# RUSSIA AND GLOBAL GREEN TRANSITION

## RISKS AND OPPORTUNITIES

2021

WORLD BANK GROUP

HSE UNIVERSITY

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1818 H Street NW
Washington DC 20433
Telephone: 202-473-1000;
Internet: www.worldbank.org



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# Acronyms and abbreviations

| | |
|---|---|
| ATS | Administrator of territory systems |
| BAT | Best available technologies |
| BCAT | Border carbon adjustment taxes |
| CBAM | Carbon Border Adjustment Mechanism |
| CBR | Central Bank of Russia |
| CCDR | Country Climate and Development Report |
| CCS | Carbon capture and storage |
| CDE | Constant differences in elasticities |
| CES | Constant elasticity of substitution |
| CGE | Computable general equilibrium |
| CHM | Chemical product |
| $CO_2$ | Carbon dioxide |
| $CO_2e$ | Carbon dioxide equivalents |
| COALEX | Coal exporters |
| CPLs | Climate policy leaders |
| CRESS | Capacity- based renewable energy support scheme |
| CWON | World Bank Changing Wealth of Nations |
| DOM.RF | The Russian Federation Government's integrated housing development institution |
| ECA | Europe and Central Asia |
| EFI | Equitable Growth, Finance and Institutions Global Practice |
| EFTA | European Free Trade Association |
| EITE | Energy intensive, trade exposed |
| ELY | Electronics |
| ENVISAGE | Environmental Impact and Sustainability Applied General Equilibrium |
| ESG | Environmental, social and governance |
| ETFs | Exchange traded mutual funds |
| ETS | Emissions Trading System |
| EU | European Union |
| € | The Euro |
| FFDCs | Fossil fuel dependent countries |
| IEA | International Energy Agency |
| G20 | Group of Twenty |
| GDP | Gross domestic product |

| | |
|---|---|
| GHG | Greenhouse gas |
| GRI | Global Reporting Initiative Standard |
| GTAP | Global Trade Analysis Project |
| IFC | International Finance Corporation |
| IIASA | International Institute for Applied Systems Analysis |
| ILO | International Labor Organization |
| IMF | International Monetary Fund |
| KPI | Key performance indicator |
| LULUCF | Land use, land use change and forestry |
| MACCs | Marginal abatement cost curves |
| MED | Ministry of Economic Development (Russia) |
| MNRE | Ministry of Natural Resources and Environment (Russia) |
| MOEX | Moscow Exchange |
| Mt | Megaton |
| Mtoe | Million tonnes of oil equivalent |
| NDC | Nationally determined contribution |
| Nec | Not elsewhere classified |
| NFM | Non-ferrous metal |
| NGFS | Network for Greening the Financial System |
| NMM | Non-metallic minerals |
| OECD | Organization for Economic Cooperation and Development |
| OXT | Other extraction |
| P- -C | Petroleum, coal product |
| R&D | Research and development |
| RE | Renewable energy |
| SD | Sustainable development |
| SME | Small and medium enterprise |
| SSP | Shared socioeconomic pathways |
| TCFD | Recommendations of the Task Force on Climate-related Financial Disclosures |
| UK | United Kingdom of Great Britain and Northern Ireland |
| UN | United Nations |
| U.S. | United States |
| US$ | United States dollar |
| VEB | Vnesheconombank |
| VNIILM | All-Russian Research Institute for Silviculture and Mechanization of Forestry |
| WEO | World Economic Outlook |

# Executive Summary

**Greener economic development in Russia will allow the country to overcome the limits of its current fossil fuel-dependent growth model.** It can deliver prosperity to Russia's citizens that is more sustainable and more resilient to external shocks in a rapidly changing global economy. The choices toward carbon neutrality made by an increasing number of countries and companies bring a new wave of uncertainty to the value of fossil fuel assets. This uncertainty is likely to result in lower and more volatile revenue from exports of hydrocarbons and energy-intensive industrial products.

**The launch of the European Green Deal and China's commitment to carbon neutrality are a few examples of external action by Russia's main trading partners that may soon affect the competitiveness of Russian exports**. The preferences of global consumers and investors are also changing, and green technologies and business models are disrupting more markets, including those where Russia revealed its global comparative advantage. Not surprisingly, countries that decided to lead climate action to reach the goals of the Paris Agreement are concerned that their unilateral increase of ambition will lead to "leakage" of emissions to countries that allow unconstrained greenhouse gas (GHG) emissions.

**The European Union (EU) has proposed a carbon border adjustment mechanism (CBAM) as a companion to its ambitious policy package to accelerate green transition before 2030**. Canada and Japan are also considering similar trade measures. Reducing the environmental footprint of economic activities becomes a decisive factor in international competitiveness and in the ability to attract international finance and investment. Being part of a green transformation not only hedges risk for Russia, but is also an opportunity to boost long overdue diversification and modernization of its economy and create new knowledge-intensive and productive sectors and jobs.

## Scope and Methodology

**The objectives of this study are threefold.** First, the study assesses the impacts of the global green transition, including decarbonization efforts of other countries and the introduction of a carbon border adjustment, on Russia's economy. Second, it looks at how Russia can respond to mitigate these impacts and build a more resilient growth model. Finally, the study examines the opportunities that the global green transition could bring to Russia and outlines specific sectors it could benefit.

**This report examines several scenarios of how global decarbonization can evolve and how Russia can respond**. The study applies the Environmental Impact and Sustainability Applied General Equilibrium (ENVISAGE) Model, a recursive dynamic and global computable general equilibrium (CGE) model. ENVISAGE links macroeconomic variables together in regional and sectoral dimensions to simulate the impact of external events on the Russian economy and how these impacts interact with alternative national policy responses by Russia. These are “what if” exploratory scenarios that aim to provide economic insight for Russia’s decision makers without trying to predict the future or judge which scenario is most likely or desirable. The advantage of such an approach is its ability to identify the pros and cons of the different ways in which the national economy can adjust to external events.

**The scenarios are designed to reflect alternative plausible developments of external events of global low-carbon transition in the order of their increasing level of likely impact on the Russian economy.** The first set of scenarios focuses on EU CBAM and its possible future marginal extensions. The reference scenario reflects the recently announced ambitious package of EU climate policies. The exploratory scenarios of future actions include the currently proposed EU CBAM covering Scope 1 (direct) emissions only, as proposed in July 2021. The following set of scenarios hypothetically extend EU CBAM to both Scope 1 and Scope 2 (indirect) emissions. Further scenarios explore hypothetical expansion of CBAM to more sectors as well as its introduction not only by the EU, but also the U.S. For two of these scenarios the model simulates the impact of Russia’s choice to introduce a domestic carbon price on the same sectors and with the same rates as those covered by EU CBAM. This reduces the EU CBAM import duties on Russian products to zero. The two scenarios differ in how additional Russian government revenues collected through the carbon price are spent: one scenario assumes their transfer to households, and the other, their conversion to savings and investment.

**The design of the EU CBAM scenarios closely approximates the July 2021 EU proposal and its possible future extensions, but due to the standard model limitations, the results should be treated as indicative.** The economic insight into impact transmission mechanisms is as important as the numerical results. For example, the model overestimates the EU CBAM impact by taxing the entire Global Trade Analysis Project (GTAP) sectors rather than only a few selected products in each sector, as the July legislative proposal stipulates. Moreover, this study applies an average carbon intensity to the covered sector. In reality, the EU CBAM payments will depend only on the intensity of specific imported products. Individual firms will be able to prove lower carbon intensity of their exported product and reduce the CBAM rate accordingly for the importer.

**The second set of scenarios explores the implications of ambitious climate policies and an economy-wide CBAM implemented by a much wider “club” of climate policy leaders on the full value chain emissions embedded in products imported from non-cooperating countries.** Multiple cooperative and non-cooperative policy pathways to reach the goals of the Paris Agreement are simulated. In subsets of non-cooperative scenarios, the OECD countries, China, India, and other net importers of fossil fuels levy much stricter CBAM against all imports from non-cooperating fossil fuel-dependent countries, including Russia.

# Key Findings

**The low-carbon transition efforts of the EU and other large trading partners create a fresh incentive for Russia to catch up with overdue diversification and modernization of its economy.** The CBAM legislative proposal, as published by the EU in July 2021, was carefully designed as a “warning signal” rather than a biting trade sanction. EU CBAM is narrowly targeted at relatively few products in few emission-intensive and trade-exposed sectors covered by the EU emissions trading system (ETS). It only covers direct emissions from production processes, and not emissions associated with indirect inputs to these products, such as electricity and heat. EU CBAM will become effective in 2026 and will apply initially to 10% of total direct emissions. Its coverage will gradually increase to 100% over 10 years, as free emission allowances to the EU ETS companies are phased out. Therefore, the affected Russian exporters will have ample time and options to adjust. But it is a clear signal that a high carbon price is there to stay in the EU and that the bloc aims to encourage the global emission reduction rather than just shifting emissions between countries.

**The simulations show that CBAM's introduction by the EU only reduces Russia's exports to the EU, however, this is partly offset by redirecting exports to other countries that are not participating in climate mitigation policy.** EU CBAM imposed on direct (Scope 1) emissions would only result in an average loss of less than 3% of Russia's real exports to the EU in 2030–2035 as compared to the reference scenario without CBAM. If Scope 2 emissions (associated with production of electricity inputs to production) are covered by CBAM, Russia's exports to the EU would be reduced by about 7%. The largest EU export reductions will be in chemical products (above 60% in 2030–2035), mineral products (30–40%), electricity (nearly 30%), ferrous metals, and petroleum coal products (each around 20%). The decline of exports to the EU would be partly compensated by a rise in exports to other regions. While in 2035, exports from Russia to the EU could decrease by about US$19 billion, exports from Russia to the rest of the world would increase by about US$11 billion. Overall, by 2035, the loss of exports would be merely 0.4% if EU CBAM covers only Scope 1 and would rise to 1.2% if Scope 2 is also included.

**The introduction of EU CBAM as proposed in July 2021 can be easily weathered by the Russian economy.** Even if Russia continues its current growth model, the economy-wide macroeconomic effect of EU CBAM (GDP reduction) would be negligible to small depending on its design. Russia's gross domestic product (GDP) is projected to be 0.06% lower compared to a no-CBAM baseline GDP if only Scope 1 emissions are covered by CBAM, and 0.12% lower if both Scope 1 and Scope 2 are covered by CBAM. Even if the U.S. joins the EU in introducing a carbon border adjustment, Russia's losses will increase only negligibly.

**Without carbon border adjustment, ambitious climate policies by the EU and other fossil fuel importers would reduce Russia's oil and gas export revenues, while adding carbon border adjustment could result in some reversal of this impact.** Bold external climate policies would reduce global demand for fuels. Global hydrocarbon commodity prices would become more volatile and eventually fall. This, in turn, would result in depreciation of the Russian ruble and make exporting other non-fossil fuel commodities cheaper, encouraging diversification of Russia's export of manufacturing products beyond oil and gas. Furthermore, lower global oil and gas prices would reduce the opportunity costs of using fuels by domestic industries. These macroeconomic forces would increase international competitiveness of Russian carbon-intensive industries, and therefore attract emissions leakage, especially as—unlike their foreign competitors—Russian polluters would not face any costs of carbon emissions. Carbon border adjustment introduced by large fuel importers would eradicate this (unfair) international competitive advantage of Russian emission-intensive industries. EU CBAM, for example, is to be paid by EU importers, effectively increasing prices for Russian exporters of products that are highly emitting during production in Russia and increasing consumer prices for these products in the EU. Therefore, EU CBAM leads to an increase of Russian exports by the sectors not covered by it, especially the export of oil and natural gas (though the model may underestimate direct and fugitive emissions related to extraction, processing, and transport of fuels). In the model, this increase in absolute value of hydrocarbon export is negligible, but the macroeconomic transmission channels of such external impacts on fossil fuel exporters are real. The growth of fossil fuel exports relative to the no-CBAM baseline does not imply growth of exports in comparison to the present level.

**Redirecting exports to the countries with weak climate policies may be a risky strategy for responding to EU CBAM.** Model simulations, which assume that stringent climate policies and carbon border adjustment are applied by larger "climate club" fuel importers than the EU alone, have a much stronger impact on the Russian economy. They could encourage an asset diversification, not just beyond coal, oil, and gas, but also beyond heavy industries and into new, knowledge-intensive, and green growth drivers. The benefits from redirecting trade or from splitting production processes into "green" destined for the EU market and "brown" directed elsewhere are reversed if more countries are participating in the global climate action club, making its market power much stronger. For example, climate action by OECD countries, China, India, and other fossil fuel net importers could lead to a decrease in Russian aggregate exports by 3–10% depending on scenarios including a 20–30% lower export revenue of oil, natural gas, and coal by 2050 compared to the reference scenario. Therefore, GDP could be 0.3 to 3% lower.

**Russia would benefit from participating in global efforts to reduce emissions and from diversifying its assets beyond those related to fossil fuels and downstream value chains.** Initially, some Russian stakeholders, especially emission-intensive heavy industries burning coal and gas, could temporarily benefit from freeriding[1] on the rest of the world's climate mitigation action, increasing output, and attracting emissions leakage. But global simulations show that with a sufficiently large global "climate club," such benefits could be completely erased by the economy-wide carbon border adjustment on full value-chain emissions. Interestingly, global cooperative scenarios would benefit Russian oil revenues compared to the scenarios where hydrocarbon importers act alone on climate. This finding informs some challenges to the political economy for Russia's carbon neutrality aspirations.

**Although ambitious climate and trade policy instruments are not yet applied by most large fuel importers, they represent a plausible part of the uncertain landscape of the future economic architecture, as more and more large economies are declaring carbon neutrality by around the mid-century**. Therefore, managing carbon border adjustment risks through the implementation of domestic climate mitigation policies is a prudent strategic choice with the lowest downside risk in the worst-case scenarios, and the highest upside opportunity in the best-case scenarios. By proactively and strategically decarbonizing its economy, Russia can further modernize its asset base and make it more resilient to weathering the anticipated more volatile and lower global fossil fuel prices and demand that will result from climate policies in all major fossil fuel importing economies. Joining common efforts to address climate change, Russia can reduce the negative impacts on welfare in the country by more than 45% in 2050, as compared to the scenario of the global climate policy without Russian participation.

