Renewable energy and prospects for decarbonising the Asian Russia

Valeriy Kryukov, *Natalya* Gorbacheva*, and *Nikita* Suslov

Institute of Economics and Industrial Engineering SB RAS, 630090, 17 Ac. Lavrentiev Av., Novosibirsk, Russia

Abstract. Decarbonisation of energy system has many reasons and climate change remains the key factor for transition from conventional to renewable sources of energy. The Asian part of Russia is closely connected with the Arctic and global agenda on climate change makes it urgent to seek the balance between abundant conventional sources of energy in Siberia and renewables, which have obtained a great technical potential. According to our study, establishing voluntary carbon markets and green certificates in Russia stimulate for penetration of renewables in Siberia.

1 Introduction

Climate change and degradation of environment become global challenges due to anthropogenic emission of greenhouse gases (GHG) as two thirds of them are produced by burning hydrocarbons (coal, natural gas, oil). Some of manifestations of these phenomena are whipped up by extreme weather events, which in their turn provoke frequent blackouts of energy system, vast crops and livestock losses, spreading diseases and internal and external migration of millions of people in search for better life conditions. In 2022, for the first time in history, quantity of forcibly displaced people overcame 100 mln people, when 23.7 mln people had to leave their habitual surroundings because of weather-related events. According to International Organization for Migration up to 1.5 billion people will be forced to leave their homes because of weather devastating occurrences in 2050 year and migrate towards northern regions [1]. That is why the solution of these acute problems has been considered to relate to decarbonising energy system, thanks to the transit from conventional to renewable energy.

At the same time the current polycrisis sharpens the issues of energy security, which underlines the importance of access to their own energy resources or to the export from friendshoring or allyshoring countries. Controversies in energy transformation are being increased. If before nowadays the energy transition was looked upon as evolutionary, gradual process, demanding tens of years, where desirable goal was the complete refusal of the most toxic resource of energy, i.e. coal, but natural gas and nuclear energy were presumed to be “bridge fuel”, and share of renewables was to be increased step by step, taking into account learning curves and economies of scale [2]. However actually energy transition appeared to be bearing contradictory character, while coal generation is still prevailing, and natural gas

* Corresponding author: nata_lis@mail.ru

is inclined to be rather rare and expensive for performing a major part, and pace of renewables penetration is not shift, as desired. Though by IEA estimations, total installed capacity of renewables globally will grow up by 2440 GW within 2022-2027 years, i.e. it will grow by 85% quicker, than in previous five years, and by 30% quicker, than IEA forecasted a year earlier. Despite the fact, that annual global investment in energy sector decreased during 2017-2021 years averagely by 1.3%, investment in electricity sector is increased by 1.6% annually and in post-COVID period this investment, for the first time in history, overcame global investment in hydrocarbon extraction: 530 bln dollars versus 457 in 2021 year.

Decarbonisation of global energy system and total electrification of world economy come to be the main priority of the most advanced countries. So, the USA are planning to invest 374 bln dollars to low-emission energy projects up to 2030 [3]. The EU, according to RePowerEU [4], intends to spend 210 bln euro for speeding up the electrification of economy and increasing the share of renewables in energy balance about 45% up to 2030. Besides that the main GHG producer, China, released "The Fourteenth Plan of the modern energy system development" [5], according to this document the share of zero-carbon sources of energy is planned to reach 25% in energy balance till 2030 (it was 15.9% in 2021). So, renewables have to achieve the status of the main player in energy system in future China. These worlwide energy plans are certainly important for Siberia as the main Russian export of hydrocarbons not only to Europe and China, but also to India and other vigorously developing economies of Asia [6].

By reason of properly responding to these energy trends it is necessary to evaluate prospects of renewables in the Asian Russia in the frame of global energy transformation.

2 Significance of Siberia in achieving low-emission strategy of Russia

Climate of Russia, especially in its Asian part, is rather vulnerable to global warming, here temperature growth rate has grown by 0,49 °C for 10 years in comparison with average global rate 0,18°C for 10 years within the period 1976-2021. As a result of this climate change there increases the vulnerability of regions in the Asian part of Russia. So, for the last 20 years territory of wildfires in Siberia has increased by 200 times: from 31.3 thousand ha in 1997 to 8.5 mln ha in 2018. During 2000-2020 years in Russia occurred 115 nature disasters with 58 300 human losses, half of them happened in Siberia.

At the same time, Siberia obtains valuable natural resources, which might be beneficial for the world community. For instance, territories, covered by the forest comprise 44.2% of Siberia and this enormous natural ecosystem serves as the foundation to secure unique biodiversity. These virgin forest areas are included in the top-5 of the most valuable megaforests in the Earth. But the climate horizon for Russia is becoming closer as a result of abnormal heat waves, floods, melting permafrost in Siberia [7]. Now these events seem to be remote and hardly to occur. But reduction of GHG is not only the factor of reaching some economic growth, but also the means for saving the economy itself.

