14, 2025)
IFC (2011): *Renewable Energy Policy in Russia: Waking the Green Giant*, Washington, DC: International Finance Corporation.
Ignat'eva, I.A. (2023): *Игнатьева И.А.* Возобновляемая энергетика в российской эколого-правовой парадигме. М.: Проспект.
IRENA (2017): REmap 2030: Renewable Energy Prospects for the Russian Federation, Working paper, April 2017, [https://www.irena.org/Publications/2017/Apr/Renewable-Energy-Prospects-for-the-Russian-Federation-REmap-working-paper] (accessed March 6, 2024)
JETRO (2018): 「日本から供給の風力発電機器がヤクーツクに到着」JETRO ビジネス短信，2018 年 7 月 27 日，[https://www.jetro.go.jp/biznews/2018/07/763ad066544d0496.html] (accessed April 12, 2024)
Joskow, P. (2022): From hierarchies to markets and partially back again in electricity: responding to decarbonization and security of supply goals, *Journal of Institutional Economics*, 18, pp. 313–329.
Katayama, H. (2010): 片山博文「ロシアの気候ドクトリンと気候変動戦略」『ロシア NIS 調査月報』2010 年 4 月号，pp. 1–13.
Katayama, H. (2012): 片山博文「ロシアにおける再生可能エネルギーの現状と課題：太陽光発電産業を中心に」『ロシア・ユーラシアの経済と社会』2012 年 10 月号，pp. 2–18.
Keppler, J., S. Quemin and M. Saguan (2022): Why the sustainable provision of low-carbon electricity needs hybrid markets, *Energy Policy*, 171, pp. 1–12.
Komaihaltec and Nomura Research Institute (2020): 駒井ハルテック・野村総合研究所『ロシア連邦・サハ共和国レナ川橋梁を中心とした周辺再開発に向けた事

業実施可能性調査』報告書［公表版］，2020 年 2 月
Komaihaltec et al. (2022): 駒井ハルテック・三井物産・野村総合研究所（2022）『ロシア連邦・北極海航路沿岸における LNG・風力活用計画等策定及び事業実施可能性調査事業 報告書』2022 年 3 月
Krasnopolski B.Kh. (2022): *Краснопольский Б.Х.* Международное сотрудничество в Арктике: новые вызовы, угрозы и риски // Пространственная экономика. Т. 18. № 2, С. 183–191.
Kudelin, A. and V. Kutcherov (2021): Wind energy in Russia: the current state and development trends, *Energy Strategy Reviews*, 34, pp. 1–19.
Kudryavtseva E. (2015): *Кудрявцева Е.* Небывалый мегаватт. Коммерсантъ. 6 июля 2015. [https://www.kommersant.ru/doc/2747880] (accessed March 20, 2024)
Laitner, J., O. Lugovoy and V. Potashnikov (2020): Cost and benefits of deep decarbonization in Russia // Экономическая политика. Т. 15. № 2. С. 86–105.
Lombardi, P., T. Sokolnikova, K. Suslov, N. Voropai and Z. Styczynski (2016): Isolated power system in Russia: a chance for renewable energies? *Renewable Energy*, 90, pp. 532–541.
Machida, K, and T. Yamashita (2022): Нобелевский лауреат Светлана Алексиевич: «Если мы не объединимся, нас уничтожат» 21 апреля 2022. [https://www3.nhk.or.jp/nhkworld/ru/news/backstories/1973/] (accessed July 6, 2022)
Matsuo, G. (2023): 松尾豪「欧州のエネルギー構造とロシアの天然ガス」『ロシア NIS 調査月報』2023 年 7 月号，pp. 78–91.
McWilliams, B., G. Sgaravatti, S. Tagliapietra and G. Zachmann (2023): The EU can manage without Russian liquified natural gas, *Policy Brief*, 16/23 (Bruegel), pp. 1–12. [https://www.bruegel.org/policy-brief/eu-can-manage-without-russian-liquified-natural-gas] (accessed August 8, 2023)
Minami, C. (2023): 南智惠子「マーケティング視点の X」『書斎の窓』第 688 号，pp. 2–3.
Ministry of Foreign Affairs of Japan (2018): Diplomatic Bluebook 2018 [https://www.mofa.go.jp/policy/other/bluebook/2018/html/chapter2/c020500.html] (accessed February 7, 2025)
Ministry of Foreign Affairs of Japan (2024): Leaders’ session of the Japan-Ukraine Conference for Promotion of Economic Growth and Reconstruction (Overview), February 19, 2024 [https://www.mofa.go.jp/erp/c_see/ua/pageite_000001_00176.html] (accessed March 29, 2024)

