

Decarbonizing Russia: Lessons from global carbon pricing practices[☆]

Marina S. Dolmatova^{a,*}, Tatiana S. Remizova^b

^a *Skolkovo Institute of Science and Technology, Moscow, Russia*

^b *Financial Research Institute of the Ministry of Finance of the Russian Federation, Moscow, Russia*

Abstract

Climate change mitigation increasingly relies on carbon pricing as a core policy tool. This study investigates the applicability of such mechanisms within the Russian context, given the country's heavy fossil fuel dependence and evolving energy landscape. A mixed-method approach is used, combining case studies (EU ETS, Nordic carbon taxes, Sakhalin pilot) with scenario modeling based on macroeconomic data. The findings suggest that although carbon pricing can drive renewable adoption and emissions reduction, Russia's centralized governance, regional inequality, and export dependence pose challenges. Key recommendations include phased implementation of carbon taxes and emissions trading, equitable revenue allocation, and integration with existing tax systems. With current limitations including reliance on secondary data and uncertainty in political feasibility, future research should explore public acceptance and institutional readiness. Overall, carbon pricing offers Russia a structured pathway to decarbonization, aligning with global climate goals if carefully adapted to local conditions.

Keywords: carbon pricing mechanisms, carbon taxes, ETS, decarbonization, Sakhalin experiment.

JEL classification: O44, P18, P28.

1. Introduction

More than 100 countries have committed to net-zero emissions or carbon neutrality to address global warming and extreme weather. The transition to a sustainable, clean-energy future is reflected in international agreements globally (Grubb et al., 2014). Examples include the Paris Agreement, which sets legally binding targets for reducing greenhouse gas emissions for 196 countries, the European Green Deal

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* Corresponding author, E-mail address: ms.marina.dolmatova@gmail.com

aiming at climate neutrality in the EU by 2050, and China's 14th Five-Year Plan incorporating ambitious carbon reduction strategies. Notable differences among these agreements include the binding nature of the Paris Agreement compared to the more policy-oriented EU Green Deal and China's strategic national planning approach, which leverages state-driven initiatives. So, China has pledged to achieve carbon neutrality by 2060. And being currently the world's largest emitter of greenhouse gases, accounting for nearly 30% of global emissions, the country is making notable progress with aggressive investments in renewable energy, including solar and wind power, and the development of carbon capture technologies.

As of 2022, global greenhouse gas emissions reached a record 53.8 billion tons of CO₂ equivalent (Gt CO₂eq), with the energy sector contributing approximately 76% of this total (Crippa et al., 2023; IEA, 2023a). Furthermore, within the energy sector, electricity and heat production accounted for about 40% of global energy-related CO₂ emissions, reaching 30% of total emissions from the fuel and energy complex (IEA, 2023a). Three strategies reduce electricity sector CO₂ emissions:

- *emission accounting*: using electricity data to assess carbon emissions economically;
- *certification*: calculating product carbon footprints and tracking green energy use;
- *market mechanisms*: analyzing market operations and implementing pricing mechanisms to reduce carbon emissions (Aldy and Stavins, 2012; Andersson, 2019).

The motivation for this study stems from the growing urgency of global decarbonization and the need to align Russia's policies with international climate commitments. Despite the widespread adoption of carbon pricing mechanisms worldwide, Russia's approach remains underdeveloped and understudied. There is a significant knowledge gap regarding the feasibility and economic implications of carbon pricing in Russia, particularly in the context of its fossil fuel-dependent economy.

While several international studies have explored the effects of carbon pricing on emissions and innovation (e.g., Aldy and Stavins, 2012; Andersson, 2019), limited research has addressed its feasibility within Russia's hydrocarbon-heavy economy. The country has launched its first pilot project aimed at achieving carbon neutrality in a specific region — Sakhalin. While the project is currently in the implementation phase, comprehensive research on the long-term planning of carbon pricing mechanisms and their potential impact on increasing the share of renewable energy generation remains limited in Russia. Existing Russian literature (Andreyev and Nelyubina, 2024) often focuses on energy efficiency or general environmental policy, without quantitatively assessing carbon pricing tools. This study addresses this research gap by not only examining the introduction of a carbon tax and tailoring international experiences to Russia's specific policy, economic, and institutional context, but also exploring its allocation and projected effects on the structure of electricity generation through 2029.

2. Literature review

The challenges and prospects of carbon pricing and emissions regulation have been extensively explored in both international and Russian academic literature. Scholars such as Aldy and Stavins (2012) and Antweiler and Gulati (2016) offer foundational insights into the theoretical underpinnings and practical applica-

tions of carbon pricing systems. Their work emphasizes the role of market-based mechanisms, including carbon taxes and emissions trading schemes (ETS), in aligning environmental goals with economic incentives.

Bertram et al. (2015) and Ekins and Speck (2011) underscore the importance of complementing carbon pricing with technological and policy innovations to achieve sustainable emissions reductions. Similarly, Haites (2018) and Green (2021) examine the relative effectiveness of existing carbon tax regimes and ETS across different jurisdictions, highlighting lessons learned and structural pitfalls.

Within the Russian context, Bashmakov (2018) discusses the integration of carbon pricing within broader environmental tax systems, while Lissovolik (2021) outlines potential development pathways for emissions trading systems in Russia. These studies provide valuable context for understanding the institutional and fiscal challenges faced by a carbon-intensive economy like Russia's.

Parry et al. (2021a) introduce the concept of a global minimum carbon price, advocating for coordinated international action to avoid competitive imbalances and carbon leakage. From a cooperative standpoint, Cramton et al. (2017) present a framework for international carbon price commitments based on mutual obligations, which is increasingly relevant given the transboundary nature of climate change.

Beyond traditional pricing tools, alternative mechanisms for emissions reduction are also gaining traction. Tarasova (2023) investigates the role of green bonds in financing sustainable development projects, while Zhang et al. (2024) assess the global feasibility of carbon capture and storage (CCS) technologies.

Country-specific experiences further enrich the discourse. Andersson (2019) offers an empirical evaluation of Sweden's carbon tax, one of the highest and most successful globally. The U.S. policy landscape is detailed by Burtraw et al. (2009) and Metcalf (2019), focusing on the incidence and economic efficiency of carbon pricing instruments. Doda (2016) analyzes the U.K.'s carbon price support mechanism, shedding light on the importance of policy stability and price signals.

In the Russian context, national policy documents such as the Strategy for low-carbon development of the Russian Federation until 2050 and Order No. 1095 of November 30, 2023,¹ which outlines Russia's electricity system development plan for 2024–2029, form the legislative basis for decarbonization planning. Notably, the Sakhalin experiment is Russia's first regional carbon neutrality initiative, and its results are increasingly referenced in both academic and policy discussions (Sakhalin Government, 2022; Beuerle, 2024).