**Asset diversification is key to Russia's prosperity in the greening world. It is modeled as investments in research and development (R&D) and human capital in Russia and is followed by increasing labor productivity, leading to net welfare gains in the long run.**

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[1] Not paying fair share in the global climate actions.

While a combination of cooperative climate mitigation efforts and asset diversification policies results in the greatest economic benefits (a 3.4% increase in welfare in 2050 compared to the baseline), even under a scenario with a carbon border adjustment where Russia does not take part in the collective global actions to mitigate GHG emissions, asset diversification leads to positive macroeconomic impacts (a 2.2% increase in welfare in 2050 compared to the baseline).

# Policy Recommendations

**Enabling green transformation in Russia requires policy measures in three broad categories:**

- **Consistent and credible climate mitigation policies integrated into economic and fiscal policy making.** Climate legislation in Russia can initiate an introduction of a carbon price in explicit or implicit form and synchronize the regulatory framework with international carbon markets or other forms of carbon pricing. The study shows that it is cheaper to reduce emissions in Russia compared to many other regions. Cheaper emissions reduction does not necessarily mean easier reduction. The high cost of capital and institutional barriers may become significant obstacles to investment in low-emission projects. However, the simulations demonstrate that even a modest carbon price, if well designed, can achieve a significant emission reduction in the country. Russia may benefit from creating a domestic carbon market and integrating into international/regional carbon markets, including voluntary markets with the potential to attract investment to low-carbon projects. In addition to fiscal instruments, enabling policies that combine standards, certification, and technical and financial support will promote climate-smart solutions, such as improving energy efficiency. Increasing energy efficiency helps to reduce emissions and simultaneously strengthen economic growth.

- **Measures aimed at creating an enabling framework to facilitate and stimulate the public and private investments required for a green transition.** A well-established green finance framework could become an important catalyst for attracting foreign and domestic investment towards sustainable recovery and growth in a variety of low-carbon sectors. Key attributes of a functioning green finance system are the unambiguous characterization of green projects in accordance with internationally accepted standards tailored to the specifics of the country's economy and climate ambitions, and full transparency of information and disclosures. Moreover, identification and management of climate-related financial risks[2] — both physical and transition— will be crucial to financial sector stability and, therefore, its ability to finance needed investments.

[2] The potential risks that may arise from climate change or from efforts to mitigate climate change, their related impacts, and their economic and financial consequences. Bank for International Settlements 2021.

- **Measures directed at specific sectors in which Russia may specialize in the decarbonized world.** This report briefly discusses four select sectors of the Russian economy to which green transition could bring large benefits: (a) renewables; (b) other energy technologies; (c) mining for low-carbon energy system;[3] and (c) climate-smart forestry.

**A comprehensive approach to green transition would combine regulating GHG emissions, lifting remaining fossil fuel subsidies, developing green finance infrastructure, and supporting new sectors of growth**. It will also require measures to protect those who may be disadvantaged by these policies and ensure the inclusiveness of green growth. As many of these measures go far beyond the objectives of GHG emissions reduction, climate policies and strategies should be integrated into the country's strategy of long-term economic development and vision of its competitive advantages in a new greener world.

## Key Messages

- Russia faces risks and opportunities associated with the global shift to carbon neutrality. By taking cooperative action along the path to a green transition, Russia can overcome the risks from global decarbonization and benefit from green growth, creating new comparative advantages in several sectors.

- Diversification of the economy is a crucial component of Russia's response to global decarbonization. To be effective, it needs to find a substitute not merely to hydrocarbon export revenues, but also to carbon-intensive industrial exports revenues. Decarbonization can facilitate deeper diversification of Russia's economic assets and foster new drivers of economic growth to gradually replace the role of fossil fuels and energy-intensive assets.

- Climate policy can be an important tool to create incentives for public and private actors to initiate green transformation and to diversify the economy, fostering economic growth, productivity, and innovation.

[3] The World Bank's Climate-Smart Mining Initiative supports the sustainable extraction, processing, and recycling of minerals and metals needed to secure supply for low-carbon technologies and other critical sectors by creating shared value and delivering social, economic, and environmental benefits throughout their value chain in developing and emerging economies.

# 1

# RUSSIAN ECONOMY AND THE CHALLENGES OF FOSSIL-FUEL DEPENDENCE

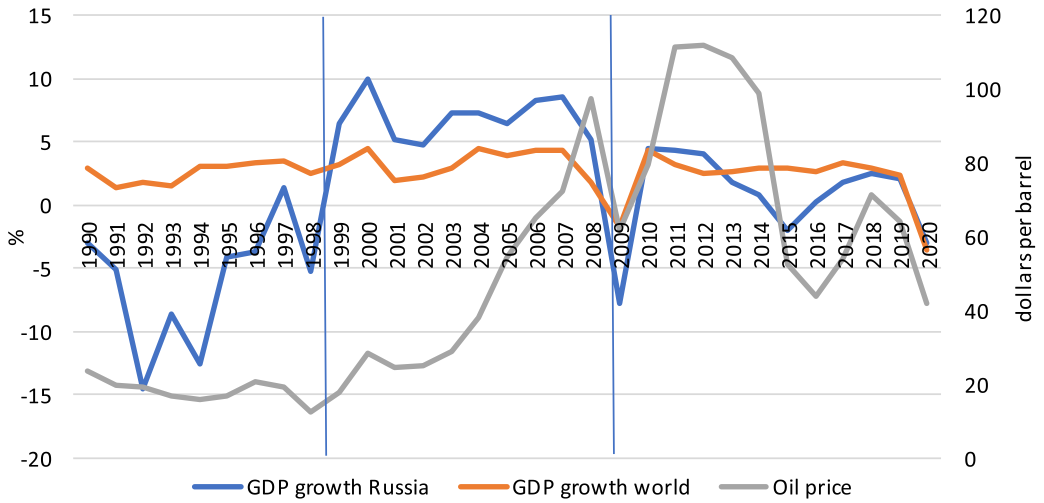
## 1.1. Evolution of Russian Economic Growth

The last 30 years of Russia's modern economic history can be divided into three periods: post-Soviet transitional crisis, rapid recovery, and slowdown (Figure 1). The first of these periods began with the collapse of the Soviet Union with 1990–1998 characterized by a serious transitional crisis.  Russia's GDP dropped by 42.5%, poverty spread throughout the country, and inequality widened dramatically. Recovery began in 1999, and for a decade, Russia's GDP grew significantly faster than the global average. To a great extent, this growth was made possible by the rise in oil prices from US$18/ barrel in 1999 to US$97/ barrel in 2008.

The oil price surge period underlies Russia's current economic model. The country's economic model remains largely based on the extraction and export of fossil fuels. In the 2000s, oil and gas revenues ensured a rise in living standards for Russian citizens, as well as the country's overall macroeconomic stability. However, this revenue helped conceal the Russian economy's structural problems: the dominance of large state-controlled companies, low productivity in processing industries, rigid labor markets, a poor investment climate, inefficient governance, weak protection of property rights, companies' insufficient access to foreign markets, and, overall, high dependence of the national economy on external shocks.

Following the global financial crisis of 2008-2009, Russia has not returned to high rates of economic growth. Even with high oil prices that, until 2014, remained over US$100/ barrel, the Russian economy lost its ability to rebound, and the drop in oil prices after 2011 plunged it into stagnation. In recent years, Russia's economy has not performed to its potential, with an average annual growth rate of 0.9% from 2013–2019 or almost three times less than the global average of 2.8%. External factors contributed to the slowdown, including the drop in oil prices and Western sanctions. However, while both of these factors began playing out in 2014, the slowdown started earlier–in 2012–meaning it was primarily caused by structural problems in the Russian growth model.

**Figure 1. Oil prices (right axis) and the GDP growth rate in Russia and the world (left axis)**



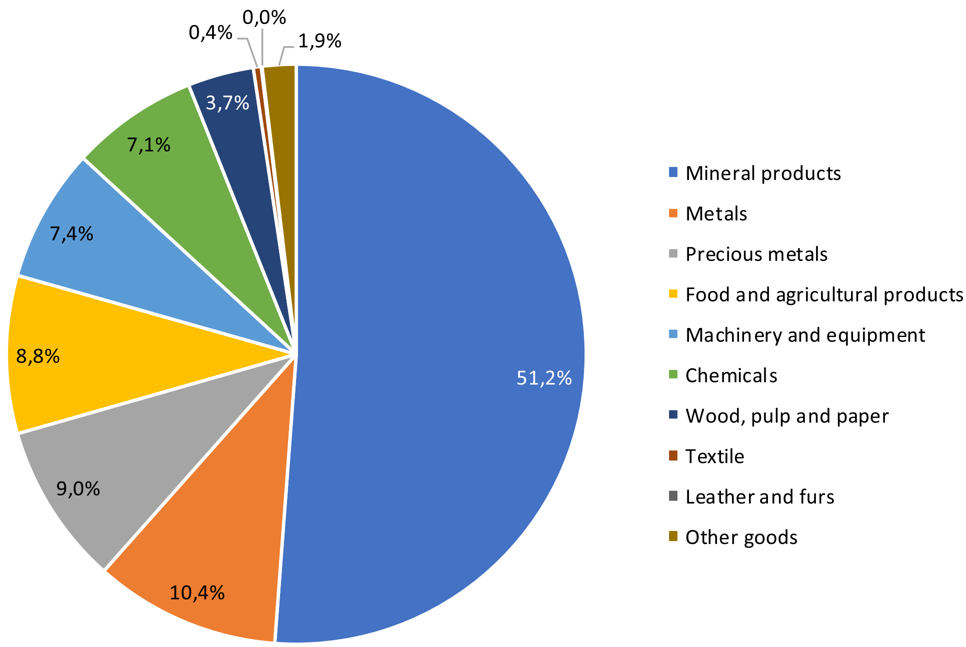

*Sources: Based on World Bank data and BP Statistical Review of World Energy 2021.*

In 2020, the COVID-19 (coronavirus) pandemic simultaneously resulted in three shocks to Russia's economy. The demand shock occurred because of a lockdown and the related decline in household consumption. The supply shock was caused by the disruptions of value chains and business activities. The third shock was related to the drop of global oil prices, which in the first half of 2020 hit their lowest point in the twenty-first century. As a result, Russia's economy contracted by 3.1%. Such a relatively modest GDP contraction, relative to other Group of 20 (G20) countries, was made possible by targeted and well-planned governmental support, balanced lockdown measures, and the relatively low share of Russia's service sector–the hardest-hit sector in most economies affected by the pandemic.

## 1.2. Dependence on Fossil Fuels

Historically, Russia has relied on the energy sector as the major driver of its economic growth. Russia is the world's largest exporter of hydrocarbons as well as one of the leading countries in terms of reserves of oil, gas, and coal. In 2019, oil and gas provided 39.3% of federal budget revenues and the share of fossil fuel exports in total Russian exports reached 59.9%, while fossil fuel rents accounted for 14.2% of GDP. In 2020, fossil fuels as share of both exports and budget revenues decreased due to the fall in oil prices. To some extent, Russian exports have diversified over the past few years: for instance, agricultural exports have expanded significantly. However, mineral products, particularly primary fossil fuels, still account for more than a half of the country's exports (Figure 2).

**Figure 2. The structure of Russian exports in 2020**



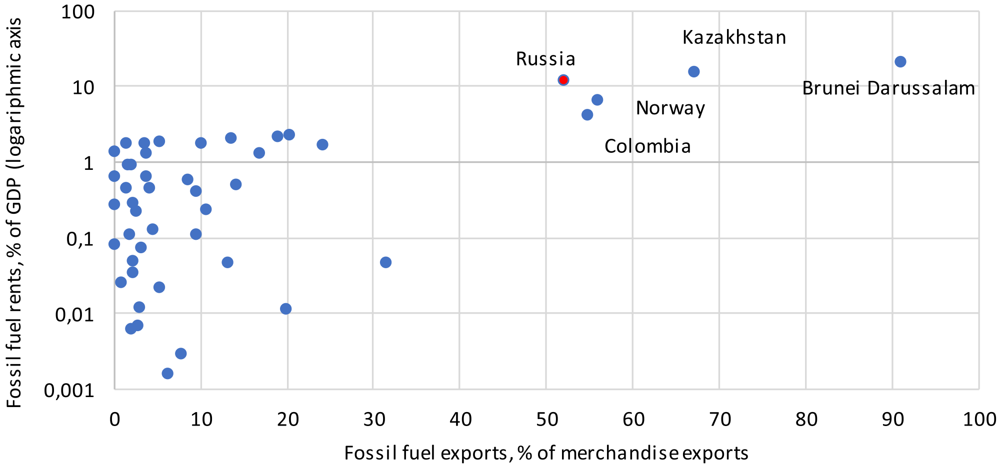

*Source: Based on Federal Custom Service of the Russian Federation data.*

The literature provides significant evidence on the variety of risks that fossil-fuel dependence brings to a country. The resource curse concept (Auty, 2001) suggests that resource endowment and economic growth are negatively correlated. An abundance of fossil fuels exposes a country to the volatility in the commodities markets, reduces competitiveness of other sectors of the economy through a rising real exchange rate, and negatively affects the quality of political institutions (see the literature overview in Peszko et al., 2020).

At the same time, the shift toward global low-carbon development brings another set of risks to fossil fuel-dependent economies. These risks, associated with the gradual global phaseout of fossil fuel use, are called transition risks, a term popularized by Mark Carney's 2015 speech (Carney, 2015).

The substantial role fossil fuels play in Russia's economy underlies challenges on the pathway toward an active climate change mitigation policy. Figure 3 shows Russia's comparison, in terms of its fossil fuel dependence, with all the countries that have carbon pricing mechanisms implemented, scheduled for implementation, or under consideration (World Bank, 2021a). Among these economies, Russia may be compared only with Colombia, Kazakhstan, and Norway, all of which have carbon pricing systems in place, and with Brunei Darussalam, which is considering introducing it (Figure 3). Fossil fuel dependence is far weaker in all the other countries. Despite the average temperature in Russia rising 2.5 times faster than the world average, the physical risks of climate change (Box 1) are still perceived as less significant than risks from green transition, which are yet to be understood and well-integrated into the country's vision of its future. The green transition remains misunderstood in Russia and risks and opportunities associated with it are not integrated into the country's vision of the future. This report provides evidence that first, passive climate policy will not secure Russia from transition risks but rather exacerbate them; and second, that the global low-carbon transition provides Russia with numerous opportunities, including the chance to develop new economic sectors, diversify its economy, and decrease its dependence on fossil fuels.