Causes of anthropogenic emission in Russia are similar to those happening in the world: Russian energy sector provides more than half of national emission of GHG, from which two-thirds (724 CO2e mln t) are produced by electricity and heat generation [8].

With the purpose of decarbonizing economy in Russia there has been introduced the system of carbon regulation, in the frame of adopted in 2021 year, the Strategy of socio-economic development of the Russian Federation with low greenhouse gas emission until 2050 [9]. According to this concept there has been planned to increase absorbing GHG from 535 to 1200 CO2e mln tons up to 2050, with the purpose achieve carbon neutrality up to 2060. There has also been established the systems of compliance and voluntary carbon markets at the level of production value chains (carbon footprint), enterprises (scope 1,2,3)

and regions (governing regional carbon budget). Russian companies, which emit above 150 thousand CO2e tons, submit annually carbon accounting report up to July, 1 2023 year, and in 2024 it will be compulsory to do the same for enterprises with emission more than 50 thousand CO2e tons. In case of submitting incomplete and not trustworthy GHG data there will be put into action the system of fines and administrative sanctions.

At regional level there has been launched the experiment for carbon pricing regulation – Sakhalin experiment of emission trading system (ETS). In 2022 Russian carbon credit registry fixed the first climatic project of "DalEnergoInvest" company, concerning preventing GHG emission as a result of electricity generation based on solar power station on Kuril Islands in the Sakhalin Region. For verification and validation carbon units by the Federal Service for Accreditation (RusAccreditation) there have been registered 13 firms. In September 2022 Moscow exchange trading system (MOEX) held the first trading auction, dealing with the sale of 20 certified carbon units in sum of 20 thousand roubles.

Despite the fact, that Russian electricity sector contains more than 80% of low-carbon energy sources (exp. coal), that still provides high carbon intensity level in the country (395,1 gr CO2e per kWh), in Siberia this level is even 1.5 times higher (530,9 gr CO2e per kWh), owing to coal generation, which is responsible for 38% installed capacity in the Asian part of Russia (fig.1).

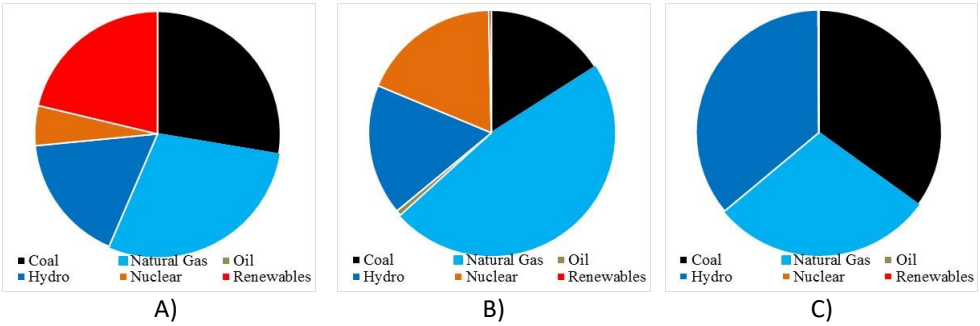

Fig. 1. Installed power generation capacity in the world (a), Russia (b) and Siberia (c) in 2019 (%) Source: Rosstat, 2021 and IAE, 2021.

If to cast a glance at localization of power generation, one sees that coal generation is concentrated in southern regions in Siberia – these regions are depicted by orange color on fig. 2. It's the result of economic development of Siberia in the long run. First, there is thoroughfare of fuel supply – Trans Siberian railway. Second, this territory is inhabited by the greater part of the Siberian population (29 mln people), they need not only electricity, but also heat, hot water and other amenities. Of course, besides electricity and heat, the population of Siberia would prefer pure air and clean water, which could be secured by decarbonising electricity sector.

Decarbonisation of electricity sector in Siberia is conditioned by two factors, i.e. objective reasons, due to increasing regional vulnerability from weather-related events, and subjective factors, such as introducing in 2023, for the first time in history, carbon accounting for Russian companies, emitting more than 150 thousand CO_2e tons annually. High-emission generation increases scope 2 of domestic products, and decreases its competitive advantages not only at the European export markets, where carbon intensity is less than 200 gr per kWh, but also at Asian ones, as, in close to Siberia regions, current GHG emission intensity is 340 gr per kWh in Kazakhstan, 430 gr per kWh in Mongolia, 580 gr per kWh in northern provinces of China. At export Asian markets carbon pricing regulation was implemented in 2021 (China and Kazakhstan) and share of renewables is supposed to be increasing, that will

lead to further growth of emission intensity gap between electricity generation in Siberia and Asian countries.