Mol, A. (2009): Environmental deinstitutionalization in Russia, *Journal of Environmental Policy and Planning*, 11, pp. 223–241.

Morotomi, T. and M. Asaoka (2010): 諸富徹・浅岡美恵『低炭素経済への道』岩波書店

Motomura, M. (2010): 本村真澄「ロシアの 2030 年までのエネルギー戦略：その実現可能性と不確実性」『ロシア NIS 調査月報』2010 年 4 月号，pp. 14–28.

Muto, R. et al. (2020): 武藤嶺奈・五十嵐若菜・山崎雅文・岩井憲一・藤原惇嗣・細見雅生・木村茂雄「極東ロシアにおける風力発電の寒冷地問題：実際と対策」第 36 回寒地技術シンポジウム，2020 年 11 月 25 日・26 日，pp. 39–44.

NEDO (2018): New Energy and Industrial Technology Development Organization, Three cold-resistant wind turbine generators start operations for Russian Far East energy infrastructure demonstration project, November 8, 2018 [https://www.nedo.go.jp/english/news/AA5en_100397.html] (accessed March 25, 2024)

NEDO (2022): 新エネルギー・産業技術総合開発機構「風力発電システムを含むエネルギーインフラ実証事業（ロシア連邦サハ共和国）」（事後評価）（2017 年度～2021 年度 5 年間）事業概要説明資料【公開】, [https://www.nedo.go.jp/content/100949490.pdf] (accessed June 29, 2023)

Nikiforov, I. (2016): *Никифоров И.* Перспективы развития электроэнергетики и ВИЭ в Республике Саха (Якутия). Развитие возобновляемой энергетики на дальнем востоке России. V Международная конференция, 22–24 июня 2017 года, Якутск. [https://eastrenewable.ru/media/presentations/2016/] (accessed March 20, 2024)

Omatsu, R. (2017): 尾松亮「ロシア連邦における再生可能エネルギー支援制度と極東における開発可能性」『ERINA REPORT PLUS』第 137 号，pp. 19–25.

Omatsu, R (2017): 尾松亮「ロシアの太陽光・風力発電産業：国営企業，外資，地域政府の協力」『ロシア NIS 調査月報』2018 年 11 月号，pp. 70–79.

Øverland I. and H. Kjærnet (2009): *Russian Renewable Energy: The Potential for International Cooperation*, Farnham: Ashgate.

Republic of Sakha (Yakutia) (2014): *Республика Саха (Якутия).* Закон Республики Саха (Якутия) от 27 ноября 2014 года N 1380-З N 313-V «О возобновляемых источниках энергии Республики Саха (Якутия)»

Republic of Sakha (Yakutia) (2019): *Республика Саха (Якутия).* Схема и программа развития электроэнергетики Республики Саха (Якутия) на 2019–2023 годы.

RIA Novosti (2023): *РИА Новости.* Развитие возобновляемой энергетики позволит реализовать проекты в Якутии. 11 сентября 2023.

[https://ria.ru/20230911/yakutiya-1895618084.html] (accessed March 22, 2024)

Romanova, T. (2021): Russia's political discourse on the EU's energy transition (2014–2019) and its effect on EU-Russia energy relations, *Energy Policy*, 154, pp. 1–11.

Russia Renewable Energy Development Association (2025): *Ассоциация развития возобновляемой энергетики.* Статистика ВИЭ. 1 Марта 2025. [https://rreda.ru/industry/statistics/] (accessed April 15, 2025)

Russian Federation (2023): *Российская Федерация*. Федеральный закон от 04.08.2023 № 489-ФЗ «О внесении изменений в Федеральный закон "Об электроэнергетике».