**Figure 3. Fossil fuel rents (% of GDP) and fossil fuel exports (% of merchandise exports) in countries with carbon pricing programs implemented, scheduled for implementation, or under consideration.**




*Source: Based on World Bank data.*

### Box 1. Physical risks of climate change for Russia

Many global integrated assessment models show that Russia is one of few countries that may benefit from moderate climate change. However, these results are explained by the limited sectoral coverage of such models. These models usually focus on the impacts of climate change which are relevant for most of the world, such as impacts on agriculture, tourism, healthcare, coastal areas, and natural disasters. Some of these impacts will be insignificant for Russia relative to many other countries, while several of Russia's sectors, like agriculture and tourism, may actually benefit from a moderate temperature rise (Stern, 2007; Roson and Sartori, 2016; Ricke et al., 2018; Kahn et al., 2019).

However, the studies that focus specifically on the impacts of climate change in Russia indicate that Russia can expect more pessimistic outcomes.

- First, Russia faces some specific physical risks from climate change such as melting permafrost. Streletskiy et al. (2019) estimated the value of buildings and infrastructure that will be affected by melting permafrost in the RCP 8.5 scenario and showed that 20% of structures, 19% of infrastructure assets, and 54% of buildings will be affected by significant permafrost degradation by the middle of the century, with a total value of US$137 billion. One good illustration of the implications of melting permafrost was the catastrophe in Norilsk in 2020, when some 20,000 tons of diesel oil leaked from a storage tank onto the ground and into local rivers. Damages were estimated at 148 billion rubles (Rospotrebnadzor, 2020).

- Second, physical risks from climate change are spread very unevenly across the country. In some cases, they occur in regions that are very important for the national economy, here the economic impact may be high. For example, the overall impact of climate change on agriculture in most Russian regions may be positive, but in the southern part of European Russia, where water stress is increasingly affecting agricultural productivity, climate change will have a negative effect. Regions such as Krasnodar krai and Stavropol krai, which are especially exposed to water stress, are Russia's major agricultural producers (Belyaeva and Bokusheva, 2017).

- Third, physical risks from climate change, namely through natural disasters, vary greatly over time. In general, Russia's vulnerability to natural disasters is lower relative to the world average, but some natural disasters may bring huge losses. For instance, the 2010 heat wave that hit the European part of Russia led to 54,000 additional deaths (Revich, 2011). Porfiriev (2013) estimated human losses in Moscow as 1.23-1.57% of the city's GDP. Another example is the forest fires of 2019 that affected 1% of the overall forest area of the country and led to the damage equal to 14-15 billion rubles (President of the Russian Federation, 2021).

- Fourth, rather optimistic estimations of economic impacts of climate change in Russia usually do not consider the asymmetry between losses and benefits. Losses will take place even if no action is taken, while to take advantage of the benefits, significant investment is usually required to adapt to climate change and to develop new infrastructure (such as the Northern Sea Route). Given the high cost of capital, such investment in the country is rarely sufficient.

## 1.3. Opportunities for Green Post-COVID-19 Recovery

The National Plan for Economic Recovery in Russia was first adopted in April 2020 and has since been updated several times in response to changing dynamics of the pandemic. Under the plan, the government provides direct payments to families with children, while most of government support takes the form of tax breaks, subsidies, relaxing administrative regulations, subsidized preferential loans, etc. Under the plan, the government channeled funds to 15 sectors that suffered the most during the pandemic. These funds helped protect 6.7 million jobs in these sectors, including 5.3 million in small and medium enterprises (SMEs), which were exposed to risk. The Russian stimulus package amounted to 4–4.5% of GDP in 2020.

Short-term recovery measures co-exist with the long-term strategic goals for 2030 as stated in the June 2020 Presidential decree. These goals fall into five major categories: 1) protecting the population, health, and welfare of people; 2) opportunities for self-realization and talent development; 3) comfortable and safe living environment; 4) worthwhile, efficient work, and successful entrepreneurship; and 5) digital transformation. Many of these objectives have remained unchanged since the long-term goals for 2024 were set by the president (President of the Russian Federation, 2018). The 2024 goals are to be fulfilled through 13 “National Projects”—a series of ambitious programs, which run until 2024 with approximately US$350 billion in planned overall funding.

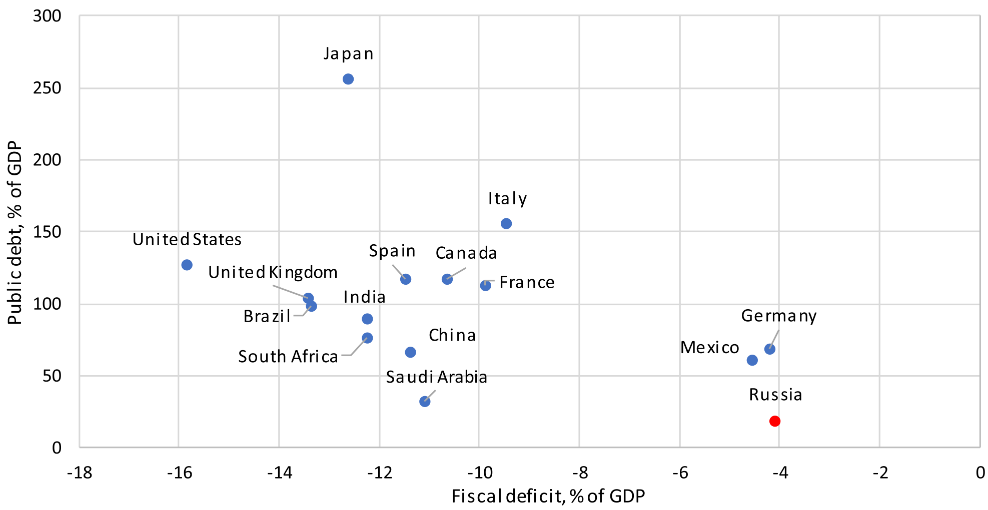
At this moment, Russia finds itself at a crossroads of trajectories for economic development beyond the pandemic. In recent years, the country’s reliance on fossil fuels has not supported economic growth and cannot be expected to do so in both the medium and long term. Russia’s fossil-fuel dependent economy will face a new challenge: the green transition of the global economy and especially of Russia’s largest trading partner, the EU. This global transition calls for Russia to now identify new sources of growth and more resilient economic strategic planning to adjust to new realities.

The experience of economic recovery in many countries shows that crises provide an opportunity for changes in the development model through implementing decisive measures that are not feasible in good times (Makarov, 2021). Today, in the EU, the recovery package is coordinated with the European Green Deal aimed at developing a new greener economy; in the US, it is linked with new infrastructure and industrial policy; and in China, it is aimed at fostering the transition towards consumption-led economic growth and development of digital infrastructure.

The current recovery plan in Russia primarily contains rescue spending aimed at supporting people and businesses, but nearly no structural stimulus spending aimed at reinvigorating the economy. Russia’s recovery plan does not seek to decrease the country’s economic dependence on fossil fuels or make Russian economic growth more resilient to global green transition. According to the Energy Policy Tracker (2021), at least US$5.18 billion of the recovery package is directed towards supporting fossil fuels while no money is provided for green energy.

Russia has an opportunity to implement such stimulus measures. The country has the largest policy space among all the major economies (Figure 4). Even after launching its stimulus package during the COVID-19-related crisis of 2020, Russia probably has the healthiest public finance among G20 economies: low public debt (19.3% of GDP) and low fiscal deficit (-4.1% of GDP). Russia also has about US$600 billion of international reserves (fourth in the world) and about US$190 billion in a sovereign fund (its Fund of National Welfare). Moreover, since the beginning of 2020, despite the pandemic, the Fund of National Welfare, measured in U.S. dollars, increased by 51.4%. The new "frontal" strategy of economic development through 2030, currently being developed by the Russian government, is an opportunity to define both short- and medium-term policy goals and priorities during recovery. This strategy can potentially help lay the framework for a greener economic development model.

## Figure 4. Fiscal deficits and public debt in G20 countries in 2020




*Source: Based on IMF data.*

On October 29, 2021, the prime minister of Russia approved the Low-Carbon Development Strategy of the Russian Federation until 2050, which links low-carbon transformation with economic growth. The target scenario of the Strategy envisages the reduction of net GHG emissions by 60% compared to 2019 and by 80% compared to 1990 by 2050. It is also compatible with the target to achieve carbon neutrality by 2060 declared by the Russian Federation President in October 2021. The Strategy names key important regulations to reduce emissions including carbon pricing, development of green finance, green energy certificates, and a solid monitoring, reporting and verification (MRV) system. The strategy estimates an investment need for the target scenario at the level of 1% of GDP in 2022–2030 and 1.5-2% of GDP in 2031–2050. Also, the target scenario relies on a significant increase in the absorptive capacity of ecosystems (by a factor 2.2 compared to 2019) as a result of measures in forestry and agriculture with estimated investments to achieve this carbon sequestration at 0.1% of GDP annually.

Better understanding of risks and opportunities to achieve the target scenario would be beneficial to implement the Strategy. This study aims to contribute to this process. First, the study assesses the impacts of the global green transition, including the reduction of demand for energy and introduction of carbon border adjustment, on Russia's economy (Chapter 2). Second, it looks at the policy responses needed to mitigate these impacts and build a more resilient development model for Russia (Chapter 3). Finally, the study examines the opportunities that the global green transition could bring to Russia and outlines specific sectors that may benefit from global low-carbon development (Chapter 4).

This study has developed analytical tools that will be further advanced in the Country Climate and Development Report (CCDR) for Russia, a new flagship analytical product of the World Bank. Conducted in cooperation with the Government of Russia, the CCDR will investigate how climate change impacts and transition risks can be aligned with Russia's development aspirations and will identify potential drivers and pathways towards diversified, low-carbon, and resilient economy and a prosperous society.

# 2

# RISKS OF THE GLOBAL GREEN TRANSITION FOR RUSSIA’S ECONOMY

## 2.1. Risk Overview

In the coming decades, climate policy is likely to become more stringent all over the world. The reduction in GHG emissions recently observed due to the COVID-19 pandemic is projected to have limited implications for long-term emission trends (Forster et al., 2020). To keep average global temperature within two degrees Celsius of pre-industrial levels, countries will still need to implement ambitious mitigation efforts (Reilly et al., 2021). Achieving stringent mitigation targets, like those outlined in the Paris Climate Agreement (UNFCCC, 2020), would bring multiple benefits for the environment and health, but would come at significant implementation costs (Liu et al., 2020). While many studies considering the full set of costs and benefits of climate change and climate mitigation find positive net welfare impacts from stringent emission reduction policies (e.g. Markandya et al., 2018; Vandyck et al., 2018), it is important to understand the potential risks of such a transition and explore policy measures that would help to minimize these risks.

Decarbonization around the world brings significant risks for economies dependent on fossil-fuels. Stringent climate mitigation pathways that include a rapid reduction in fossil fuel consumption and transition toward renewables significantly impact large fossil fuel exporters. Their fossil fuel assets may significantly drop in value, resulting in the loss of income flows and negatively impacting the welfare of the population (e.g., Mercure et al., 2018; Chepeliev et al., 2021). As one of the largest fossil fuel exporters in the world, Russia is at high risk.

This study divides these risks into two groups. In the short term, the major threat comes from border carbon adjustment applied first in the EU and then (probably) in other countries. In the longer term, the Russian economy would also be affected by the reduction of global demand for fossil fuels and corresponding devaluation of fossil fuel assets.

Increasingly in many countries, ambitious climate policies threaten their business sector's competitiveness, at least in the short term. Many countries have already declared their intent to achieve net zero emissions by the middle of the century (e.g., Net Zero Tracker, 2021). This list includes China, Germany, Japan, Kazakhstan, Netherlands, and Republic of Korea, all major trading partners for Russia. For many of these countries, climate change mitigation is a story of short-term loss for long-term gain. GHG-reduction measures require investment which could otherwise be directed towards other issues. In any country, some sectors of society or business will lose out from these measures and will need to be compensated (Meckling et al., 2018; Gaikwad et al., 2020). In the short term, GHG reduction measures may also undermine competitiveness, as compared to those economies that do not have any carbon regulation (Ellis et al., 2018; Ward et al., 2019; Evans et al., 2021).

Carbon border adjustment is an instrument to prevent carbon leakage and cope with freeriding.[4] Climate policy leaders are concerned that their unilateral emissions reduction efforts can be offset by emissions increasing in other countries, which do not implement comparable climate policies, with their emissions increasing in relative terms (carbon leakage) (European Commission, 2021). This asymmetry in the cost of carbon across countries would give polluting and energy-intensive firms located in "pollution haven" jurisdictions unfair advantages over companies that pay a high price for the climate warming they cause. Peszko et al. (2020) showed that ambitious climate policies in fuel importing countries trigger macro-economic adjustment mechanisms for a large-scale emissions leakage to countries that are

[4] Not paying a fair share in the global climate actions.

large producers and exporters of coal and gas, and relatively less leakage to oil producing countries. To address emissions leakage, investors and governments in the countries with climate policies may try to put pressure on the countries that lack such policies (Makarov, 2020). Many large companies already require their suppliers and other partners to meet basic environmental and climate standards, such as disclosing information on emissions and introducing at least minimal GHG-reduction measures. Industrial codes of conduct and even carbon regulation plans appear in some sectors, with aviation as the most illustrative example. Many companies have introduced corporate carbon prices and are now interested in expanding them to the whole market. Institutional investors divest from carbon intensive industries, encouraging them to diversify. One possible instrument gaining support from many governments and businesses is carbon border adjustment, which imposes an additional burden on imported carbon intensive products (Cosbey et al., 2012). For the first time, this instrument is likely to be implemented in the European Union (European Commission, 2019; Evans et al., 2021). Carbon border adjustment mechanism (CBAM) is included in the European Green Deal and may be launched as early as 2026 (with a transition period starting in 2023).