Together, these studies provide a comprehensive foundation for evaluating the applicability of carbon pricing mechanisms in Russia, while also informing the broader global debate on decarbonization policy.

3. Research objectives

The primary objective of this study is to evaluate the feasibility and implications of implementing carbon pricing mechanisms in Russia, with a focus on

¹ Ministry of Economic Development of the Russian Federation. Strategy for low-carbon development of the Russian Federation until 2050 (in Russian). <https://economy.gov.ru>; Ministry of Energy of Russia. Order No. 1095 of November 30, 2023: On the approval of the scheme and program for the development of electric power systems of Russia for 2024–2029 (in Russian). https://minenergo.gov.ru/upload/iblock/202/document_226117.pdf

aligning international best practices with the country's economic and energy system characteristics. Specifically, the study aims to: (1) analyze global experiences in carbon pricing, including emissions trading systems (e.g., EU ETS) and carbon tax models (e.g., Nordic countries); (2) assess the applicability and adaptability of these instruments within the Russian context; (3) model various carbon pricing scenarios to estimate potential fiscal revenues and their allocation; and (4) develop policy recommendations to support a phased and economically sustainable implementation of carbon pricing in Russia. These objectives are pursued through comparative case analysis and quantitative scenario modeling, providing a structured framework for examining how carbon pricing could influence Russia's energy transition and broader decarbonization strategy.

4. Material and methods

This study employs a mixed-method approach to assess carbon pricing's applicability in Russia. We synthesize case studies (EU ETS, Nordic taxes, Sakhalin pilot) selected for their proven emissions reductions (>20% since inception) and relevance to Russia's fossil fuel economy, drawing on data from the World Bank Carbon pricing dashboard (World Bank, 2023b), IMF reports, and national statistics (e.g., Rosstat, Ministry of Energy of Russia). Comparative analysis evaluates mechanisms against Russia's economic structure (20% GDP from hydrocarbons) and emissions (1.8 Gt CO₂eq/year). Scenarios in Section 7.5 model renewable capacity growth (14–21 GW by 2029) using IRENA cost estimates (\$2–3 bln/GW) and IMF revenue projections (4.3–4.4% GDP by 2030), adjusted for Russia's energy mix (65% fossil fuels).

4.1. Case selection rationale

The selection of the EU ETS, Nordic carbon taxes, and Sakhalin pilot stems from their diversity in policy design and relevance to Russia. The EU ETS provides a regional trading model with long-term emissions reduction success, while Nordic countries demonstrate how taxation can drive decarbonization. The Sakhalin pilot offers the first domestic example of a regulated carbon price, enabling scenario calibration. These cases were selected based on effectiveness, data availability, and provide context-specific insights for designing scalable and fiscally viable carbon pricing policies in Russia.

4.2. National approaches to carbon pricing (case contexts)

The study draws on selected international experiences to assess carbon pricing feasibility in Russia. The Nordic countries—Finland, Denmark, Sweden, and Poland—were the first to implement carbon taxes in the early 1990s, with Norway joining in 1991. In Norway, carbon tax revenues have exceeded \$33 million, with coverage extending to 65% of CO₂ emissions. The proceeds are managed via the sovereign wealth fund, contributing roughly 20% of the national budget and supporting clean energy and welfare programs.

Fuel taxation and climate policy in these countries have made fossil-fuel-based thermal generation increasingly uncompetitive, leading to a shift toward

renewables. In some cases, such as Sweden and Norway, wind and hydroelectric investments now proceed without subsidies.

The EU ETS, launched in 2005, applies a cap-and-trade model across all EU member states. It currently covers about 38% of the EU's CO₂ emissions, with gradually tightening emission limits and rising penalties for non-compliance. This framework creates a dynamic carbon price signal and has contributed significantly to emissions' reduction across regulated sectors.

5. Conceptual framework: Modern approaches to carbon pricing

The journey to decarbonization is fraught with challenges, stemming from the complexity of transitioning energy systems and economies toward low-carbon solutions. These challenges include technological, economic, and policy-related barriers, which necessitate innovative approaches, such as carbon pricing mechanisms, to drive progress (Antweiler and Gulati, 2016; Bertram et al., 2015; Cramton et al., 2017). Table 1 outlines the key challenges and market-based solutions.

The directions of solving these problems and the stages of implementation can be as follows:

- *Integrate carbon prices*: Embedding costs in producer strategies shifts markets toward renewables, as in the EU ETS, where coal-to-gas transitions reflect carbon allowance costs.
- *Revise market objectives*: Traditionally, electricity markets optimize trading based on criteria such as maximizing social welfare or minimizing costs based on operational or capital expenditures. Introducing carbon pricing requires a redefinition of these criteria to factor in carbon emissions: inclusion of carbon intensity in dispatch (e.g., Germany's renewable prioritization) or capacity payments based on footprints (e.g., California's allowances). However, this requires careful analysis to address readiness, volume commitments, and compensation mechanisms.

Table 1

Challenges and market-based solutions for CO₂ emission reduction.

Problem	Solution
Traditional electricity market models do not account for the environmental externalities of carbon emissions, making thermal generation appear cheaper than it actually is	Carbon pricing (e.g., taxes, cap-and-trade) integrates ecological costs into production pricing
Current electricity market structures may fail to effectively integrate carbon pricing, risking minimal impact on market dynamics	To ensure market efficiency, carbon pricing must be integrated into market structures, balancing short-term operational efficiency with long-term environmental considerations. This incentivizes sustained investment in clean technologies, with carbon prices typically following an upward trend to ensure continued emission reductions, with periodic reviews to adjust for economic and technological developments

Source: Compiled by the authors using data from Antweiler and Gulati (2016), Bertram et al. (2015), and Cramton et al. (2017).

- *Encourage investment*: Stable carbon prices via long-term markets (capacity markets or specialized competitive mechanisms) or power purchase agreements (PPAs; e.g., Google’s U.S. renewable contracts) secure clean energy funding (Burtraw et al., 2009; Metcalf, 2019). Australia’s Victorian Renewable Energy Auction Scheme (VREAS) uses contracts for difference to stabilize returns for renewable projects and boost wind/solar.
- *Regulatory framework*: Clear and predictable policies, like the EU’s Carbon Border Adjustment Mechanism (CBAM) integrating carbon pricing into international trade policies or New Zealand’s Emissions Trading Scheme (NZ ETS), attract green investment with consistency.

As of 2023, 73 carbon pricing initiatives were implemented, covering 11.66 Gt CO₂eq or 23% of global greenhouse gas emissions (World Bank, 2023a). Approaches to reducing CO₂ emissions and their implementation vary. The key ones are presented in Table 2.