Safonov, G., V. Potashnikov, O. Lugovoy, M. Safonov, A. Dorina and A. Bolotov (2020): The low carbon development options for Russia, *Climate Change*, 162, pp. 1929–1945.

Sakaguchi, I. (2024): 坂口泉「2023 年のロシア電力分野の回顧：クロス補助と対ロ制裁がもたらすリスク」『ロシア NIS 調査月報』2024 年 4 月号，pp. 26–47.

Seregina, A.A. (2023): *Серегина А.А.* Перспективы зеленной энергетики для России // Геоэкономика энергетики. № 1 (21). С. 108–122.

Silnitsky, A. and T. Uemura (2021): シルニツキー，アレクサンダー・植村哲士「ロシアにおけるカーボンニュートラルの取り組みと日本との連携可能性」『知的資産創造』2021 年 7 月号，pp. 42–57.

Skryzhevska, Y., V. Tynkkynen and S. Leppänen (2015): Russia's climate policies and local reality, *Polar Geography*, 38, pp. 146–170.

Strielkowski, W., A. Sherstobitova, P. Rovny, T. Evteeva (2021): Increasing energy efficiency and modernization of energy systems in Russia: a review, *Energies*, pp. 1–19.

Suutarinen, T. (2015): Local natural resource curse and sustainable socio-economic development in a Russian mining community of Kovdor, *Fennia*, 193, pp. 99–116.

Takeuchi, S. (2023a): 竹内純子「長期電源計画，国関与強化を　電力システム改革の課題」（経済教室）『日本経済新聞』2023 年 5 月 26 日（朝刊）

Takeuchi, S. (2023b): 竹内純子「電力自由化の再設計に向けた提言：各国研究者が提唱する『ハイブリッド市場』を踏まえて考える」『環境管理』2023 年 7 月号，pp. 40–44.

Toichi, T. (2023): 十市勉『再生可能エネルギーの地政学』エネルギーフォーラム

Tokunaga, M. (2010): Environmental governance in Russia: the 'closed' pathway to ecological modernization, *Environment and Planning A*, 42, pp. 1686–1704.

Tokunaga, M. (2013): 徳永昌弘『20 世紀ロシアの開発と環境：「バイカル問題」の政治経済学的分析』北海道大学出版会

Tokunaga, M. (2018): Russian Arctic development and environmental discourse, in Tynkkynen, V-P. et al. (eds.), *Russia's Far North: The Contested Energy Frontier*, Routledge, pp. 129–146.

Tokunaga, M. (2023a): 徳永昌弘「脱ロシアは脱炭素か？」『ボストーク』（ロシア極東研）第 55 号，pp. 2–5.

Tokunaga, M. (2023b): *Amplifying paradoxes of Arctic energy development: focusing on the Arctic LNG 2 project in turmoil*, The Japan Association for Russian and East European Studies, Kyoto University, November 2023.

Toyoda, L. and M. Hosomi (2012): 豊田玲子・細見雅生「ロシア国内独立系統地域における風力発電を利用したマイクログリッドシステムの導入可能性調査」『駒井ハルテック技報』Vol. 2, pp. 64–67.

Tsuchida, Y. (2022): 土田陽介「EU の EV シフト支援策」池本修一・田中宏〔編著〕『脱炭素・脱ロシア時代の EV 戦略』文眞堂，pp. 36–55.

Tynkkynen, V-P. (2020): Could Russia embrace an energy transition? *Current History*, 119, pp. 270–274.

Tynkkynen, V-P. (2021): *Тынккынен В-П.* Россия и Арктическая среда - потоки углеводородного сырья // Человек и природа в Сибири - Экологические знания и устойчивые природные отношения во времена изменения климата. Составитель и редактор: Э. Кастен, Fürstenberg/Havel: Kulturstiftung Sibirien, C. 308–324.