EU CBAM may provide strong momentum for the integration of emissions regulation policies into international trade and finally make climate-related trade barriers a common practice. Nordhaus (2015) proposes the idea of climate clubs – groups of countries that agree to regulate emissions at a stricter level and coordinate border tariffs against those countries not introducing such regulations. Peszko, van der Mensbrugghe, and Golub (2020) used global macroeconomic and trade model ENVISAGE to simulate unilateral climate policies of such a hypothetical climate club consisting of net importers of fossil fuels and various designs of border carbon adjustment taxes that they could apply on freeriding fossil fuel-dependent countries. California was the first to apply CBAM on the carbon content of electricity imported to the state's grid. EU CBAM may be the first step towards the formation of a climate club that would embrace other large economies and possibly include the U.S. and China (Tagliapietra and Wolff, 2021). Canada is looking to engage with international partners to advance a global dialogue on CBAM (Government of Canada, 2021). Following the logic of climate clubs, the present study applies global CGE model ENVISAGE to not only simulate the impact of EU CBAM on Russia's economy but also the impacts of carbon border adjustment measures implemented by much larger climate clubs.

Ambitious climate policies worldwide may reduce the demand for Russian energy exports. Orlov and Aaheim (2017) estimate that if the parties to the Paris Agreement fulfill their nationally determined contribution (NDC) targets, Russia would experience a 1.8% loss in welfare by 2030, primarily due to a reduction in fossil fuel exports. Makarov et al. (2020) show that in the NDC scenario, Russian energy exports would be 20% lower by 2030, and 25% lower by 2050 relative to the Reference scenario. In general, under the NDC scenario, climate policies outside Russia would lower Russia's GDP growth rate in 2020–2030 by 0.2-0.3 of a percentage point. If global mitigation ambition increases on par with the two degrees trajectory after 2030, it would add almost a half of a percentage point to the decline in Russia's GDP growth rate in 2035–2050 (Makarov et al., 2020). The present study applies CGE modeling to provide updated scenarios of the impacts of worldwide climate policies on Russian macroeconomic performance.

Ambitious global climate policies would mean that many fossil fuels will stay in the ground and their value as a component of national wealth would decrease. According to a recent World Bank study, the devaluation of oil reserves as a result of active climate policies globally amounts to US$3.1 trillion; coal reserves, up to US$1.9 trillion; and natural gas, up to US$1.2 trillion. In percentage terms, coal reserves would lose the most value, up to 48% as compared with the reference scenario (when no global climate policy is implemented) (Peszko et al., 2021). The present study uses the same computable general equilibrium (CGE) model to estimate the losses of fossil fuel assets in Russia in different scenarios of global mitigation action. This not only shows the losses of natural wealth but also demonstrates the vulnerabilities associated with policies relying on fossil fuels. These policies include subsidizing fossil fuels, building infrastructure and conducting R&D policies in oil and gas and related sectors, and investing in technologies that will not be needed in the future.

The following sections present the results of modelling the EU CBAM's impacts on Russia's economy as well as the impacts that broader climate policy measures outside of Russia have on Russian wealth, exports, and asset value. In this report the Environmental Impact and Sustainability Applied General Equilibrium (ENVISAGE) model (van der Mensbrugghe, 2019) is used, which is a recursive dynamic and global CGE model. The methodology is described in detail in Annex A, while Annex C presents the approach for considering technological progress and innovations in the model.

## 2.2. Deep Dive into CBAM: Modeling Impacts on Russia's Economy up to 2035

### 2.2.1. The EU Carbon Border Adjustment Mechanism

The EU Green Deal represents a roadmap for joint action of the EU countries toward reduction of greenhouse gas emissions by at least 55% by 2030 from the 1990 levels, and achievement of carbon neutrality by 2050. The Green Deal covers all sectors of the European economy from transport and energy to construction and information and communications technologies, and aims to increase energy efficiency of resource use and contribute to solving climate change and other environmental challenges like air pollution and biodiversity loss.

As part of the Green Deal, the EU has announced plans to introduce CBAM to prevent carbon leakage and support the EU's mitigation ambition as well as those of other countries (European Commission, 2021). CBAM is proposed to come into full force in 2026 after its transitional phase from 2023–2025, when CBAM is gradually introduced in line with the phasing out of free allocations for $CO_2$ allowances.[5]

[5] Allocation of $CO_2$ emission allowances is the process of distributing allowances to covered entities in an ETS. There are two basic options for allocation: allowances can either be allocated for free or sold by auction. Free allocation is based on benchmarks that reward the most efficient installations in each sector. In Phase 4 of the ETS free allocation will focus on sectors at the highest risk of relocating their production outside of the EU. These sectors will receive 100% of their allocation for free. For less exposed sectors, free allocation is predicted to be phased out after 2026 from a maximum of 30% to 0 at the end of Phase 4 (2030) (https://ec.europa.eu/clima/eu-action/eu-emissions-trading-system-eu-ets/free-allocation/allocation-industrial-installations_en).

### Box 2. EU Carbon Border Adjustment Mechanism

The July 2021 package in support of the EU's climate targets introduces the Carbon Border Adjustment Mechanism (CBAM) as a climate measure to prevent the risk of carbon leakage and to support the EU's increased ambition on climate mitigation, while ensuring WTO compatibility.

Climate change is a global problem that needs global solutions. As the EU raises its own climate ambition and less stringent environmental and climate policies prevail in non-EU countries, there is a strong risk of "carbon leakage" – i.e., companies based in the EU could move carbon-intensive production abroad to take advantage of lax standards, or EU products could be replaced by more carbon-intensive imports. Such carbon leakage can shift emissions outside of Europe and therefore seriously undermine both EU and global climate efforts. CBAM is expected to equalize the price of carbon between domestic products and imports and ensure that the EU's climate objectives are not undermined by production relocating to countries with less ambitious policies.

The CBAM system will work as follows: EU importers will buy carbon certificates corresponding to the carbon price that would have been paid had the goods been produced under the EU's carbon pricing rules. Conversely, once a non-EU producer can show that they have already paid a price for the carbon used in the production of the imported goods in a third country, the corresponding cost can be fully deducted for the EU importer. The CBAM will help reduce the risk of carbon leakage by encouraging producers in non-EU countries to green their production processes.

*Source: https://ec.europa.eu/commission/presscorner/detail/en/qanda_21_3661*

CBAM will be integrated into the EU Emissions Trading System (EU ETS) requiring importers to purchase certificates to cover emissions embodied in imported goods. The price for certificates will mirror the EU ETS price. According to the European Commission proposal, during the transitional phase, importers will not be obliged to pay a financial adjustment but will have to report the emissions embodied in goods imported from third countries.

The coverage of CBAM is now limited to the most carbon intensive sectors and only to Scope 1 (direct) emissions, although, it may be extended in the future. As now planned, starting from 2026, CBAM will apply to imports in those sectors that most exposed to carbon leakage, i.e., cement, iron and steel, aluminum, fertilizers, and electricity. However, by the end of the transitional phase, the European Commission plans to evaluate the system's performance and decide whether to extend the coverage of CBAM to also include Scope 2 (indirect) emissions.

Since the EU is the largest trading partner for Russia, CBAM is expected to affect its economy more than that of other countries. In 2020, 42% of Russian exports were directed to EU and European Free Trade Association (EFTA) countries, and in 2019, it was 46%. More than 10% of these exports represent energy intensive, trade-exposed sectors (EITE) potentially exposed to CBAM. CBAM would act as an increase in tariffs imposed by the EU on the goods from these sectors, with tariffs based on the carbon intensity of commodities covered in the exporting countries.

CBAM would impact the Russian economy in several ways. It will cause Russia's emission-intensive exports to the EU to decline. However, this is only the direct impact. CBAM might cause a significant reallocation of resources across sectors based on their carbon intensity and change the geography of trade flows. Quantification of these indirect impacts is instrumental for designing an adequate policy response to the CBAM implications.

### 2.2.2. Model and Scenario Assumptions

For the assessment of the CBAM's impacts on Russia's economy, the simulation uses the Global CGE model ENVISAGE (v.10) (see Annex A for more information) specifically tailored to analyze climate change mitigation policies. The modeling is based on the GTAP 10 Power database. Simulations cover the period 2014–2035, where 2014 is the base year. Baseline projection for the years 2014–2035 covers all variables of the model, including industry outputs, the trade in commodities, relative commodities prices, aggregate economic categories, energy use, and GHG emissions. Baseline assumes that countries reduce their emissions in line with their NDC until 2030 submitted as part of the Paris Agreement. Emissions reduction is partly facilitated by assumed exogenous technical change, such as energy efficiency improvements and expansion of renewables in generation of electricity. Where these exogenous changes are insufficient, an endogenous emission price (a carbon price) is determined to facilitate further emission reduction. Emission price invokes substitution of energy for capital (and therefore, further energy efficiency improvement), substitution of fuels for electricity, substitution of more carbon-intensive fuels for less carbon-intensive fuels, and changes in the power generation sector's technology mix.

This study is the first attempt to apply a CGE approach to the analysis of the CBAM effects on Russia's economy. The advantage of this approach is that it takes wider macroeconomic effects and structural economic adjustments into account. These effects have been neglected in the growing number of analyses of the CBAM's impacts on Russia (Rossiyskaya Gazeta, 2021; Bashmakov et al., 2021; Gayda et al., 2021). Among other things, the existing estimations do not account for changes in redistribution of the export flows or changes in the structure of Russian exports (including the possible rise in exports of non-energy-intensive goods and services). However, the CGE model's focus on macroeconomic and industry effects of CBAM does not allow it to take the heterogeneity of companies into account, and it may neglect the specifics of individual reactions at the entity level. In particular, CBAM may have different implications for different companies or facilities within the same industry, depending on the carbon intensity of the technology they use. Even when overall exports of an industry decrease because of CBAM, several producers in that industry may take advantage of lower carbon intensity (relative to the industry average) and increase their exports. Moreover, even the relatively more carbon-intensive producers may reshuffle their trade flows: directing less carbon-intensive goods to the European market while keeping relatively more carbon-intensive goods at the domestic market to help decrease potential losses.

Modeling is done for a set of scenarios describing various combinations of policy choice in the EU and Russia (Table 1). All scenarios assume that CBAM is gradually implemented in the EU and European Free Trade Association (EFTA) countries in the form of an import tax on the emissions content of the imported products (see Annex D for further details). By default, the CBAM tax is calculated based on Scope 1 and 2 emissions. However, an additional scenario: "Carbon price / CBAM, Scope 1 (EU)," only for Scope 1 emissions is added to reflect the initial EU proposal to estimate the sensitivity of the model outputs. There is also an additional "Carbon price / CBAM Scope 1, 2, FF included (EU)" scenario which implies that the CBAM also extends to crude oil, natural gas, and coal exports (based on Scope 1 and Scope 2 emissions arising during the extraction and transportation process, not the carbon content of fuels themselves). Additionally, a "Carbon price / CBAM Scope 1, 2 (EU + US)" scenario is added to simulate the situation when country climate clubs start to emerge with the U.S. joining the EU in restricting imports of carbon-intensive goods from countries with less stringent emissions regulation policies. Finally, there is a "Carbon price / CBAM Scope 1, 2 (EU and ECA w/o Russia)" scenario, which still implies no action in Russia but against the backdrop of increasing carbon prices in the countries of Eastern Europe, the Caucasus, and Central Asia.

Another scenario: "Russia carbon price with recycling to HH," assesses CBAM in the presence of Russian domestic climate policy to reduce emissions. This policy is modeled by adopting a carbon price across the economy, not just to the CBAM sectors. At the same time, the latter gradually reduces CBAM on energy intensive, trade-exposed (EITE) industries, as the CBAM rate depends on the difference between explicit carbon prices in the EU and exporting countries. The general assumption of the action scenarios for Russia is that from 2023 through 2027, the price of carbon is gradually raised to the EU level. In the case of no action, the carbon content of Russian exports to the EU is priced at the level of the EU carbon price (at a constant 2014 price of around US$110 in 2030).

The revenues received by the government from the introduction of the carbon price may be spent in different ways. Under the "Russia carbon price with recycling to HH" scenario, all revenues are transferred to households, so that the government deficit is fixed.[6] An alternative way of using the additional government resources presented by the "Russia carbon price with recycling to investment" scenario, is the reduction of government deficit (increase in government savings), which, in the model, fully translates to higher investment (either public or private). These two variants can be considered as two extremes, whereas the actual use of carbon price revenues might fall somewhere between them.

In the model, starting in 2023, the CBAM is applied to the sectors which are simultaneously carbon-intensive and trade-intensive and thus most exposed to potential carbon leakage. Since the simulation was conducted before the rules on CBAM were issued, the timeframe of implementation and the sectoral coverage used in the model vary in several ways from those set in the official European Commission proposal for CBAM (European Commission, 2021). However, these differences are negligible and do not significantly affect the overall impact of CBAM in the period up to 2035. The analysis also assumes that it is likely that sectoral and emissions scope coverage will increase in accordance with the European Commission plans. In the model, CBAM is implemented in two phases. In 2023, it is

[6] The model does not distinguish household types, income groups etc., and the design of such transfer would require active distributional analysis. Facilitating the transfer would also require active policies not analyzed here.

**Table 1. Policy Scenarios**

| Incentives for action | Short name | Description |
|---|---|---|
| CBAM (in the EU, EFTA and in the US) | Carbon price / CBAM Scope 1, 2 (EU) | CBAM introduced in the EU and EFTA. No action in Russia and other countries. |
| | Carbon price / CBAM, Scope 1 (EU) | CBAM introduced in the EU and EFTA based on scope 1 emissions only. No action in Russia and other countries. |
| | Carbon price / CBAM Scope 1,2, FF included (EU) | CBAM introduced in the EU and EFTA, extended to fuel extraction sectors (the tax based on emissions during the extraction process, not the carbon content of fuels). No action in Russia and other countries. |
| | Carbon price / CBAM Scope 1, 2 (EU + US) | CBAM introduced in the EU and EFTA as well as in the U.S. No action in Russia and other countries. |
| CBAM in the EU and EFTA in the presence of ambitious action in other countries | Carbon price / CBAM Scope 1, 2 (EU and ECA w/o Russia) | CBAM introduced in the EU and EFTA. No action in Russia; other ECA countries (Caucasus and Central Asia) act by imposing or increasing economy-wide price on GHG emissions. |
| | Russia carbon price with recycling to HH | CBAM introduced in the EU and EFTA. Russia acts, by increasing economy-wide price on GHG emissions. |
| | Russia carbon price with recycling to investment | CBAM introduced in the EU and EFTA. Russia acts, by increasing economy-wide price on GHG emissions. Increased government savings in Russia, due to carbon price introduction, effectively translates to additional investment. |

imposed on chemicals, mineral products not elsewhere classified (NEC), ferrous metals and electricity. Beginning in 2025, CBAM is extended to other mining products, refined petroleum and coke, non-ferrous metals, and metal products (as a sensitivity analysis variant, we also impose CBAM on coal, oil and gas exports, starting in 2025). See Table 2 for details.