It is important to note that carbon pricing mechanisms, including the EU ETS and carbon taxes, do not apply uniformly across all sectors responsible for CO₂ emissions. Certain industries are either fully exempt or subject to reduced obligations due to their strategic importance, limited capacity for rapid decarbonization, or administrative considerations. For example, small-scale emitters—typically installations emitting less than 25,000 tons of CO₂ per year—are excluded from the EU ETS to avoid disproportionate regulatory burdens. Similarly, agriculture is not currently covered by the EU ETS, largely due to the technical complexity of accurately measuring emissions from diffused biological sources. Land

Table 2

Approaches to reducing CO₂ emissions.

Approach	Description	Pros	Cons
Carbon taxes	Direct levies on CO ₂ emissions, charged per ton of carbon released into the atmosphere	Simple to implement; transparent in its cost structure	May provoke public backlash due to higher energy prices
Cap-and-trade mechanisms	Establishes a cap on total emissions, with allowances traded among emitters	Flexible and market-driven; incentivizes emissions reductions	Risk of over-allocation of permits, reducing effectiveness
Carbon credit trading schemes	Allows trading of carbon reduction credits within set limits to reward innovation in emission cuts	Encourages innovation and low-carbon projects	Requires robust monitoring and enforcement mechanisms
Bans and restrictions	Implements prohibitions, such as on internal combustion engine vehicles, to phase out polluting technologies	Effective in specific sectors; clear and decisive intervention	Risks consumer resistance and potential economic disruption
Carbon capture and storage (CCS) initiatives	Focuses on capturing CO ₂ emissions and storing them underground or repurposing them	High potential for significant emission reductions	Expensive; requires extensive infrastructure and technology

Source: Compiled by the authors using data from Gillingham and Stock (2018), Haites (2018), Nordhaus (2017), and Green (2021).

use, land use change, and forestry (LULUCF) activities are also excluded from carbon pricing and instead fall under separate EU frameworks focused on carbon sequestration rather than emissions taxation. Energy-intensive and trade-exposed sectors such as steel, cement, and chemicals frequently receive substantial free allowances—sometimes up to 100% of their benchmark allocation—to mitigate the risk of carbon leakage and preserve international competitiveness. Furthermore, while the EU’s CBAM aims to equalize carbon costs between domestic producers and foreign importers, it initially applies only to a limited set of sectors and does not extend to exempted industries like agriculture or forestry. These exclusions highlight the selective scope of existing carbon pricing regimes and underscore the need for further research into mechanisms for broadening coverage, minimizing exemptions, and ensuring a more comprehensive and equitable approach to decarbonization.

One of the most direct and widely discussed approaches to carbon pricing is the imposition of carbon taxes. Their straightforward nature makes them appealing for policymakers. However, the effectiveness of such taxes depends on setting the tax level high enough to encourage businesses to innovate and transit toward cleaner technologies. A well-designed carbon tax not only generates revenue but also signals the market to shift investments toward sustainable practices. Despite these advantages, carbon taxes often face public resistance due to the potential for increased energy costs, which can disproportionately affect low-income households.

Cap-and-trade systems, another prevalent mechanism, set a maximum allowable limit on emissions (the “cap”) and distribute or auction permits that entities can trade. This system provides flexibility by allowing market forces to determine the price of carbon. Companies that can reduce emissions at a lower cost may sell their surplus permits to others, incentivizing cost-effective emission reductions across the economy. The success of cap-and-trade systems hinges on careful design to prevent over-allocation of permits, which can undermine the scheme’s effectiveness. Examples from jurisdictions such as the European Union highlight the need for periodic adjustments of the cap to reflect changing economic and environmental conditions.

An alternative market-based mechanism is the carbon credit trading system, which focuses on generating credits for projects that actively reduce or sequester carbon emissions. These credits can then be sold to offset emissions elsewhere, supporting initiatives such as reforestation or renewable energy projects. While this approach promotes innovation and investment in sustainability, it requires robust monitoring and verification processes to ensure that credits represent genuine and additional reductions in emissions.

Other less common but significant initiatives include bans on high-emission technologies and policies supporting carbon capture and storage (CCS). The major weaknesses of these initiatives are the necessity of complementary policies to mitigate economic disruptions from bans and the often needed government co-financing and tax subsidies to make CCS projects viable.

Beyond these mechanisms, emerging approaches like CBAM and renewable energy certificate systems complement the aforementioned. CBAM aims to prevent carbon leakage by imposing tariffs on imports from countries with weaker carbon regulations, while certificate systems incentivize renewable energy use by allowing

the trading of renewable energy credits. These initiatives underscore the importance of tailoring carbon pricing approaches to specific national and regional contexts.

The relative popularity and effectiveness of these mechanisms depend on their ability to balance environmental goals with economic and social considerations. Carbon taxes and cap-and-trade systems, for instance, offer broad applicability and scalability but require careful design to avoid unintended consequences, such as economic inequities or market distortions. By contrast, targeted initiatives like bans and CCS projects address specific sectors or technologies but often demand significant financial and regulatory support.

Limitations and scope. The conceptual model presented here simplifies sectoral variability and assumes stable policy implementation. The findings are limited by reliance on secondary data, lack of granular sectoral emissions breakdowns, and assumptions about political feasibility. Mitigating these would require stakeholder engagement and in-country pilot evaluations. Future work should include bottom-up simulations and stakeholder analysis to refine these assumptions.

The data presented in this paper are based on the recent publications available at the time of writing. After publication, some figures may differ from updated sources. Discrepancies can occur because of revisions in official energy data, correction of previously reported errors, and changes in the methodologies used by statistical agencies or international organizations. Readers are encouraged to consult the latest datasets when comparing or replicating the findings.

6. Assessment of carbon tax and CO₂ emissions trading system

6.1. Carbon pricing mechanisms and challenges in implementation

Carbon taxes and emissions trading systems internalize emission costs, incentivizing cleaner energy. Globally, approximately 36 countries implement carbon taxes, covering a wide range of CO₂ emissions from an estimated 0.15 megatons of CO₂ equivalent (Mt CO₂eq) in Liechtenstein to 694 Mt CO₂eq in Canada. In contrast, ETS is implemented in around 33 countries or regions, addressing a larger emissions volume, ranging from nearly 5 Mt CO₂eq in Switzerland to nearly 5,000 Mt CO₂eq in China (World Bank, 2023b). In 2023, ETSs and carbon taxes covered approximately 17.6% and 4.7% of global greenhouse gas emissions, respectively (World Bank, 2023b).