UNFCCC (2023): COP28 agreement signals "beginning of the end" of the fossil fuel era [https://unfccc.int/news/cop28-agreement-signals-beginning-of-the-end-of-the-fossil-fuel-era] (accessed April 30, 2024)

Urinson, J.M., I.S. Kozhukhovski and I.S. Sorokin (2019): *Уринсон Я.М., Кожуховский И.С., Сорокин И.С.* Реформирование российской электроэнергетики: результаты и нерешенные вопросы // Экономический журнал ВШЭ. № 24, C. 323–339.

Wilson Row, E. (2012): International science, domestic politics: Russian reception of international climate-change assessments, *Environment and Planning D: Society and Space*, 30, pp. 711–726.

Yamamoto, Y. and K. Iwai (2017): 山本佳宏・岩井憲一「カムチャツカ風車工事」『駒井ハルテック技報』Vol. 7, pp. 93–96.

Yamawaki, D. (2020): 山脇大「ロシアにおける気候変動政策のステークホルダー分析」『ロシア・東欧研究』第 49 号，pp. 126–143.

Yamawaki, D. (2022): 山脇大「石油・ガス大国ロシアの再生可能エネルギーへの移行：現状と課題」『ロシア・ユーラシアの社会』2022 年 1-2 月号，pp. 30–

43.
Yamawaki, D. (2024): 山脇大「環境投資と情報開示：ロシアにおける現状と課題の考察」『ロシア・東欧研究』第 52 号（2023 年版）, pp. 1–18.
Yanitsky, O. (2001): *Russian Greens in a Risk Society: A Structural Analysis*, Kikimora Publications: Helsinki.
Volobuev, A. (2022): *Волобуев А.* Минэнерго хочет отложить конкурсы на строительство зеленой генерации на 2024 год. Ведомости. 06 апреля 2022. [https://www.vedomosti.ru/business/articles/2022/04/05/916805-minenergo-zelenoi-generatsii] (accessed March 7, 2024)
Voropai, N., K. Suslov, T. Sokolnikova, Z. Styczynski and P. Lombardi (2012): Development of power supply to isolated territories in Russia on the bases of microgrid concept, 2012 IEEE Power and Energy Society General Meeting, pp. 1–5.
Yakutia daily (2024): *Якутия daily.* Возобновляемые источники в Якутии наращивают выработку энергии. 10 января 2024. [https://yakutia-daily.ru/vozobnovlyaemye-istochniki-v-yakutii-narashhivayut-vyrabotku-energii/] (accessed March 22, 2024)
YASIA (2023): ЯСИА. Солнце, ветер и атом: опыт развития альтернативной энергетики в Якутии. Якутское-Саха Информационное Агентство (ЯСИА). 24 мая 2023. [https://ysia.ru/solntse-veter-i-atom-opyt-razvitiya-alternativnoj-energetiki-v-yakutii/] (accessed March 22, 2024)

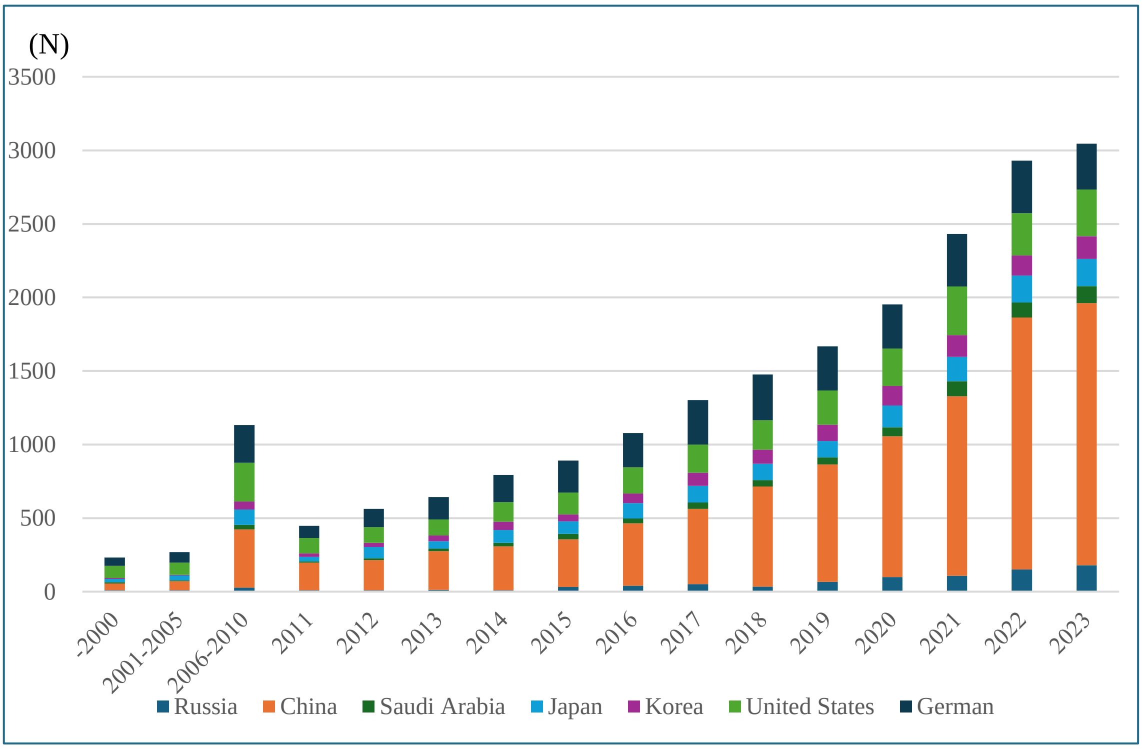
Table 1 Number of research publications on decarbonization and renewable energy in Russia