**Table 2. CBAM Coverage and Implementation Phases with Mapping to GTAP/ENVISAGE Sectors**

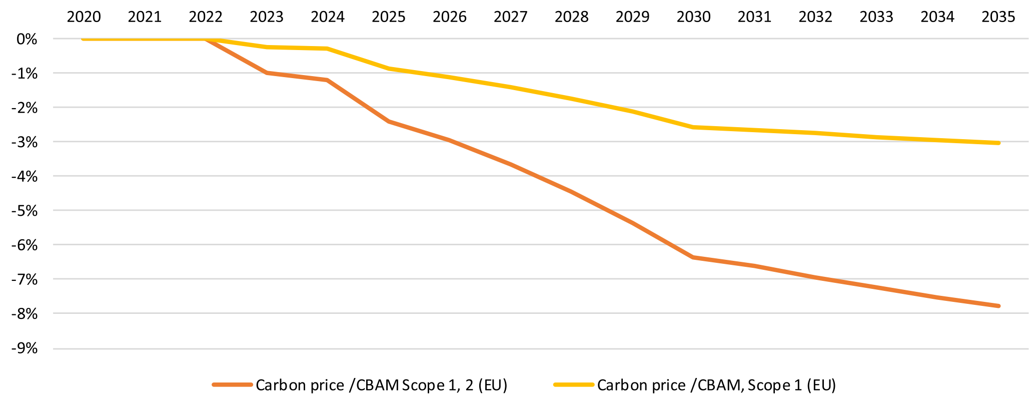
| Phase 1: 2023 | |
|---|---|
| **Sectors** | **GTAP match** |
| Steel | Ferrous metals (i_s) |
| Cement | Non-metallic minerals (nmm) |
| Electricity | Electricity (ely) |
| Fertilizer | Chemical products (chm) |
| Chemicals | Chemical products (chm) |
| **Phase 2: 2025** | |
| **Sectors** | **GTAP match** |
| Coking coal | Petroleum, coal product (p_c) |
| Asphalt bitumen | Other extraction (oxt) |
| Petroleum products | Petroleum, coal product (p_c) |
| Iron Ores | Other extraction (oxt) |
| Aluminum | Metals nec (nfm) |
| Glass | Non-metallic minerals (nmm) |
| Non-ferrous metals (lead, tin, zinc) | Metals nec (nfm) |

The reference scenario is constructed based on the macroeconomic and demographic assumptions of the Shared Socioeconomic Pathways (SSP) database, in particular, the OECD-developed SSP2 scenario which represents the “middle of the road” pathway with intermediate socio-economic challenges for mitigation and adaptation (Riahi et al., 2018). The labor productivity is calibrated to replicate the latest projections of the World Economic Outlook (WEO) (IMF, 2020) until 2026, and then uses SSP2 GDP growth assumptions corrected for the difference between SSP2 and WEO projections. The impact of COVID-19 appears in the baseline through reduced GDP growth in all regions. All countries are assumed to reach their latest NDC targets (e.g., EU reaches a 55% reduction) by 2030 and then the carbon price increases by 1% annually. The NDC targets are introduced to the baseline as emission intensity per unit of GDP.  Emission saving technological changes are assumed in all countries as a proxy for both innovation and non-carbon price mitigation policies (e.g., expanding renewables, higher efficiency standards, increases in electricity shares for the final and intermediate consumers, and improvements in energy efficiency), but this change is much more ambitious in the EU as it reflects the higher ambition level in the EU Green Deal. Free allowances in the EU initially cover 80% of all emissions and are gradually removed until 2035.

## 2.2.3. Modeling Results under "No Action" Scenarios

The direct effect of the CBAM introduction is the reduction of Russia's exports to the EU and EFTA countries. This reduction of exports is the result of the European countries' substituting their imports for domestic production, as well as switching to imports from other world regions, where the production emission content might be lower. Compared to a no-CBAM baseline, the introduction of CBAM in the "Carbon price / CBAM Scope 1, 2 (EU)" scenario will result in the average loss of 7.1% of real exports to the EU in 2030–2035 (Figure 5). If only Scope 1 emissions are covered,[7] the loss will account for 2.8%. By 2035, real exports to the EU and EFTA will decrease overall by around US$19 billion (in constant 2014 prices), but exports to the other regions will increase by around US$11 billion at the same time.

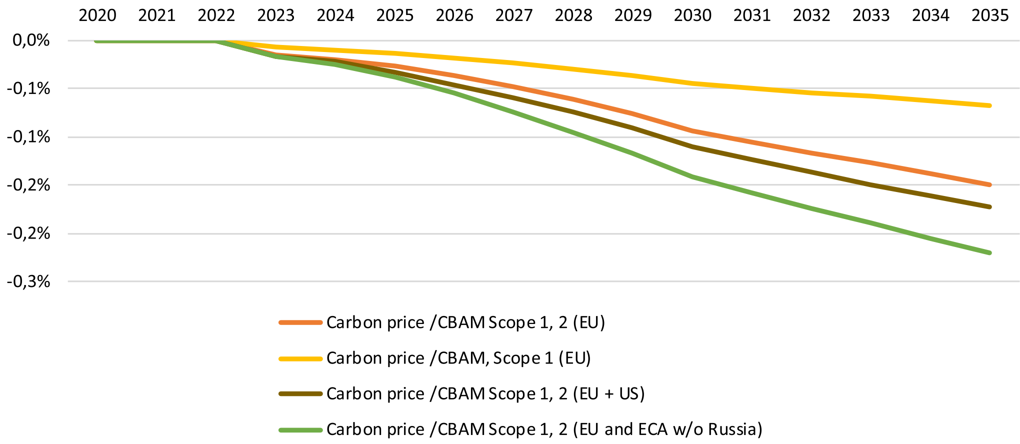
**Figure 5. Russia's real exports to EU & EFTA, deviation from no-CBAM reference scenario in %**




CBAM, by itself, is unlikely to have any significant effects on Russia's economy at the macroeconomic level. In the "Carbon price / CBAM Scope 1, 2 (EU)" scenario, Russia will on average lose 0.12% of its GDP in real terms compared to a no-CBAM baseline in 2030–2035 (Figure 6). If only Scope 1 emissions are covered, Russia will lose 0.06% of real GDP. Simulation results also show that CBAM leads to the reduction of real household consumption by around 0.31% and of real investment by 0.25%. If the U.S. joins the EU in introducing carbon border adjustments, the macroeconomic effects may increase, but also insignificantly. Real GDP loss on average will account for 0.14% in the period 2030–2035. Considering the scenario "Carbon price / CBAM Scope 1, 2 (EU and ECA w/o Russia)," implying that all ECA countries raise domestic carbon prices to the EU level while Russia preserves the status quo on climate policy, Russia will lose 0.18% of real GDP.

[7] Due to the data and modeling limitations, Scope 1 emissions do not cover industrial process and product use emissions, which might be high for sectors like cement. Therefore, the "Carbon price / CBAM Scope 1 (EU)" scenario presents a rather optimistic projection.

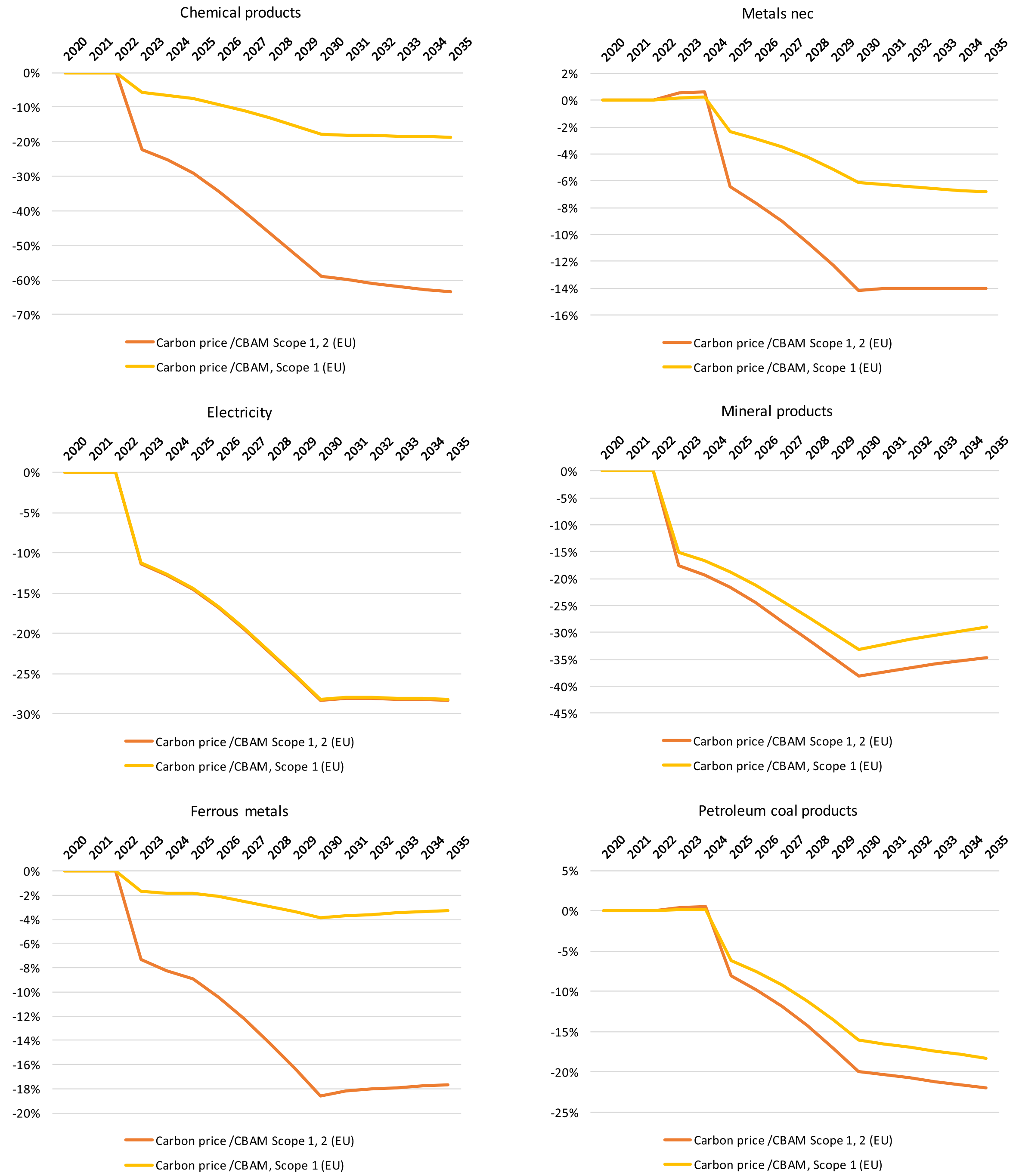
**Figure 6. Real GDP deviation from no-CBAM reference scenario in %**




Despite its limited impact at the macroeconomic level, CBAM has significant implications for selected sectors of Russia's economy. The share of CBAM payments in the price of EU and EFTA imports from Russia varies substantially across export commodities. Over the period 2030–2035, CBAM payments range from a little more than 1% of the price of EU and EFTA imports from Russia for metal products to 27% for electricity and 15% for chemicals. As Figure 7 shows, under the *"Carbon price / CBAM Scope 1, 2 (EU)"* scenario, the largest exports reductions, in percentage terms, concern chemical products (above 60% for 2030–2035), mineral products (30–40%), electricity (nearly 30%), and ferrous metals and petroleum coal products (both around 20%).

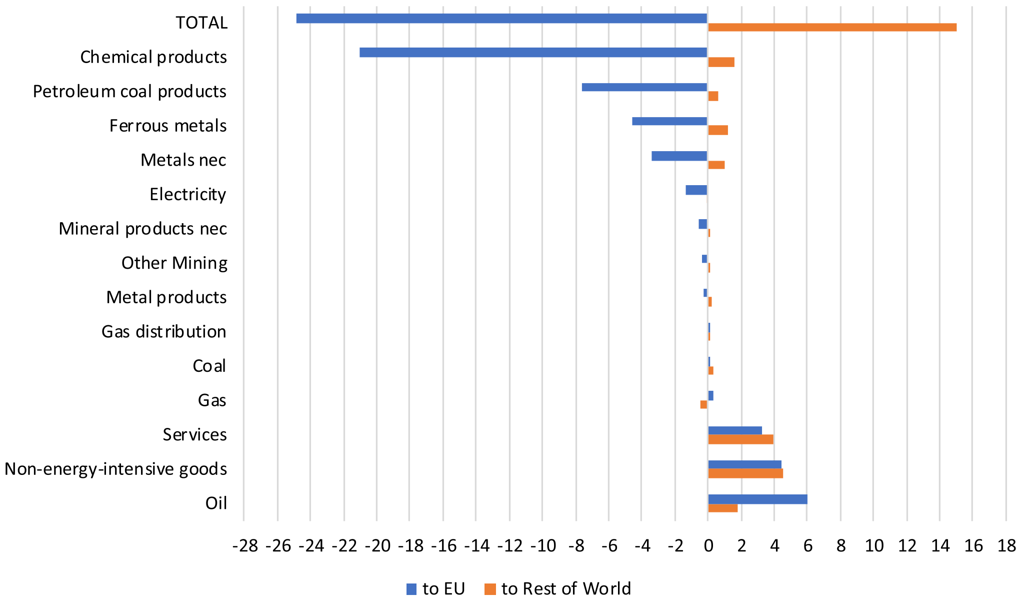
To a large extent, sensitivity of Russian exports to CBAM depends on the scope of emissions covered. Restricting CBAM to only Scope 1 emissions significantly reduces the losses for chemicals, ferrous metals, and metals and other mining, whereas Scope 2 emissions constitute a substantial part of overall emission intensity. In the other EITE industries in which Scope 1 emissions dominate, the electricity sector in particular, the change in emission scope has a smaller impact.