A carbon tax imposes a direct fee on the carbon content of fossil fuels, thereby providing a predictable price signal that encourages businesses and individuals to transition toward low-carbon alternatives. In contrast, an ETS establishes a cap on the total volume of greenhouse gases that can be emitted within a regulated region. Emission allowances are either distributed or auctioned, allowing companies to trade them based on their needs. This market-driven approach incentivizes emission reductions where they are most cost-effective, fostering technological innovation and efficiency improvements (Parry et al., 2021b; Doda, 2016; Ekins and Speck, 2011).

Both carbon taxes and ETS aim to align financial interests with environmental sustainability by making carbon-intensive activities economically less viable. However, while these mechanisms have demonstrated effectiveness in some regions, they also present notable challenges that impact their broader imple-

mentation. Despite their theoretical advantages, carbon pricing mechanisms face several obstacles:

- *Effectiveness in emissions reduction*: While these instruments contribute to emissions' mitigation, they have yet to significantly reverse the upward trend in global emissions. Market fluctuations and economic slowdowns often lead to volatility in carbon prices, reducing immediate pressure on industries to innovate.

- *Public resistance and economic impact*: Carbon taxes can lead to increased energy costs, disproportionately affecting lower-income households and businesses. Historical instances, such as the 2018 “Yellow Vest” protests in France and similar demonstrations in Chile, underscore the socio-economic challenges associated with carbon taxation.

- *Revenue allocation and carbon leakage*: Effective reinvestment of carbon tax revenues remains a key concern. Some nations struggle to channel these funds into sustainable projects or compensation mechanisms for vulnerable populations. Additionally, carbon leakage—where industries relocate to countries with weaker environmental regulations—undermines global emission reduction efforts.

The primary function of carbon taxes remains incentivization, pushing companies to adopt low-carbon technologies and reduce fossil fuel dependency. International experiences with carbon taxes and cap-and-trade systems provide valuable lessons for evaluating and refining these mechanisms and are described in the following section.

6.2. Case study: The Nordic experience with carbon taxation

The first countries to introduce a national carbon tax were Finland, Denmark, Poland, and Sweden, followed by Norway in 1991. The implementation of these taxes was largely influenced by regional agreements and international climate commitments, including the United Nations Framework Convention on Climate Change (UNFCCC) and the Kyoto Protocol (1997). Furthermore, participation in the EU ETS reinforced these nations' commitments to emission reductions. These international agreements, combined with the domestic political will to combat climate change, laid the legal foundation for the introduction of the carbon tax (Stern, 2007; Hassett and Metcalf, 2006). Fig. 1 illustrates the price trends of carbon pricing instruments across the jurisdictions analyzed in this study, along with selected others. The data reveal that carbon prices do not follow a strictly monotonic trajectory; rather, they fluctuate over time in response to evolving policy, economic conditions, and market dynamics.

By 2022, Norway, Sweden, Denmark, and Finland had achieved an average renewable energy consumption share of approximately 56.2%, significantly exceeding the 22% average for the 27 EU member states (Eurostat, 2023). Norway's \$90.86/ton tax (2023) on fossil fuels and ETS for industry had reduced net emissions by approximately 23% since 1990, supporting investments in renewables and electric vehicles (EVs), with Norway leading globally in per capita EV adoption (Norwegian Environment Agency, 2024; World Bank, 2023b). Notably, Norway utilizes carbon tax revenues through its sovereign wealth fund, the Government Pension Fund Global, which contributes around 15–20% of the national budget annually, supporting social welfare and addressing economic inequality (Norwegian Environment Agency, 2024).

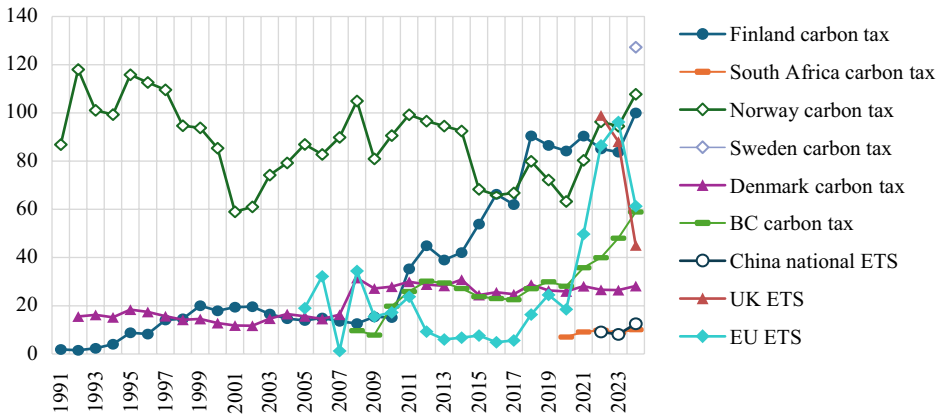


Fig. 1. Price trends for the selected instruments, 1991–2024 (U.S. dollars).

Note: BC—British Columbia; the provincial tax was effectively canceled on April 1, 2025.

Source: Compiled by the authors using data from World Bank, 2023b.

With Norway's carbon tax (\$90.86/ton, 2023), net GHG emissions, including all sources and sinks, reduced to 31.6 Mt CO₂eq in 2023, a 23% decrease from 1990. Covering about 60% of total GHG emissions, carbon tax generates approximately \$1.4 billion in 2023 (~0.25% GDP in 2023; Norwegian Environment Agency, 2024, 2025; World Bank, 2023b; Statistics Norway, 2025b). This funded a 7.8 GW renewable increase (mostly hydro) over nearly a decade and EV adoption (~65% of new cars in 2021 and ~82% in 2023) (International Energy Agency, 2023b; Statistics Norway, 2025a). Sweden, with ~\$125.56/ton tax, cut emissions by ~38%. Covering about 36% of total GHG emissions, carbon tax yields ~\$2 billion/year (~0.4% GDP, 2023 GDP \$597 billion) (Swedish Environmental Protection Agency, 2025; World Bank, 2023b). Russia, with 1,680 Mt CO₂eq/year, could achieve a 20% cut (336 Mt CO₂eq) at \$50/ton, generating ~\$84 billion (~4.2% GDP), per IMF estimates (IMF, 2023; Crippa et al., 2023). However, Norway's 96% hydro-based grid contrasts with Russia's 67% fossil fuel mix, limiting direct applicability (IEA, 2023a). Russia's export dependency (~50% vs. Norway's 36%) and weaker monitoring (~45% digitized firms vs. ~83% in Norway) suggest higher transition costs and resistance, necessitating phased rates and CCS integration (World Bank, 2024; Kommersant, 2023).

7. Results: Considerations for implementing carbon pricing approaches in Russia

7.1. The analysis of potential mechanisms

The analysis of potential for implementing key carbon pricing mechanisms in the Russian jurisdiction requires consideration of the country's economic, social, political, and environmental specifics. Below, each mechanism is evaluated, including its advantages, disadvantages, influencing factors, numerical estimates, and comparisons with international experiences.