Year	Decarbonization	Renewable energy
2000 or earlier	0	10
2001–2005	1	10
2006–2010	1	28
2011	0	9
2012	1	10
2013	1	12
2014	1	11
2015	1	31
2016	5	40
2017	0	51
2018	2	34
2019	6	67
2020	5	99
2021	19	109
2022	49	151
2023	39	179

Note: The table shows the cross-search results of the country name “Russia” and “decarbonization” or “renewable energy” in the field of paper topics as of March 11, 2024.

Source: Compiled by the authors based on the Web of Science.

Figure 1 Number of research publications on renewable energy in major countries



Note: The figure shows the cross-search results of the country name ("Russia" and others) and "renewable energy" in the field of paper topics as of March 7, 2024.

Source: Compiled by the authors based on the Web of Science

Table 2 Trends in electric generation capacity (million kW) and electricity production (billion kW/h) in Russia in 2010–2023

	2010	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023
Generation capacity (total)	230.0	256.0	257.1	266.5	272.4	265.6	269.8	270.2	269.8	269.7	270.5
Power	158.1	179.4	179.1	187.6	190.6	184.3	186.1	185.6	184.2	183.7	
Hydro	47.4	50.8	51.0	51.0	53.2	51.3	51.8	52.3	52.4	52.5	266.3
Nuclear	24.3	25.3	26.3	27.2	27.9	29.1	30.3	29.4	29.6	29.6	
Renewables	**0.1**	**0.4**	**0.6**	**0.7**	**0.7**	**0.9**	**1.6**	**2.9**	**3.5**	**3.9**	**4.2**
Electricity production (total)	1038	1064	1068	1091	1094	1115	1121	1090	1159	1170	1178
Power	699	707	701	706	703	716	714	656	715	738	750
Hydro	168	175	170	187	187	193	196	214	216	199	203
Nuclear	171	181	196	197	203	205	209	216	222	224	217
Renewables	**0.5**	**0.7**	**0.9**	**1.1**	**1.1**	**1.4**	**2.1**	**3.7**	**6.0**	**8.6**	**7.8**

Note: In the 2017 edition of the statistics collection, the category for renewable energy generation is referred to as "alternative energy," while in editions from 2018 onward, it is referred to as "used renewable energy sources."