**Figure 7. Russia's exports to EU & EFTA, by commodity, deviation from no-CBAM reference scenario in %**



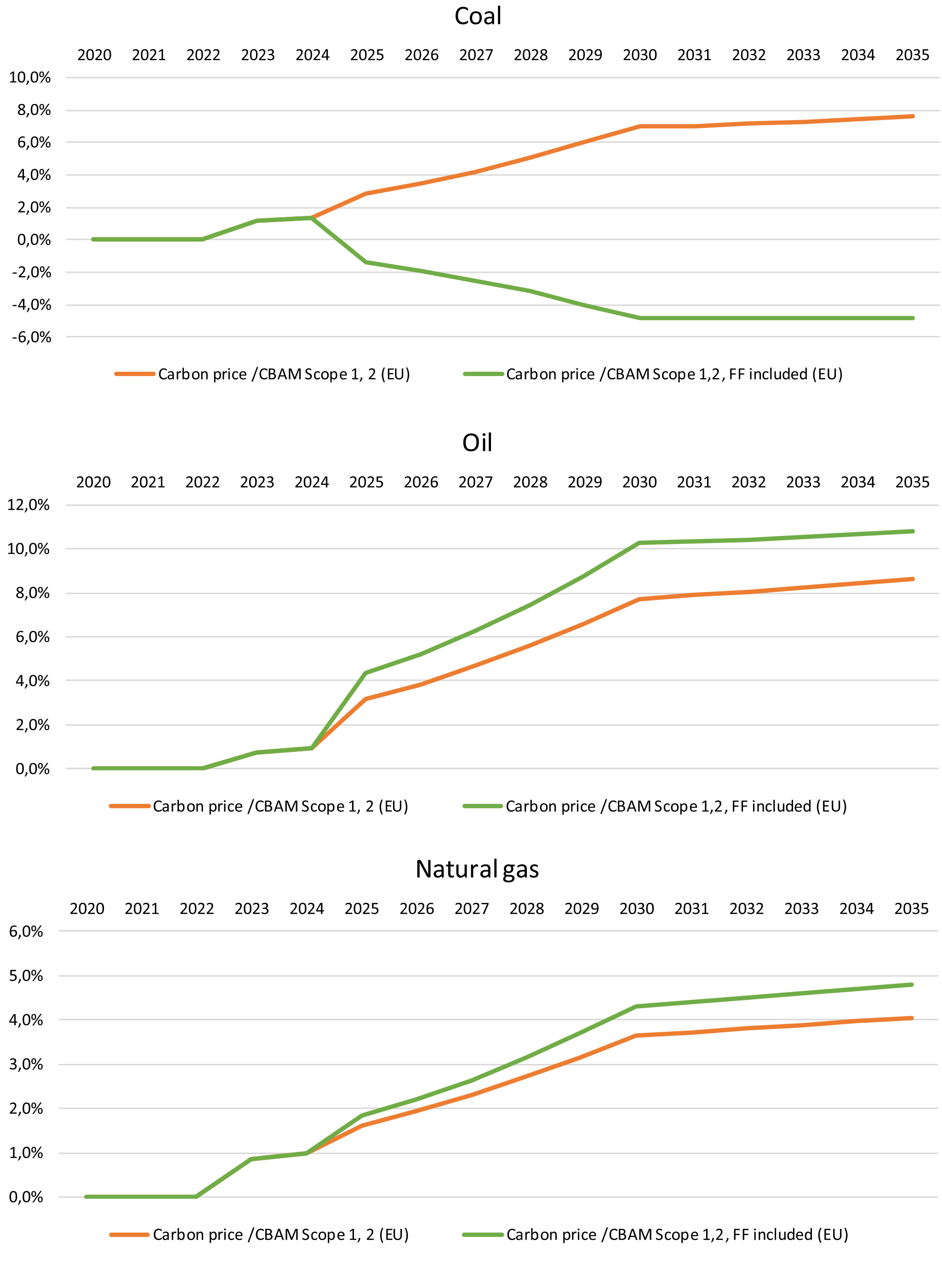
Overall, the decline in exports of energy-intensive goods from Russia to the EU and EFTA will be partly offset by adjunct changes in sectoral and geographic patterns of trade. CBAM will particularly lead to increased exports of carbon-intensive commodities to non-EU and EFTA countries as well as to increased exports of non-energy intensive goods and services to the EU and EFTA (Figure 8). The increase in oil exports causes Russian export diversification to decrease and shift to non-energy intensive exports, likely non-oil exports. Although CBAM targets emission intensive sectors, the shift in exports is not guaranteed to be towards greener commodities in the absence of domestic policies that would incentivize such a shift.

**Figure 8. Russia's exports to the EU & EFTA and Rest of World, under "Carbon price / CBAM Scope 1, 2 (EU)" scenario, deviations from no-CBAM reference scenario, in constant 2014 US$ billions, 2035**




An important finding is the diversion of EU trade with Russia towards fossil fuels. CBAM makes importing covered commodities more expensive for the EU, which triggers an increase in the production of these commodities in the EU. Since these commodities are emission-intensive, ramping up their production requires more fossil fuels as intermediate inputs. As fossil fuels are not covered under CBAM, they also become relatively cheaper for the EU to import signaling the increase in energy intensive production in the EU, translated to higher overall demand for fuels. As a result, the EU starts importing more primary fossil fuels to use in the production of commodities covered under CBAM. Russia, as one of the most efficient producers of gas among the suppliers of EU, significantly increases its exports to the EU. The model results show that the introduction of CBAM slightly increases exports of primary fossil fuels to EU and EFTA unless the CBAM is extended to those extractives, too. On average, in 2030–2035, coal export is projected to be about 7% higher than the 2030–2035 baseline, oil 8% higher, and natural gas 4% higher (Figure 9). In the "Carbon price / CBAM Scope 1,2, FF

**Figure 9. Russia's exports of fossil fuels to EU & EFTA, by commodity, 2035, deviation from no-CBAM reference scenario in %**



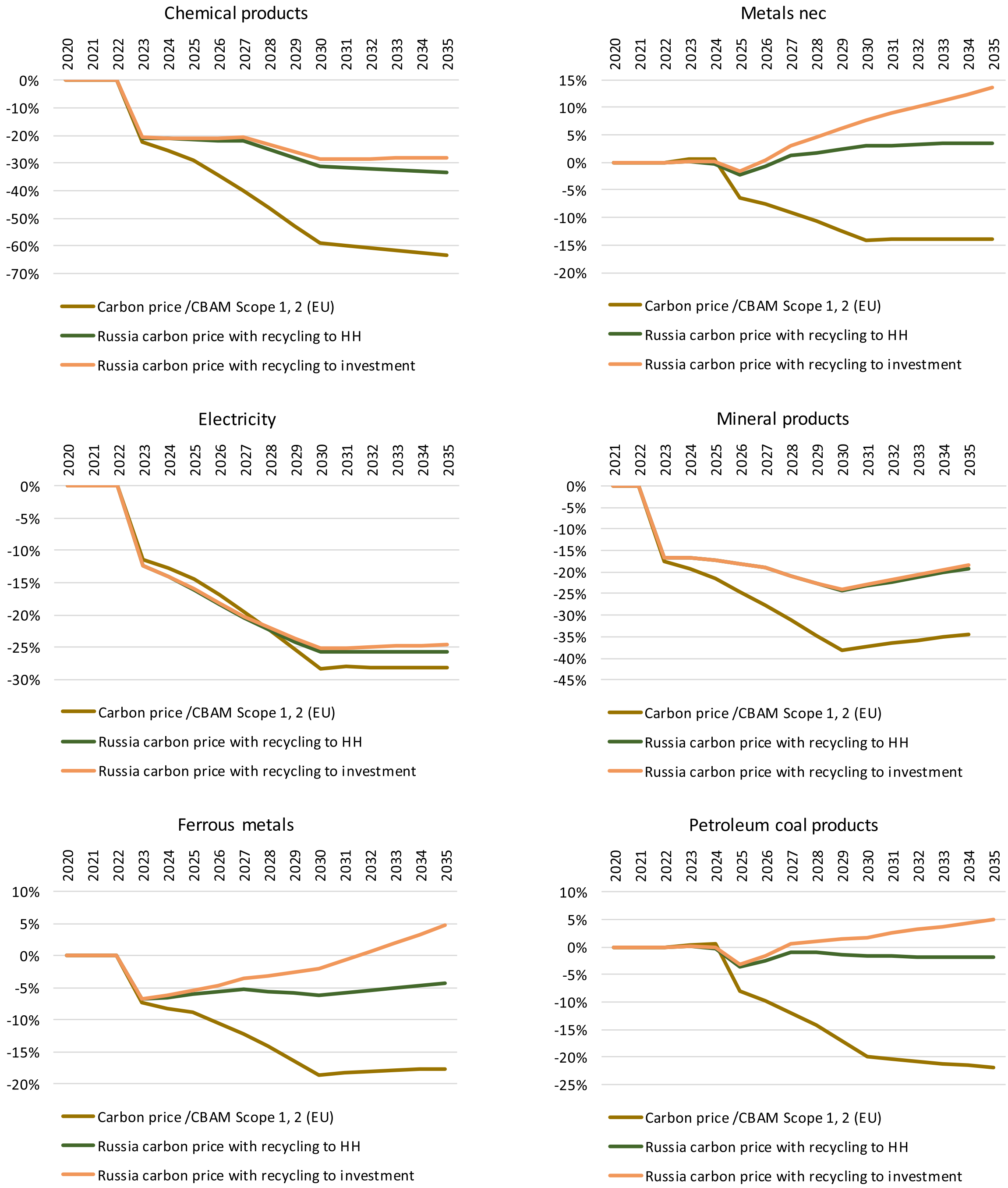
included (EU)" scenario, which implies that the CBAM extends to trade in primary fossil fuels, Russian exports of coal, as the most energy-intensive to produce, decrease while exports of oil and natural gas increase in comparison to a no-CBAM baseline (Figure 11) as the indirect impacts on oil and gas demand is higher than the direct impact of the CBAM introduction. Importantly, an increase in oil and gas exports in this scenario is even higher relative to the "Carbon price / CBAM Scope 1, 2 (EU)" scenario; this is a result of enhanced competitiveness of Russian oil and gas exporters in comparison to exporters from the rest of the world. When interpreting the results of the simulation, it is important to note that the modeling does not account for anything further than what is included in the reference scenario increase in the ambition of EU climate and energy policy as a result of possible increase in fossil fuel exports. The growth of fossil fuel exports relative to the no-CBAM baseline therefore does not imply growth of exports in comparison to the present level.

## 2.2.4. Modeling Results under "Action" Scenarios

"Russia carbon price" scenarios imply adopting carbon pricing in Russia and gradually raising it to the EU level. This automatically reduces the CBAM tax, which hinges on the difference between the EU and EFTA, and Russia's carbon price levels. It also reverses some of the effects of CBAM, which can be seen in the aggregate export increase relative to the "Carbon price / CBAM, scope 1, 2 (EU)" scenario, because a carbon tax encourages a reduction in emission intensity throughout the economy. It can also be seen in the recovery of exports to the EU and EFTA of individual commodities. For example, the reduction in exports of chemical products in the "Russia carbon price with recycling to HH" scenario turns out to be nearly half of the "Carbon price / CBAM Scope 1, 2 (EU)" scenario (a 63% vs. a 33% decrease in 2035), while even exports of metals increase (a 4% increase vs. a 14% decrease in 2035) (Figure 12). A significant increase in oil (18% and 37% increase in 2035) and gas (40% and 52% increase in 2035) export is also observed under the "Russia carbon price" scenarios (Figure 10). For natural gas, it comes along with a reduction in output following a reduction in Russia's domestic consumption. It creates an indirect effect of a drop in natural gas prices, thus increasing exports with substitution of the EU's and other regions' own extraction for more imports. No reduction in oil production is observed under any of these scenarios, signaling a stronger indirect impact on oil demand than a direct impact of a carbon tax introduction in Russia.

A smaller reduction of exports of carbon-intensive goods in the "Russia carbon price" scenarios is likely to be offset by the more significant decrease in domestic consumption. With the increase in the economy-wide carbon price, the impact on exports is analyzed against the impact on the output by sector (Figure 11). Domestic demand for a given commodity would often move opposite to foreign demand. In particular, domestic demand for gas drops sharply due to domestic climate policy. At the same time, reduced domestic demand drives down the

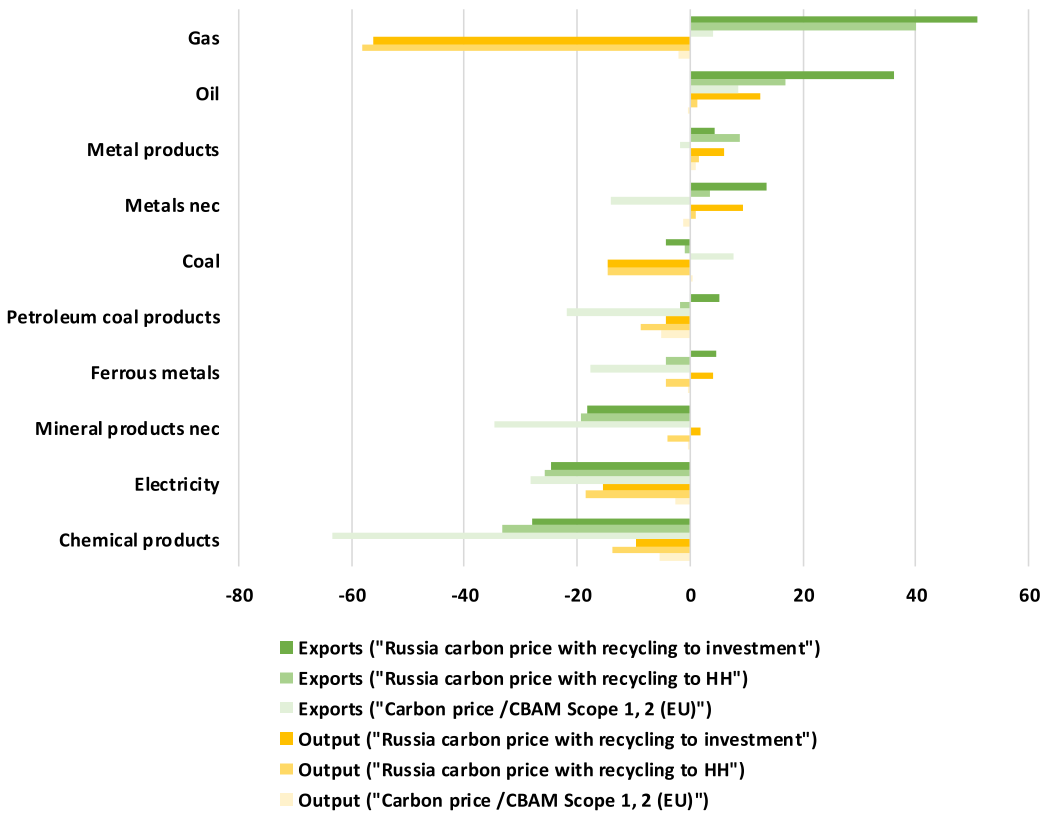
**Figure 10. Russia's exports to EU & EFTA, by commodity, deviations from no-CBAM baseline in "Carbon price / CBAM Scope 1, 2 (EU)" and "Russia carbon price" scenarios, in %**



price of gas which, all else being equal, increases gas exports. These changes in domestic and foreign demand are likely to decrease the diversification of Russian exports by increasing fossil fuel exports to the rest of the world. However, diversification of non-oil exports would further increase towards greener exports as a carbon price would create a relative cost advantage for them.