The introduction of a *carbon tax*, which involves charging a fee for each ton of CO₂ or equivalent greenhouse gas emissions, has not yet been implemented nationally in

Russia, though it is under discussion within the framework of the Paris Agreement and the Low-Carbon Development Strategy until 2050. A pilot project in Sakhalin (launched in 2022) could serve as a foundation for assessing its feasibility. This mechanism offers simplicity in administration, as it can be integrated into the existing tax system, reducing the costs of establishing new structures. According to the IMF (2023), a carbon tax in Russia could generate 4.3–4.4% of GDP by 2030 (approximately 7.4–7.6 trillion RUB, given a 2023 GDP of 172 trillion RUB²). It also incentivizes decarbonization by motivating companies to reduce emissions to lower their tax burden. However, Russia's heavy reliance on hydrocarbon exports (around 45% of exports in 2022; CREA, 2024) means a tax could undermine the competitiveness of the oil and gas sector. Additionally, rising energy and goods prices could disproportionately affect low-income populations (12.4 million people below the poverty line in 2023³), and large corporations like Gazprom and Rosneft may resist this policy due to increased costs. Key influencing factors include the economy's dependence on fossil fuels (about 15% of GDP) underdeveloped emissions monitoring infrastructure, and a political preference for "soft" regulation.⁴ Compared to Sweden, where a carbon tax of \$125.56 per ton contributes ~0.4% of GDP annually, Russia might start with a lower rate of \$15 per ton, though reaching \$50–70 would be necessary for comparable impact (Swedish Environmental Protection Agency, 2025).

The *cap-and-trade mechanism*, which sets an emissions limit and allows companies to trade quotas, is being tested in Russia through the Sakhalin experiment since 2022 (Library of Congress, 2022). Here, 35 companies with emissions exceeding 20,000 tons of CO₂ annually received quotas, with a fee of 1,000 RUB per ton for exceeding limits.⁵ This system offers flexibility, enabling firms to either reduce emissions or purchase quotas, and leverages market dynamics to encourage innovation (Lissovnikov, 2021). If successful in Sakhalin, with regional emissions of about 12.3 million tons of CO₂ yearly (Library of Congress, 2022), it could be scaled nationally. However, it requires sophisticated emissions tracking and a trading infrastructure. The current quota price (1,000 RUB/ton) is significantly lower than the EU's \$80/ton, risking inefficiency (European Commission, 2024). Sanctions also limit integration with global systems like the EU ETS (Beuerle, 2024). Scaling the Sakhalin model nationwide, with total emissions of 1.8 billion tons of CO₂ annually, could yield 1.8 trillion RUB yearly at 1,000 RUB/ton, though a price increase to 5,000–7,000 RUB/ton would be needed for meaningful reductions. In contrast, the EU ETS (since 2005) covers 11,000 enterprises and cut emissions by 35% by 2020 at \$80/ton (European Commission, 2024).

Carbon credit trading schemes became operational in Russia in September 2022 with a voluntary carbon unit registry, allowing companies to sell credits from climate projects like reforestation.⁶ This voluntary approach minimizes business resistance and could help exporters avoid the EU's CBAM. Demand remains low without mandatory quotas, and Russia's market is nascent compared to the global carbon market

² https://rosstat.gov.ru/storage/mediabank/86_07-06-2024.html (in Russian).

³ *Ibid.*

⁴ Ministry of Economic Development of the Russian Federation. Strategy for low-carbon development of the Russian Federation until 2050 (in Russian). <https://economy.gov.ru> (in Russian).

⁵ https://www.economy.gov.ru/material/news/za_dva_goda_eksperimenta_vybrosy_parnikovyh_gazov_na_sahaline_sokratilis_v_dva_raza.html (in Russian).

⁶ <https://carbonreg.ru/en/news/1-sentyabrya-2022-v-rossii-zapustilsya-reestr-uglerodnykh-edinic/>

under mechanisms like the Kyoto Protocol. Verification for international credibility is also lacking. Russia's forests (absorbing approximately 560 million tons of CO₂ yearly) offer potential (Sorokina et al., 2023), but sanctions and low awareness hinder progress. Approximately 12.5 billion metric tons of carbon permits were traded globally in emissions markets—comparable to the volume in 2022—but the total market value increased due to record-high prices in regions like Europe and North America, as reported in the LSEG Carbon Market Year in Review 2023.⁷ Meanwhile Russia's traded volume was under 1 million units in 2023.

Bans and restrictions, such as limits on coal-fired plants or flaring of associated gas, align with Russia's 2050 Strategy to reduce carbon intensity by 9% by 2030 and by 48% by 2050. These measures ensure direct emissions cuts and require minimal monitoring costs. However, coal contributes 15% to electricity generation, within a 65% fossil fuel energy mix,⁸ and phasing it out could harm regions like Kuzbass, risking 150,000 jobs (Ministry of Energy of the Russian Federation, 2016). Substitution with gas (50% of the energy mix) is feasible but costly, and regional political resistance is likely. The UK's plan to close all coal plants by 2025, cutting 20 million tons of CO₂ (UK BEIS, 2023) suggests Russia would need to decommission 30 GW of coal capacity for similar results.

Carbon capture and storage (CCS) initiatives are in early stages in Russia, with pilot projects by Metafrax and Rosneft aiming for 2028 deployment. The Intergovernmental Panel on Climate Change (IPCC, 2005) projects that up to 30 gigatons of carbon dioxide could be stored underground by 2050. However, a study from researchers at Imperial College London suggests a much lower optimistic estimate of only 5 to 6 gigatons (Zhang et al., 2024). The study challenges the IPCC's figures, calling them unrealistic, especially in terms of expectations for China's future carbon capture capabilities. Compatible with the oil and gas sector, CCS could enhance oil recovery, and Rosneft targets a 20-million-ton reduction by 2035 (Rosneft, 2023). Yet, Russia lacks commercial-scale experience and costs are prohibitive. According to The National News,⁹ the total investment for the Al Reyadah project was approximately AED 450 million, equivalent to around \$122 million. This funding covered the development of CO₂ capture, compression, and transportation infrastructure, including a 43-kilometer pipeline directing captured CO₂ to ADNOC's onshore oilfields for enhanced oil recovery. Geological suitability (depleted fields) and state funding are critical. Globally, investments in carbon capture and storage have surpassed \$83 billion, with 41 commercial-scale facilities currently in operation—most of which are managed by major fossil fuel corporations. However, according to a report from the Institute for Energy Economics and Financial Analysis, many CCS projects worldwide have underperformed, often failing to meet their projected outcomes (Robertson and Mousavian, 2022; Natter and Merrill, 2023; IEA, 2025). Against this backdrop of global underachievement, Russia's slower pace in CCS deployment appears less consequential. The country has recently launched its

⁷ <https://carbonherald.com/lseg-global-carbon-market-value-reached-record-949b-in-2023/>

⁸ Ministry of Energy of Russia. Order No. 1095 of November 30, 2023: On the approval of the scheme and program for the development of electric power systems of Russia for 2024–2029 (in Russian). https://minenergo.gov.ru/upload/iblock/202/document_226117.pdf (in Russian).