Sources: Federal State Statistics Service (2017, p. 355; 2018, pp. 361–362; 2022, pp. 395–396; 2023, pp. 397–398; 2024) and Global Energy (2024)

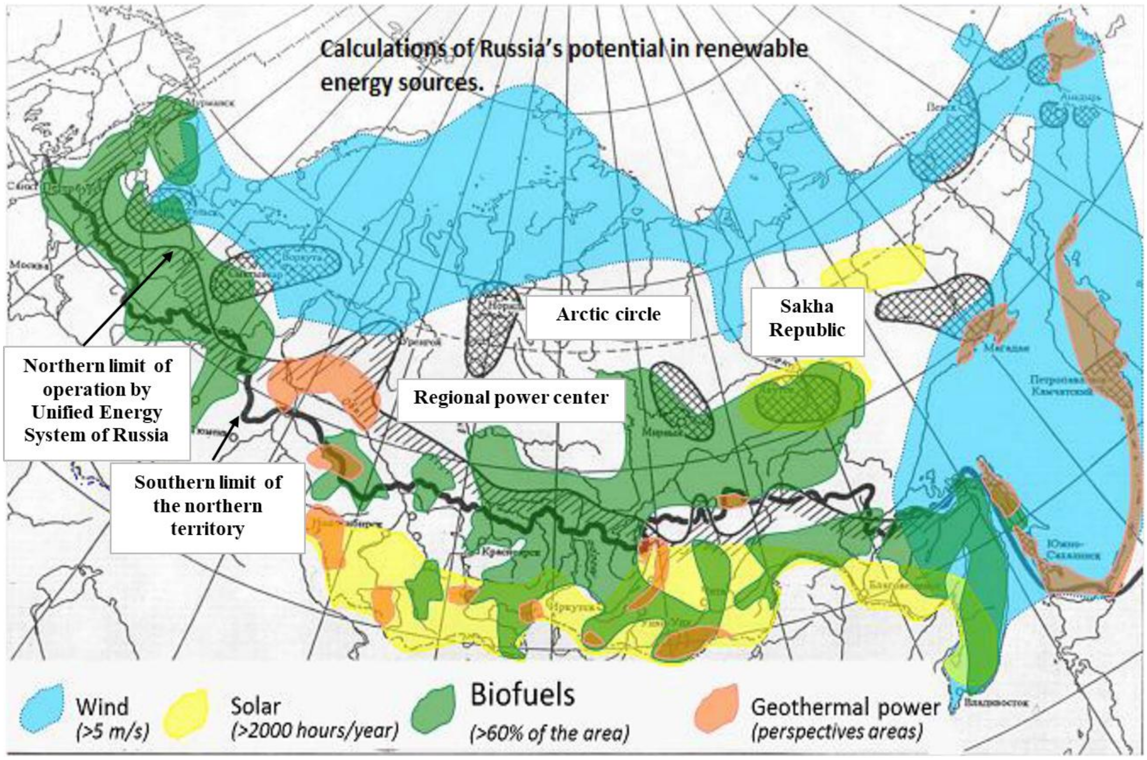
Table 3 Summary of “Renewable Energy Progress Tracker” (IEA assessment)

	Russia	China	Saudi Arabia	Japan	Korea	United States	Germany	World
Share of renewable energy in power generation, 2023 (performance)	**18%**	31%	1%	24%	8%	22%	52%	30%
Share of VRE in power generation, 2023 (performance)	**1%**	15%	1%	11%	6%	15%	39%	13%
VRE phase, 2023 (performance)	**Phase 1**	Phase 2 (as of 2022)	Phase 1	Phase 3	Phase 1	Phase 2	Phase 4	—
Share of renewable energy in power generation, 2030 (prediction)	**20%**	52%	14%	36%	16%	37%	83%	46%
Share of VRE in power generation, 2030 (prediction)	**1%**	39%	14%	22%	12%	30%	70%	30%
Forecast revision from the previous assessment	**7% down**	24% up	20% up	30% up	76% up	6% up	4% down	17% up

Note: VRE denotes variable renewable energy. See the text for details.