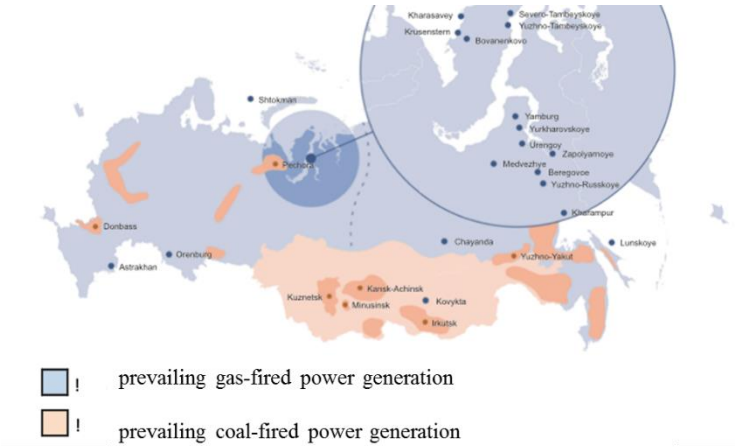

Fig. 2. Prevailing type of electricity generation in Siberia.

3 Renewable energy in Siberia and voluntary carbon markets

Besides conventional energy, Siberia obtains high renewable technical capacity (fig.3), which is realized rather modestly, only by 0.19% of total electricity generation in region.

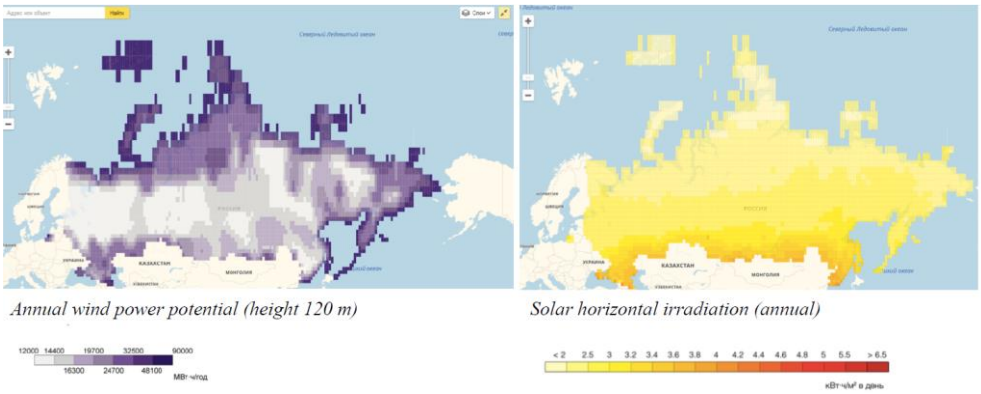

Fig. 3. Renewable energy potential in Siberia.
Source: Popel O., etc. Atlas of renewable energy resources of Russia, 2015

Penetration of renewables in Siberia can enable the growth of voluntary carbon markets, which are, according to the world practice, stimulate carbon credits and offsets trading, based on renewables projects [10]. Nowadays voluntary carbon markets accumulate more than 10% of annual GHG emission. These markets are not regulated by governments, as these markets have been arranged by international organizations, such as REDD+ under IPCC supervision, and nonprofit nongovernmental organizations, such as Gold Standard, Plan Vivo, etc. All of them have developed accounting methodology and standards for estimating climatic projects and programmes, they register issuance and acceptance of verified carbon units. Up to the moment, capacity of voluntary markets is insignificant, but they are dynamic, rapidly developing with double annual growth rates of trading carbon units. As soon as more

companies would implement "net-zero" or "carbon neutrality" corporate strategies, the capacity of voluntary markets, according to VSCI, will grow up to 23% of global annual GHG emission by 2030.

Renewable energy projects, enabling to prevent CO_2e emission, take the second place by issuance volumes at voluntary carbon markets, after forestry projects (fig. 4), however the significance of these carbon credits will be possibly devaluated because of making "net-zero" concept more well-known.