Increase in domestic carbon pricing not only reduces the losses of exports to the EU, but it also boosts government revenue that may be used in different ways. Introduction of domestic carbon price is broader than just the CBAM response. CBAM is paid by the importers to the EU, with no direct payments expected from Russian companies; their losses will take the form of the loss of the EU market share as a result of the EU importers' decision to shift towards less carbon-intensive suppliers. Importers of carbon-intensive products will allocate CBAM into the EU budget, effectively buying Russian exports at a higher price, which will signal erosion of the comparative advantage of Russian exporters. Moreover, gradual introduction of a carbon tax will redirect tax revenues into the Russian budget, reducing the budget deficit. Introduction of the domestic carbon policy will have much wider coverage than CBAM, and the resulting large, economy-wide GHG emission reductions entail certain macroeconomic costs and require additional investment. The overall macroeconomic effects on the Russian

**Figure 11. Russia's exports and output, deviations from no-CBAM reference scenario, 2035, in %, by sector**



industry will involve channeling the additional revenue to support households and/or to boost investments to less carbon-intensive industries as they become more competitive under a carbon tax.

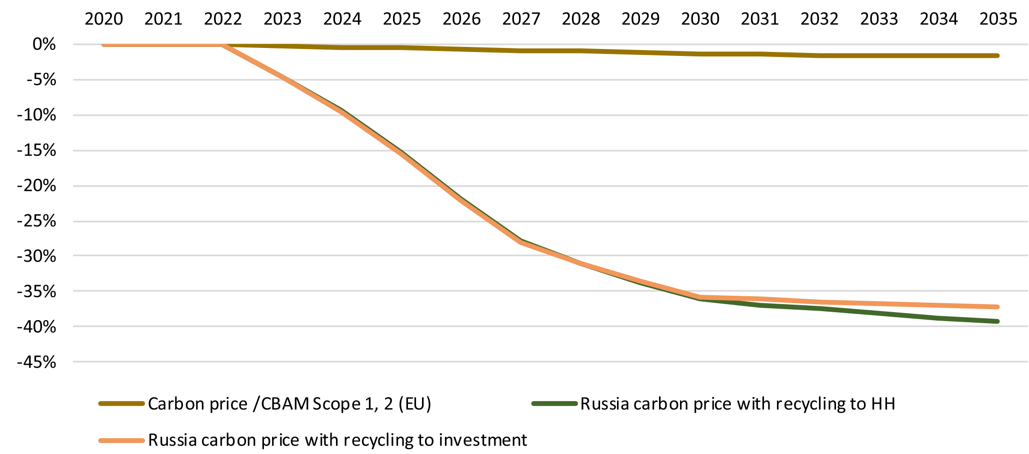
Under the “Russia carbon price with recycling to HH” scenario with tax revenue recycling to households (so that government deficit is fixed), there is no significant fall in household consumption. The GDP and its demand-side components except exports, however, show weaker performance compared to the “Russia carbon price with recycling to investment” scenario in which revenue is channeled to the reduction of the state deficit though increased spending, i.e., with higher investment (Figure 14). Under the “Russia carbon price with recycling to HH” scenario, there is a slight decrease in GDP and household consumption as well as modest growth in investment relative to the “Carbon price / CBAM Scope 1, 2 (EU)” scenario. Alternatively, under the “Russia carbon price with recycling to investment” scenario, there is a boost in GDP growth and investment activities, but real household consumption falls sharply. These two scenarios represent extreme cases to help strike the right balance between different ways to allocate revenue.

If additional net government revenue fully translates to an investment increase (by as much as 22–30% in the years 2030–2035), a substantial GDP increase is observed in the long run, reaching 5% as compared to the “Carbon price / CBAM Scope 1, 2 (EU)” scenario (Figure 12). The boost in investment initially comes at a high cost of decreased real household consumption (around 4% in 2030), but consumption gradually recovers in the later years. Moreover, increased investment leads to a decline in the rate of return on capital, which, in reality, could further mitigate investment expansion and thus limit long-run GDP gains. However, this effect is not modeled in our scenarios. A comparison of the “Russia carbon price with recycling to HH” and “Russia acts, high inv” scenarios illustrates that the way carbon price revenue is used is crucial for macroeconomic outcomes. At the same time, it might be questionable whether the “Russia carbon price with recycling to investment” scenario in its current, extreme form is plausible, given the temporary significant drop in household consumption and reduction in the rate of return on capital accompanying investment expansion.

Finally, raising the carbon price in Russia to the EU level results in a substantial reduction in GHG emissions, as shown in Figure 13. While in the “Carbon price / CBAM Scope 1, 2 (EU)” scenario, emissions in Russia decrease merely by 1.6% in 2035 as compared to the no-CBAM baseline, in the “Russia carbon price with recycling to HH” scenario, emissions decrease by nearly 38%, with a slightly smaller decrease under the “Russia carbon price with recycling to investment” scenario.

**Figure 12. GDP and its demand-side components in "Russia carbon price" scenarios, deviations from "Carbon price / CBAM Scope 1, 2 (EU)" scenario, in %**


**Figure 13. Greenhouse gas emissions, deviations from no-CBAM reference scenario in %**



### 2.2.5. Conclusions

CBAM in the European Union poses some challenges for Russian exports, though not unsurmountable. Compared to the reference scenario that assumes achievement of declared emissions reduction targets but does not suggest CBAM, the introduction of CBAM (Scope 1 emissions only) would result in an average loss of 2.8% of Russia's real exports to the EU in 2030–2035. If Scope 2 emissions are covered by CBAM, the loss will account for 7.1%; the largest export reductions will be in chemical products (above 60% in 2030–2035), mineral products (30–40%), electricity (nearly 30%), ferrous metals, and petroleum coal products (each around 20%).

The introduction of EU CBAM will be weathered reasonably well by the Russian economy. The decline of exports to the EU would be partly compensated by a rise in exports to other regions. While in 2035, exports from Russia to the EU are expected to decrease by around US$19 billion, exports from Russia to the rest of the world will increase by around US$11 billion. Overall, the loss of exports by 2035 would be equal to just 1.2% if Scope 2 is included and to 0.4% if the EU CBAM covers only Scope 1. As a result, the macroeconomic effect of CBAM on the Russian economy would be small: 0.06% of GDP compared to a no-CBAM baseline if only Scope 1 emissions are covered, and 0.12% of GDP if both Scope 1 and Scope 2 are covered. Even if the U.S. joins the EU in introducing a carbon border adjustment, Russia's losses will increase only negligibly.

## 2.3. Deep Dive into Long-Term Decarbonization: Modeling Impacts on Russia's Economy up to 2050

EU CBAM is only a small part of the climate policies that would affect Russia. In the long term, the reduction in demand for fossil fuels as a result of global mitigation action would affect Russia's economy much more significantly than the carbon border adjustment. This section presents estimates of long-term impacts of worldwide climate policies on Russia's economy: its energy exports, welfare, sectoral outputs, and value of fossil fuel assets. A set of exploratory scenarios for the period up to 2050 was developed representing a set of plausible assumptions regarding future mitigation measures taken worldwide, following an approach outlined in Peszko et al. (2021). These scenarios are simulated using a global recursive dynamic CGE model, ENVISAGE (van der Mensbrugghe, 2019) (for more information see Annex A), with an integrated resource depletion module calibrated to the Rystad U-Cube extractive model (Rystad Energy, 2021).

### 2.3.1. Reference and Policy Scenarios

The reference scenario is constructed based on the macroeconomic and demographic assumptions of the Shared Socioeconomic Pathways (SSP) database used for the EU CBAM analysis. Similarly, additional energy-related baseline assumptions include declining costs of renewable electricity generation, non-price related changes in preferences towards renewables, increases in electricity shares for the final and intermediate consumers, and improvements in energy efficiency and reduction in international transportation costs. It is further assumed that in the baseline scenario, countries implement their unconditional Nationally Determined Contributions (NDCs) and further extend NDC mitigation efforts until 2050. For quantification of the 2030 NDC emission reduction targets, an approach outlined in Vandyck et al. (2016) is applied. In contrast to the EU CBAM modeling approach, the baseline scenario does not incorporate the impact of COVID-19 and the EGD.

To develop the policy scenarios, 16 countries and regions represented in the ENVISAGE model were grouped into two stylized climate clubs: climate policy leaders (CPLs) and fossil fuel dependent countries (FFDCs) (Table 3). CPLs are assumed to lead the implementation of climate mitigation policies. This group includes most high-income countries (e.g., the EU, Japan, Norway, U.S., and other OECD countries), as well as low- and middle-income net fossil fuel importers (including China and India). FFDCs include coal, oil, and gas exporters, with Australia, Columbia, Indonesia, Russia, Saudi Arabia, and other countries in this group (Table 3). It is assumed that FFDCs either cooperate in climate efforts (e.g., engage in global emission trading) or freeride and thus risk border carbon adjustment taxes (BCAT[8]) imposed by CPLs.

**Table 3. Climate Clubs**

| Climate Policy Leaders (CPLs) | Fossil-Fuel Dependent Countries (FFDCs) |
|---|---|
| CPL-HI: High income countries in the EU, Canada, Norway, U.S, and other high-income fossil-fuel importers | FF MNA (Saudi Arabia + all other members of Gulf Cooperation Council + all other oil and gas exporters in Middle East and North Africa) |
| CPL-MI: Middle Income net fossil fuel importers, including China, India, and other middle-, and low-middle-income net FF importers | FF ECA (Russian Federation + the Caucasus + Central Asia)<br>FF SSA (Sub-Saharan Africa)<br>FF LAC (Latin America and Caribbean)<br>FF SEA (South-East Asia)<br>COALEX (Coal exporters: Australia, Columbia, Indonesia, Mongolia, and South Africa) |

*Source: Based on IMF data.*

In addition to the Reference scenario, the study explores four ambitious climate policy scenarios (Table 4). First, a standard global climate coalition scenario (“Carbon price globally”) is developed, which includes a uniform global carbon tax. In this scenario, both climate policy leaders and fossil-fuel dependent countries collaborate to achieve a two-degree Celsius-consistent carbon budget by 2050. Two unilateral climate mitigation scenarios have the same global carbon budget as the “Carbon price globally” scenario but involve emission reduction actions by climate leaders only. The “Carbon price in CPL” scenario assumes no BCAT, while “Carbon price and BCAT by CPL” scenario assumes that climate policy leaders implement

[8] BCAT has the same goal as EU CBAM to prevent carbon leakage, but is defined much more broadly. BCAT are taxes on imports that account for difference in carbon pricing across different countries. In the model setting, they are applied to all sectors and cover Scope 1 (direct), Scope 2 (indirect) and Scope 3 (along the value chain) $CO_2$ emissions from fossil fuel combustion.

BCAT on imports from fossil fuel dependent countries based on the carbon content of the country/region of commodity origin. Finally, a more ambitious cooperative scenario "High carbon price globally" is considered. Under the "High carbon price globally" scenario 2018–2050, the carbon budget is 10% lower than under the three other policy scenarios and can be considered consistent with the effort of limiting global warming well below two degrees Celsius (e.g., Rogelj et al., 2018).

All climate mitigation targets, including the unconditional NDC measures within the baseline scenario, are achieved using the instrument of carbon pricing, which is applied to all agents in the model, thus covering both intermediate and final users. In the policy scenarios, carbon pricing is implemented starting in 2025.