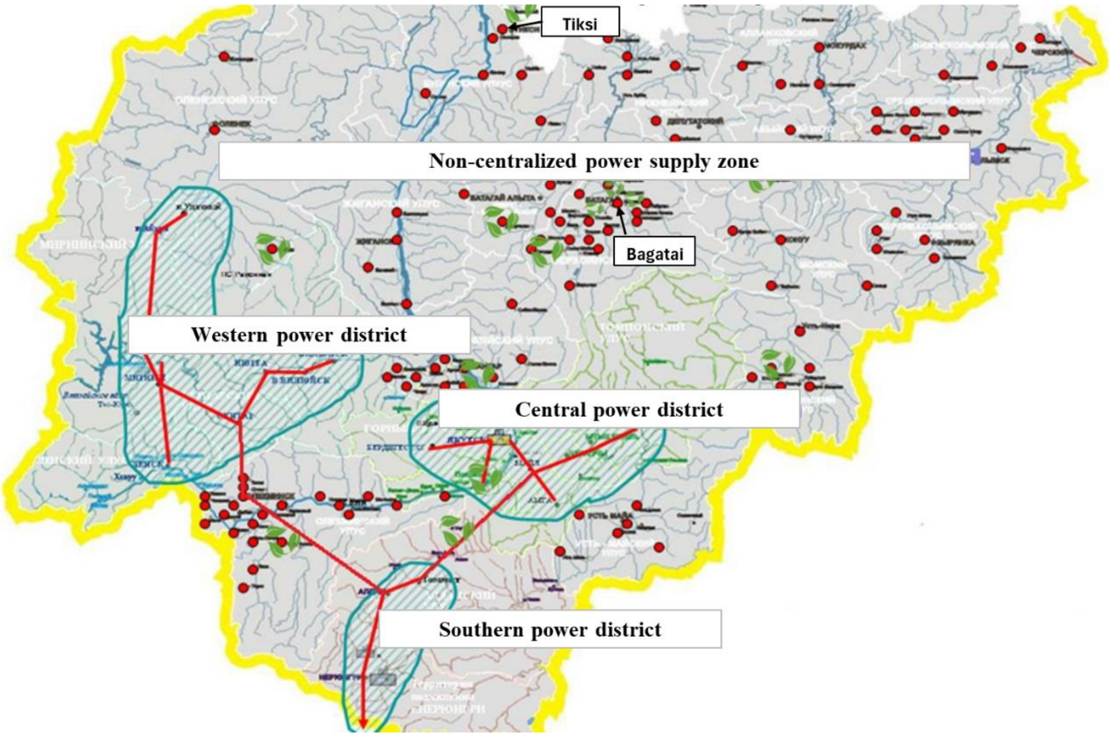
Source: IEA (2024c)

Figure 2 An overview of renewable energy potential in Russia



Note: The map is partially based on Voropai et al. (2012).
Source: Lombardi et al. (2016)

Figure 3 Electricity production and supply networks in the Republic of Sakha (Yakutia)



Note: Some legends are translated into English.
Source: Nikiforov (2016)

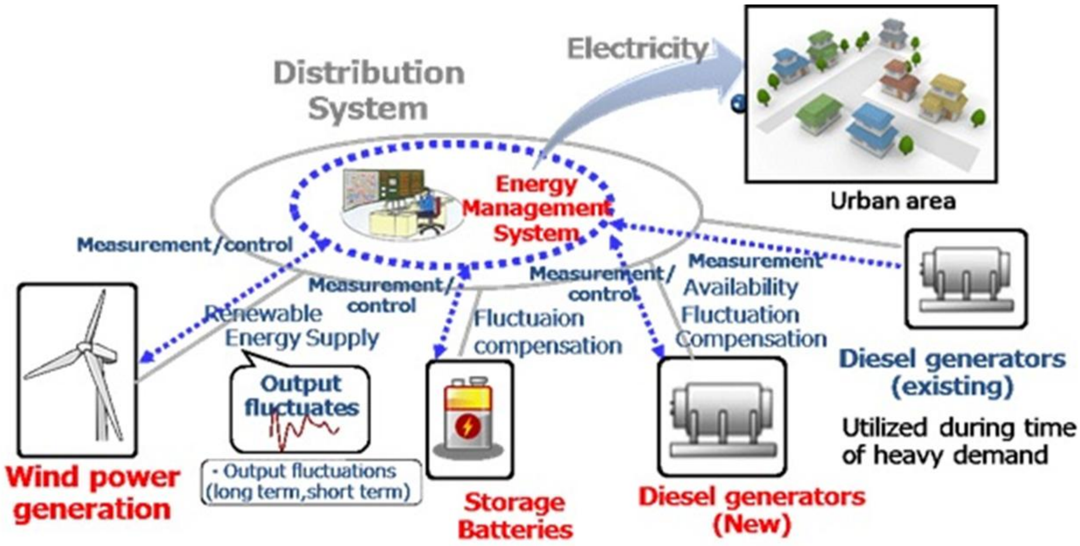
Table 4 Trends in renewable energy electric generation in the Republic of Sakha (Yakutia) in 2014–2023