⁹ <https://www.thenationalnews.com/business/abu-dhabi-starts-up-worlds-first-commercial-steel-carbon-capture-project-1.213295>

first climate-focused carbon capture and storage project, and around a dozen additional initiatives are currently under evaluation by domestic companies.¹⁰

In conclusion, taxes and cap-and-trade offer the most immediate potential due to their simplicity and revenue generation, though Russia's hydrocarbon dependency, sanctions, and low carbon prices pose challenges. Starting with modest rates (\$15/ton for taxes, 5,000 RUB/ton for quotas) and scaling up, alongside CCS investment and better monitoring, could balance economic and environmental goals. Russia can draw from the EU's hybrid approach and China's voluntary market, tailoring them to its unique context.

7.2. Feasibility of a carbon tax in Russia

The Russian case offers a distinct mix of challenges and opportunities for implementing a carbon tax (Chuzhmarova, 2023). Several critical factors shape its feasibility:

- *Economic structure*: Russia's economy relies heavily on fossil fuel exports, with hydrocarbons contributing approximately 20% of GDP. A carbon tax could impair the competitiveness of energy and manufacturing sectors, necessitating a balanced approach—e.g., starting at \$15/ton and scaling to \$50–70/ton—to avoid economic disruption while encouraging green diversification (Parry et al., 2021a).
- *Energy mix*: With coal and gas dominating the energy supply (50% gas, 15% coal),¹¹ a carbon tax must incentivize a shift to renewables. Russia's vast geography offers potential for wind and solar, which could be integrated into tax-driven decarbonization strategies.
- *Regional variability*: Industrial regions like Siberia emit more than urban centers like Moscow, reflecting stark disparities. A flexible tax design—potentially with differentiated rates—could address these differences, ensuring equitable application across diverse economic and energy profiles.
- *Social equity*: Fossil fuel subsidies lower living costs for low-income citizens. Replacing them with a tax risks public backlash unless offset by compensatory measures, such as direct transfers, to protect vulnerable households and secure social acceptance.
- *Political readiness*: Centralized governance and energy sector influence may resist carbon pricing. Strong political will and clear communication of benefits—e.g., 4.3–4.4% GDP revenue by 2030 (more than 7 trillion RUB) are essential to overcome opposition.
- *International pressure*: Commitments under the Paris Agreement and looming EU carbon border adjustments push Russia toward a tax to curb emissions (under the intensive scenario, Russia will reduce emissions by 36% by 2030, and by 2050 will reduce them by 48%, to 1.6 billion tons of CO₂e¹²) and maintain export competitiveness.

¹⁰ <https://trends.rbc.ru/trends/green/cmrm/679348469a79478caae805c9>; <https://www.vedomosti.ru/business/articles/2022/10/25/947155-v-rossii-gotovyat-desyatok-proektov-po-ulavlivaniyu-co2> (in Russian).

¹¹ Ministry of Energy of Russia. Order No. 1095 of November 30, 2023: On the approval of the scheme and program for the development of electric power systems of Russia for 2024–2029 (in Russian). https://minenergo.gov.ru/upload/iblock/202/document_226117.pdf (in Russian).

¹² <https://www.rbc.ru/business/23/03/2020/5e73c8739a7947f53f4f3a06> (in Russian).

- *Revenue use:* Tax proceeds could fund renewables and efficiency upgrades, aligning with global benchmarks (\$50–70/ton for impact). Reinvesting in social programs could mitigate economic strain, supporting a just transition.

In conclusion, a calibrated carbon tax, starting low and rising gradually, could leverage Russia's resources while addressing its structural and social challenges, aligning with global climate goals.

The Russian Federation currently lacks an explicit carbon emissions tax but employs various environmental taxes and payments based on negative environmental impacts. According to Rosstat Methodological Guidelines (Rosstat, 2023b), these are categorized into: environmental taxes (e.g., energy, transport, pollution, and natural resource taxes) and other environmental payments (e.g., land use, resource extraction payments, and fines), as detailed in Table 3. Energy taxes, such as fuel excises, implicitly influence carbon emissions by raising fossil fuel costs, though they lack the direct per-ton CO₂ pricing of an explicit carbon tax.

Since 2022, Russia has piloted carbon pricing on Sakhalin Island, aiming for carbon neutrality by 2025. Companies exceeding CO₂ quotas (set for 35 firms with emissions > 20,000 tons/year) face a penalty of \$11/ton CO₂eq (Sakhalin Government, 2022). This initiative tests scalability for national application. Russia's electricity market, reliant on fossil fuels (50% gas, 15% coal in 2023), could shift toward renewables with a carbon tax, as higher fossil fuel costs enhance renewable competitiveness. Revenues—potentially 4.3–4.4% of GDP by 2030 (more than \$85 billion, given 2023 GDP of approximately \$2.1 trillion; IMF, 2023) could fund renewable projects, reducing emissions (1.7 billion tons CO₂/year; Rosstat, 2023a) and creating jobs.

Table 3

Categories of environmental taxes and payments in Russia.

Category	Type of tax/payment	Description
Environmental taxes	Energy taxes	Taxes on fossil fuels (e.g., oil, gas, coal), implicitly pricing carbon
	Transport taxes	Taxes on vehicle emissions to curb transport pollution
	Pollution taxes	Taxes on industrial emissions into air, water, or soil
	Natural resource taxes	Taxes on resource extraction (e.g., timber, minerals) for sustainable use
Other environmental payments	Land use payments	Payments for environmental impacts of land development and extraction
	Payments for oil and natural gas extraction	Payments for oil and gas extraction, supporting environmental protection
	Payments for the extraction of other resources	Payments for extracting resources like coal and metals
	Fines	Penalties for environmental law violations to enforce compliance

Source: Compiled by the authors using data from Rosstat (2023b).

Table 4
Adapting tax principles for carbon taxes in Russia.

Variant	Description of base tax	Applicability of principles to carbon tax
VAT/excises analog	Consumer-level; impacts prices directly	Raises electricity prices, affecting consumers
Transport tax analog	Producer-level; varies by type	Varies by fuel, included in costs
Profit tax analog	Producer-level; profit-based, no price impact	Differentiated by fuel; encourages cleaner technology

Source: Compiled by the authors using data from Russian Tax Code (Article 247) and international tax models.