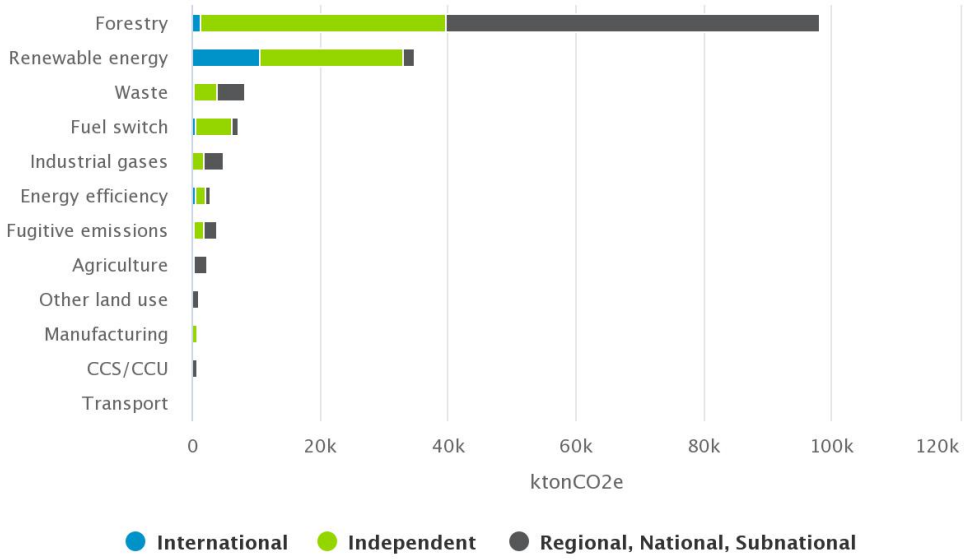

Fig. 4. Issuance volumes of carbon credits by type of mechanism at voluntary carbon markets worldwide, 1990-2022.
Source: Carbon Pricing Dashboard

In the context of establishing the Russian voluntary carbon market, new installations of renewables are projected to raise up 2.5 times in Siberia for the next two years, 2024-2026 (table 1).

Table 1. Renewable power stations in Siberia (installed and projected).

Regions of Siberia	Renewable power stations (over 5 MW)	Total installed capacity (projected), MW
Altai Republic	Kosh-Agach PV No.1**, Ust-Kansky PV**, Ongudaysky PV**, Maima solar power park**, Kosh-Agach PV No.2**, Ininsk PV** , Usk-Koksinsk PV**, Chemal PV**	120
Altai Krai	Slavgorod* wind farm (100), Aleysk* wind farm (10.5), Kulunda* wind farm (50), Rubtsovsk* wind farm (32), Habary* wind farm * (32), Kamen-na-Obi* wind farm (8), Kluchi* wind farm (12.5), Rebriha* wind farm (8), Charysh* SHP(15), Krasnogorodsky* SHP(8), Sibiryachikha* SHP(15)	0 (261,5)
Buryat Republic	Khorinsky PV(15)**, Kabanskaya PV(15)**, Tarbagatay PV (15)**, Kyakhta PV (15)**, Torey PV(45)**, Dzhidinsky* PV (30), Udinsk* no. 1	60 (120)

	PV(15), Udinsk* no. 2 PV(15), Pribaykalsky* PV(15)	
Khakassia Rebublic	Abakan PV**	5,2
Kamchatka Krai	Mutnovskaya geothermal power plant(25+25*), Verhne-Mutnovskaya geothermal power plant(12), Pauzhetskaya geothermal power plant(8), Manily* marine power plant (10), Kavavlaya* small hydropower station (6), Belaya* SHP (5), Kinkil SHP (12), Big Khapitsa* SHP (24), Rossoshina* SHP (12), Tolmachevo* SHP (10)	33 (104)
Omsk Oblast	Novovarshavsk PV (30)**, Russian meadow PV (30)**, Gasprom-Avangard PV*(20)	30 (50)
Irkutsk Oblast	Mamakanskay small hydropower station (86)**	86
Sakhalin Oblast	Kunashir* onshore wind farm (5) Mendeleevskay geothermal power plant (7,4), Kunashir* onshore wind station (5)	12,4 (5)
Zabaykalsky Krai	Kenonskay(Balei) PV (15), Ingodinskay (Orlovskiy GOK) PV (15)**, Chernovskay PV(35)**, Chita PV (35)**	30 (70)

Note: * highly possible to be built up till 2026; ** registered as qualified power generation for providing green certification in Russia

Source: authors' systematization based on The updated General Scheme for the Development of the Electricity Sector in 24 regions in Siberia during 2021-2026 and Renewable energy registry of Association "NP Market Council", 2023

4 Conclusion

According to our research study, prices of green certificates vary from 50 to 80 roubles per 1 MWh in Siberia, that provides additional annual revenue 400-500 thousand roubles per each power station, export-oriented companies can counterbalance their scope 2 emission through buying green certificates with purpose of achieving carbon neutrality corporate targets. In comparison with revenues, gained from oil&gas sector, these cash flows seem to be insignificant, but if to take into account profitability from DPM-agreements (the long-term capacity supply agreement) with 12% annual return on investment (ROI), green certificates appear to be as the trigger for mass penetration of renewables in Siberia.

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