<table>
<tr><th></th><th>2014</th><th>2015</th><th>2016</th><th>2017</th><th>2018</th><th>2019</th><th>2020</th><th>2021</th><th>2022</th><th>2023</th></tr>
<tr><td>Generation capacity (MW)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Solar power</td><td>0.15</td><td>1.29</td><td>1.43</td><td>1.63</td><td>1.63</td><td>1.63</td><td>1.67</td><td>2.02</td><td>4.98</td><td>4.98</td></tr>
<tr><td>Wind power</td><td>—</td><td>—</td><td>—</td><td>0.04</td><td>0.04</td><td>0.94</td><td>0.94</td><td>0.94</td><td>0.94</td><td>0.94</td></tr>
<tr><td>Capacity introduction (MW)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Solar power</td><td>0.11</td><td>1.14</td><td>0.14</td><td>0.20</td><td>—</td><td>—</td><td>0.04</td><td>0.35</td><td>2.96</td><td>—</td></tr>
<tr><td>Wind power</td><td>—</td><td>—</td><td>—</td><td>0.04</td><td>—</td><td>0.90</td><td>—</td><td>—</td><td>—</td><td>—</td></tr>
<tr><td>Electricity production (million kW/h)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Solar power</td><td>0.04</td><td>0.14</td><td>1.18</td><td>1.31</td><td>1.49</td><td>1.49</td><td>1.51</td><td>1.53</td><td>2.50</td><td>4.54</td></tr>
<tr><td>Wind power</td><td>—</td><td>—</td><td>—</td><td>0.08</td><td>0.11</td><td>0.11</td><td>2.62</td><td>2.62</td><td>2.62</td><td>2.62</td></tr>
<tr><td>(For reference)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Generation capacity (MW)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Thermal power</td><td>n/a</td><td>1960.4</td><td>2139.4</td><td>2139.4</td><td>2165.2</td><td>1848.0</td><td>1839.2</td><td>1875.3</td><td>n/a</td><td>n/a</td></tr>
<tr><td>Hydro power</td><td>n/a</td><td>957.5</td><td>957.5</td><td>957.5</td><td>957.5</td><td>957.5</td><td>957.5</td><td>957.5</td><td>n/a</td><td>n/a</td></tr>
<tr><td>Electricity production (million kW/h)</td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>Thermal power</td><td>5712</td><td>6016</td><td>6285</td><td>6223.6</td><td>6274.4</td><td>6667.6</td><td>7148.2</td><td>7347.8</td><td rowspan="2">10252.1</td><td rowspan="2">11821.5</td></tr>
<tr><td>Hydro power</td><td>2866.2</td><td>2989.8</td><td>3041.1</td><td>3001.1</td><td>3451.5</td><td>3438.6</td><td>2956.2</td><td>2858.9</td></tr>
</table>

Note: Renewable energy electric generation is conducted entirely within a non-centralized power supply zone. Since there are no small-scale hydropower plants with a capacity of less than 25 MW in the Sakha Republic, it is solar and wind power sources that are classified as renewable energy sources under the common definition of Russian legislation (see note 11 in the text). As of 2024, there is no operational nuclear power generation in the Sakha Republic (under contemplation).

Sources: The records of solar and wind power generation are based on the Russia Renewable Energy Development Association (2025). The records of thermal- and hydro-power generation are referenced from government documents of the Republic of Sakha (Yakutia) (2019, pp. 45, 50; 2020, pp. 45, 69; 2022, pp. 63, 85) and media reports (YASIA, 2024).

Figure 4 “Polar Microgrid System” in Tiksi, the Republic of Sakha (Yakutia)



Source: NEDO (2018)