7.3. Applications of carbon taxes

A carbon tax could align with existing Russian taxes:

- *tVAT/excises*: Applied at the consumer level, raising electricity prices like fuel excises;
- *transport tax*: Producer-level tax with rates varying by fuel type, indirectly affecting costs;
- *corporate profit tax*: Producer-level tax on profits, incentivizing cleaner generation without direct price hikes.

The adaptation of tax principles to carbon taxes in Russia is presented in Table 4. The profit tax model, taxing profits minus emissions (per Article 247, Tax Code), avoids consumer price shocks and incentivizes low-carbon technology, especially as loss-making firms pay no tax. Sweden's phased carbon tax (from \$30/ton in 1991 to \$130/ton in 2023) and British Columbia's rebates (British Columbia Government, 2025) suggest Russia start at \$15/ton, rising to \$50–70/ton, with exemptions for early adopters (e.g., 3-year relief). Border carbon adjustments, like the EU's CBAM, could prevent industry relocation, while a carbon fund (e.g., Norway's model, Norwegian Environment Agency) could redirect payments to renewables, offering tax relief.

Russia's vast geographical diversity necessitates a flexible carbon tax, with lower initial rates or quotas in coal-dependent regions (e.g., Siberia, producing about 50% of electricity from coal, 2023). A phased approach, supported by renewable infrastructure investments, ensures a just transition. Revenues should balance immediate social support for low-income citizens with long-term renewable subsidies, mitigating regressive impacts while driving sustainability. High transition costs remain a barrier, requiring targeted workers retraining to shift coal-reliant regions to renewable jobs.

7.4. Allocation of carbon tax revenues

Carbon tax revenues, projected at 4.3–4.4% of GDP by 2030 (\$42–60 billion annually from \$25–35/ton on 1.7 billion tons CO₂/year, though IMF estimates suggest \$73–75 billion with higher effective rates or broader coverage) provide a predictable fiscal stream despite declining emissions over time. Strategic allocation can balance economic stability, environmental goals, and social equity:

- *Redistribution to households*: Direct transfers to 12.4 million low-income citizens mitigate the tax's regressive impact (~\$4 billion/year could halve energy cost increases), though this supports consumption rather than long-term growth.

Table 5

Suggestions for allocating carbon tax revenues.

Option	Baseline tax allocation	Carbon tax allocation proposal
VAT/excises	Social policy, defense	Social aid, renewable subsidies
Transport tax	Road infrastructure	Social measures, renewable support
Profit tax	Budget allocations	Renewable subsidies, tax cuts for RES firms

Source: Compiled by the authors using data from Bashmakov (2018) and Swedish Environmental Protection Agency (2025).

- *Investment in renewables*: Allocating funds to renewable projects could add 16 GW capacity by 2029 (~\$40 billion at \$2.5 billion/GW; IRENA, 2023), potentially raising GDP by 5% by 2035 (according to the authors' assessment), despite short-term consumption dips.
- *Balanced approach* (Bashmakov, 2018): Splitting revenues (~30% social, \$22 billion; 70% renewables, \$51 billion) ensures equity and sustainability, as seen in Sweden's tax cuts and wind funding (15 GW added; Swedish Environmental Protection Agency, 2025).

Suggestions for the distribution of carbon tax revenues are presented in Table 5. Profit tax-based allocation minimizes consumer price impacts while incentivizing cleaner production. However, as emissions fall (e.g., 20% revenue drop by 2040), revenues must fund green infrastructure to sustain impact (Tarasova, 2023). Integrating this into environmental tax reform, e.g., a dedicated fund for energy efficiency and R&D, could amplify systemic change, unlike VAT/excise models that raise electricity costs. Challenges include high initial renewable costs (~\$2–3 billion/GW) and resistance from coal sectors (about 15% of electricity), requiring targeted support for affected regions and workers.

7.5. Potential scenarios for renewable energy development through carbon pricing

Carbon pricing could drive Russia's energy transition under distinct scenarios, leveraging revenues (projected at 4.3–4.4% of GDP by 2030) to shift from fossil fuels (which were about 65% of electricity in 2023) to renewables.

- *Baseline* (Fig. 2): Current plans prioritize thermal power expansion,¹³ maintaining fossil fuel dominance without carbon pricing. Adding 5 GW of coal and gas power plants by 2029 increases emissions by ~10 Mt CO₂eq/year (2 Mt CO₂eq/GW coal average), with no GDP decarbonization gain.
- *Minimalist* (Fig. 3): From 2026, revenues redirect 30% of new capacity investments to renewables (e.g., wind, solar), scaling to 100% by 2029, adding ~8 GW of renewable capacity while reducing thermal reliance by 3 GW annually. 8 GW renewables cuts ~16 Mt CO₂eq/year (2 Mt CO₂eq/GW displaced coal), creating ~40,000 jobs (5,000/GW; IRENA (2023) estimate), with a 0.5% GDP boost by 2035 (the authors' estimate).

¹³ Ministry of Energy of Russia. Order No. 1095 of November 30, 2023: On the approval of the scheme and program for the development of electric power systems of Russia for 2024–2029 (in Russian). https://minenergo.gov.ru/upload/iblock/202/document_226117.pdf

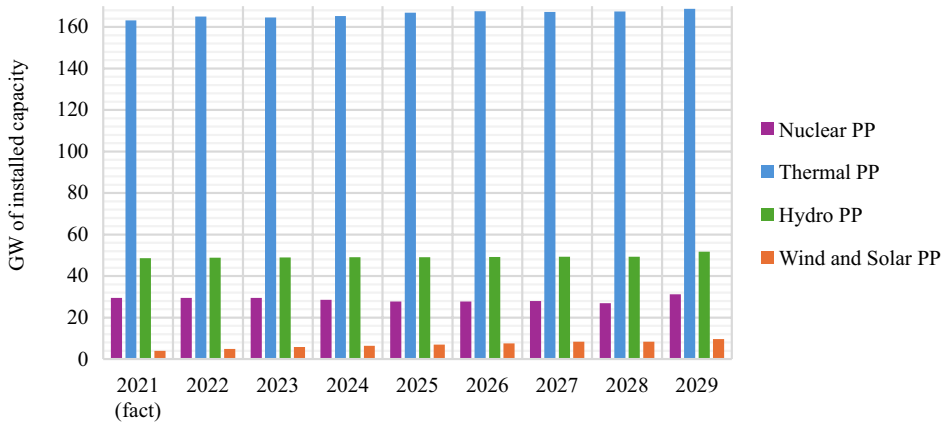


Fig. 2. Generation fleet for Baseline scenario.

Source: Authors' calculations based on Ministry of Energy of Russia Order No. 1095 of November 30, 2023. https://minenergo.gov.ru/upload/iblock/202/document_226117.pdf

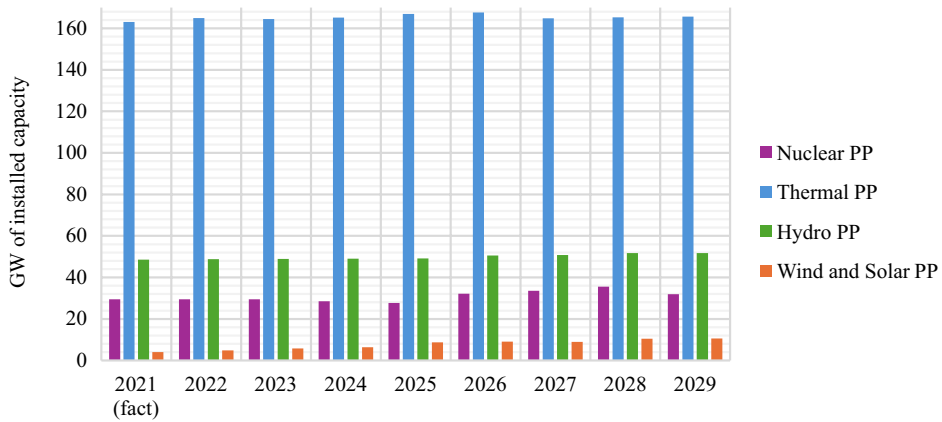


Fig. 3. Generation fleet for Minimalist scenario.

Source: Authors' calculations based on Ministry of Energy of Russia Order No. 1095 of November 30, 2023. https://minenergo.gov.ru/upload/iblock/202/document_226117.pdf

- *Optimistic* (Fig. 4): Combines investment shifts with retiring inefficient thermal plants (3% yearly from 2026, 10% by 2029), yielding 16 GW of new capacity by 2029—split across nuclear (5 GW), hydro (5 GW), and renewables (6 GW, solar/wind). Nuclear leverages Rosatom's 1 GW/year pace; hydro taps 300 GW potential; renewables scale from 4 GW, prioritizing solar/wind.¹⁴ These 16 GW reduce ~32 Mt CO₂eq/year, adding ~80,000 jobs and 1% GDP growth by 2035, retiring 10% of 60 GW thermal capacity (~120 Mt CO₂eq baseline).

Financially, a \$25/ton tax on 1.7 billion tons CO₂/year could fund this shift, with \$42.5 billion annually supporting 14–21 GW of clean capacity (at ~\$2–3 billion/GW, global average; IRENA, 2023). Sweden's revenue-funded wind growth (15 GW

¹⁴ Ministry of Energy of Russia. Order No. 1095 of November 30, 2023: On the approval of the scheme and program for the development of electric power systems of Russia for 2024–2029 (in Russian). https://minenergo.gov.ru/upload/iblock/202/document_226117.pdf

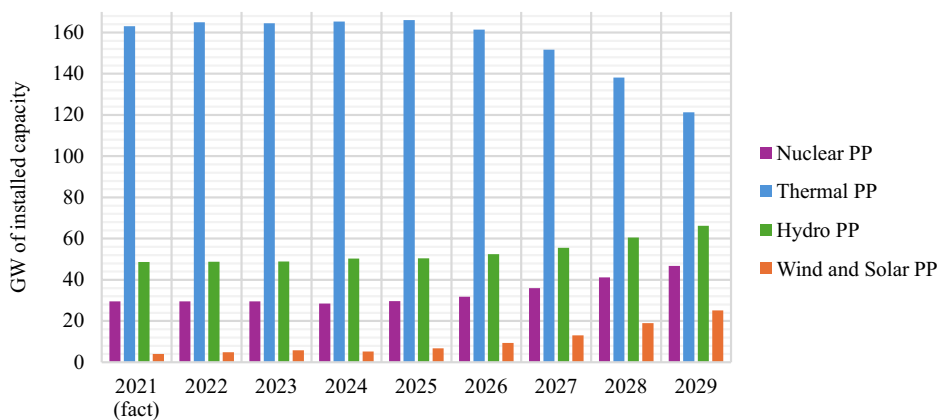


Fig. 4. Generation fleet for Optimistic scenario.

Source: Authors' calculations based on Ministry of Energy of Russia Order No. 1095 of November 30, 2023. https://minenergo.gov.ru/upload/iblock/202/document_226117.pdf

since 1991) suggests viability, though Russia's coal regions (e.g., Siberia) require phased implementation—starting in high-readiness areas (e.g., solar-rich South) to limit price shocks and build acceptance.

8. Conclusion and recommendations

In this study, the authors have undertaken a detailed examination of carbon pricing mechanisms—specifically carbon taxes and emissions trading systems—as viable strategies for reducing CO₂ emissions and advancing renewable energy adoption in Russia. Drawing on international case studies—such as the EU ETS (35% emissions' cut since 2005), Sweden's \$130/ton tax (27% reduction between 1990 to 2018), and Norway's \$60/ton hybrid model (up to 25% cut for some oil and gas companies)—the authors demonstrate how these mechanisms embed ecological costs into economic decisions, driving renewable energy transitions. Through a mixed-method approach using World Bank, IMF, and national data, the study adapts these lessons to Russia's unique context.

In Russia, which emits 1.7 Gt CO₂eq annually and relies on fossil fuels for 20% of GDP, the study's findings reveal significant potential. The Sakhalin pilot (\$11/ton carbon price) highlights scalability, with projections showing a phased national tax (\$15–\$50/ton rising to \$70/ton) could generate more than \$85 billion annually (4.3–4.4% of GDP by 2030), and, based on the results for the minimalist and optimistic scenarios, cut emissions by 16–32 Mt CO₂eq/year, enabling 8–16 GW of renewable capacity by 2029. Yet, coal-dependent regions (responsible for 15% of electricity and 150 000 jobs) require gradual implementation and \$5 billion in transition support.

Based on these findings, the study recommends several targeted measures: (i) regionally differentiated carbon pricing rates to reflect energy mix and economic structure; (ii) a transparent carbon fund with 70% of revenues allocated to renewable energy and 30% to social protection measures; and (iii) border carbon adjustments to protect trade competitiveness. Key challenges include public resistance, insufficient emissions monitoring infrastructure, and technology access constraints due to sanctions. Addressing these risks may

require strengthened domestic innovation policies and selective international cooperation.

This research advances the literature on decarbonization in fossil fuel-reliant economies and positions Russia as a potential leader in sustainable transitions. Future studies should examine the political feasibility of implementation, public acceptance of carbon pricing, the technical and economic viability of carbon capture and storage. The limitations of this study include its reliance on secondary data sources and the inherent uncertain political will in long-term scenario modeling.

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