**Table 4. Scenario Structure**

| Scenario | Climate policies | Trade policies | Carbon budget, 2018–2050, Gt $CO_2$ |
|---|---|---|---|
| Reference (NDC) | Reference with unconditional NDCs | No border carbon taxes | 1238 |
| Carbon price globally | Global cooperative carbon taxes | No border carbon adjustment | 862 |
| Carbon price in CPL | Unilateral carbon taxes in CPLs | No border carbon adjustment | 862 |
| Carbon price and BCAT by CPL | | Border carbon adjustment taxes levied by CPLs on carbon content of imports from FFDCs | 862 |
| High carbon price globally | High global cooperative carbon taxes | No border carbon adjustment | 777 |

*Source: Peszko et al. (2021).*

BCAT is a mechanism which has the same economic logic as the EU's CBAM, but the implementation details differ. Like CBAM, BCAT is also directed at preventing carbon leakage and stimulating mitigation efforts in countries that have no incentives for active climate policies, specifically in FFDC. Technically, BCAT is imposed in the form of an ad valorem equivalent tax on region- and commodity-specific carbon content of imports to the climate policy leaders. To provide an accounting of the $CO_2$ emissions embodied into bilateral trade,[9] an approach outlined in Peters (2008) is applied. Country-specific $CO_2$ emissions per unit of output by sector are used to estimate emissions associated with bilateral trade flows. For every commodity, the total $CO_2$ emissions associated with fossil fuel combustion and embodied in trade flows from region r to region s ($f_{rs}$) are estimated as $f_{rs} = F_r(E - A_r)^{-1}e_{rs}$, where $F_r$ is a vector of region-specific $CO_2$ emissions per unit of output by industries, E is an

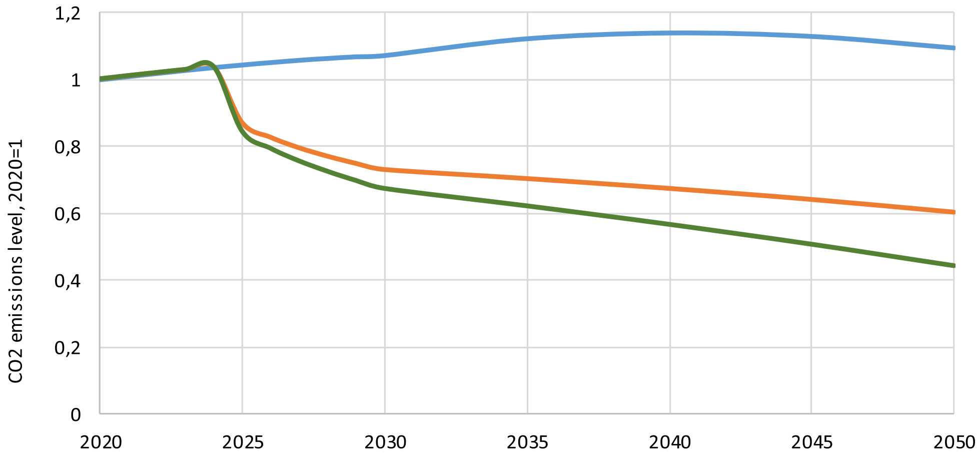
[9] Only gross $CO_2$ emissions from fossil fuel combustion are considered in this study.

identity matrix, $A_r$ is the technological matrix, which represents the industry requirements of domestically produced products in region r, and $e_{rs}$ corresponds to the bilateral trade flow from region r to region s.

Different scenarios imply different global emissions dynamics. Under the baseline scenario global $CO_2$ emissions increase by 10% in 2050 relative to 2020 levels (Figure 14).[10] Under the "Carbon price globally" (and respectively both unilateral mitigation options), $CO_2$ emissions fall by 40% in 2050 relative to the 2020 levels, while under a more ambitious mitigation effort ("High carbon price globally") corresponding emissions reduction is almost 56%.

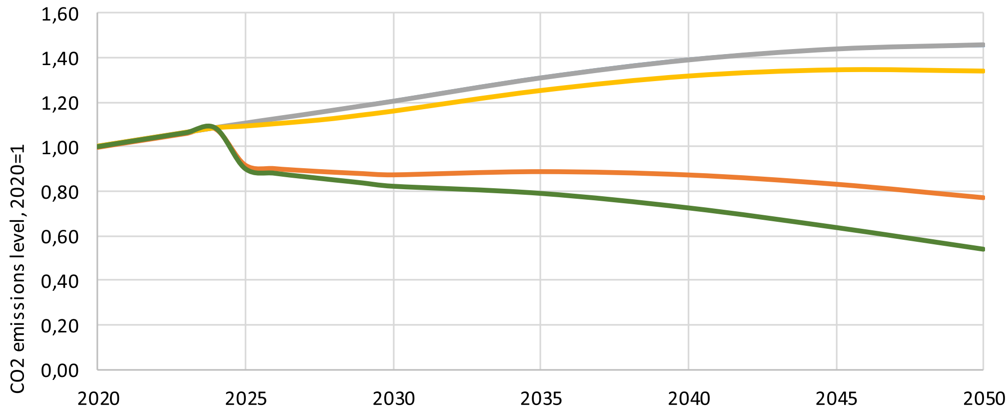
In the case of Russia, baseline emission trends suggest an increase in emissions between 2020 and 2040 with further flattening of the emissions level in the post-2040 period (Figure 15). Implementation of unilateral mitigation efforts by climate policy leaders does not have any

**Figure 14. Global gross $CO_2$ emissions from fuel combustion under different scenarios**




*Source: Based on data from Peszko et al. (2021).*

**Figure 15. Gross $CO_2$ emissions from fuel combustion in Russia under different scenarios**




*Source: Based on data from Peszko et al. (2021).*

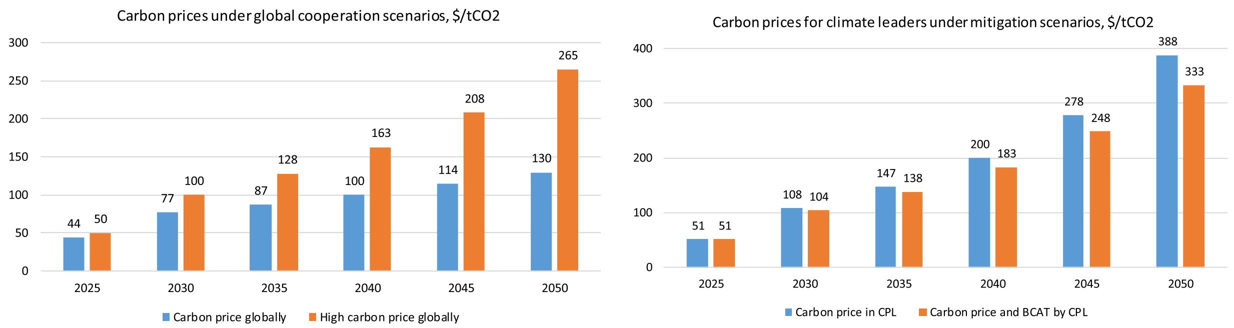
[10] In the current assessment, we do not take the impacts of the COVID-19 pandemic into account.

major impact on the Russian emission trends, as they do not differ much from the baseline path. Application of BCAT, on the other hand, has a substantial impact on $CO_2$ abatement in Russia, as emissions fall by around 8% in 2050 relative to the Reference scenario level. Both cooperative scenarios result in major emission reductions in Russia, ranging from 47% (under "Carbon price globally") to 63% (under "High carbon price globally") relative to the 2050 baseline level.

Achievement of such stringent climate mitigation targets is associated with substantial carbon pricing efforts. Under the cooperative scenarios, carbon prices start from US$44-50/t$CO_2$ in 2025 and reach US$130-265/t$CO_2$ under "Carbon price globally" and "High carbon price globally" mitigation cases, respectively. If Russia and other fossil-fuel exporting countries participate in global climate mitigation efforts, this is the level of carbon taxes Russia's economy would face under the considered policy scenarios.

Much higher carbon prices need to be implemented by climate leaders under the unilateral mitigation effort to achieve the same carbon budget (Figure 16). Compared to the corresponding cooperative scenario ("Carbon price globally"), the unilateral mitigation effort without border carbon tax results in an almost threefold higher carbon price for climate leaders in 2050. Implementation of BCAT partially shifts the mitigation effort to the fossil fuel exporters and lowers carbon price for climate policy leaders by around 14% in 2050, providing a strong incentive for considering the BCAT policy option.

**Figure 16. Carbon prices under different climate mitigation options**

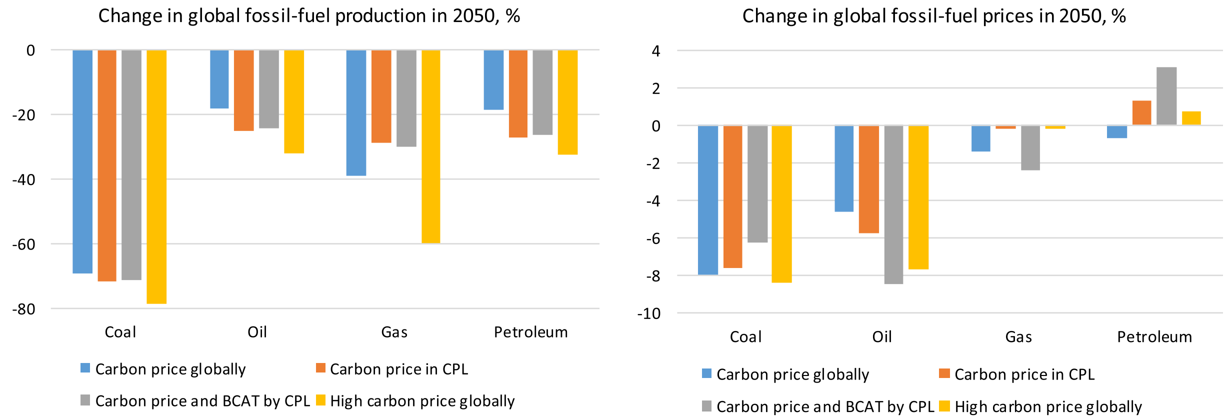



*Source: Based on data from Peszko et al. (2021).*

## 2.3.2. Macroeconomic and Trade Impacts

Implementation of the ambitious climate mitigation efforts leads to the reduction in global fossil fuel demand and prices (Figure 20). Coal, the dirtiest fossil fuel, is impacted the most under all climate mitigation scenarios, with a reduction in global production and demand at a range of 70–80% in 2050 (relative to the baseline level). Production of natural gas experiences especially high reduction under the most ambitious cooperative scenario ("High carbon price globally"), as it is the second most-impacted fossil fuel after coal. Due to their wide use in transportation, as well as some industrial processes (e.g., production of chemicals), oil and petroleum production and prices experience more limited impacts compared to coal and gas; still, however, by 2050, the reduction in global oil and petroleum products demand reaches 20–35%, depending on the mitigation scenario (Figure 17).

**Figure 17. Change in global fossil fuel production and prices by scenarios in 2050, % change relative to the baseline**

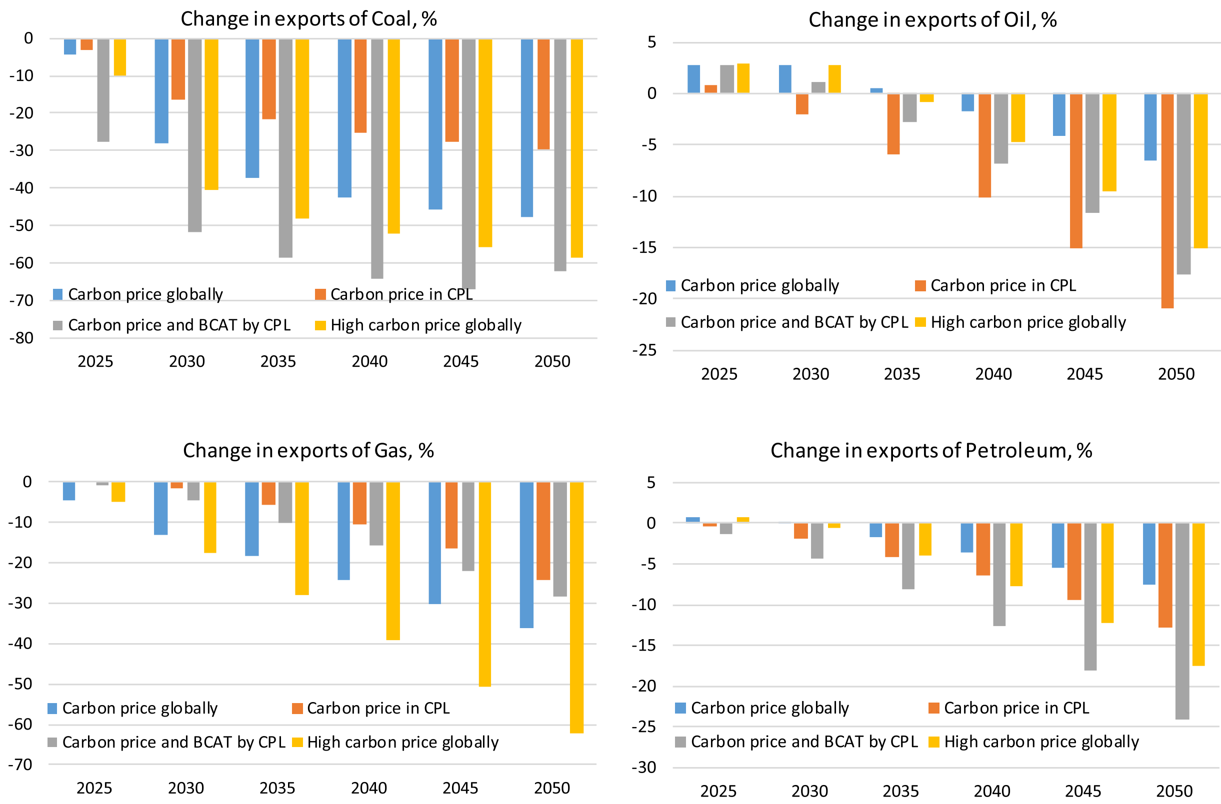



*Source: Based on data from Peszko et al. (2021).*

In a scenario when Russia does not implement domestic climate mitigation policies or does not participate in global climate cooperation, reduction in global fossil fuel demand and prices still have a major impact on Russia's economy, mainly through the reduction in fossil fuel exports and deterioration of terms of trade. In relative terms, Russian exports of coal and gas are impacted the most under climate mitigation scenarios, following the previously discussed global trends (Figure 9). As coal is the most carbon-intensive fossil fuel, its global demand falls sharply, which in turn depresses trade in coal, and exports from Russia fall anywhere between 30% and 60% relative to the baseline in 2050. A unilateral effort with BCAT ("Carbon price and BCAT by CPL") has a stronger negative impact on Russian exports than the one without border adjustment tax ("Carbon price in CPL").

Exports are impacted heterogeneously across scenarios. For instance, coal and gas experience a large reduction in exports under the "Carbon price globally" effort compared to the "Carbon price in CPL" scenario, partly because global coal and gas prices fall less significantly in the latter case (Figure 18). In the case of natural gas, global demand is also less impacted under the unilateral climate mitigation compared to the "Carbon price globally" case. Implementation of the border carbon adjustment tax by climate leaders significantly reduces exports of Russian coal and petroleum products, while oil, which is a primary energy commodity with relatively low carbon intensity of production, is less affected (Figure 18).

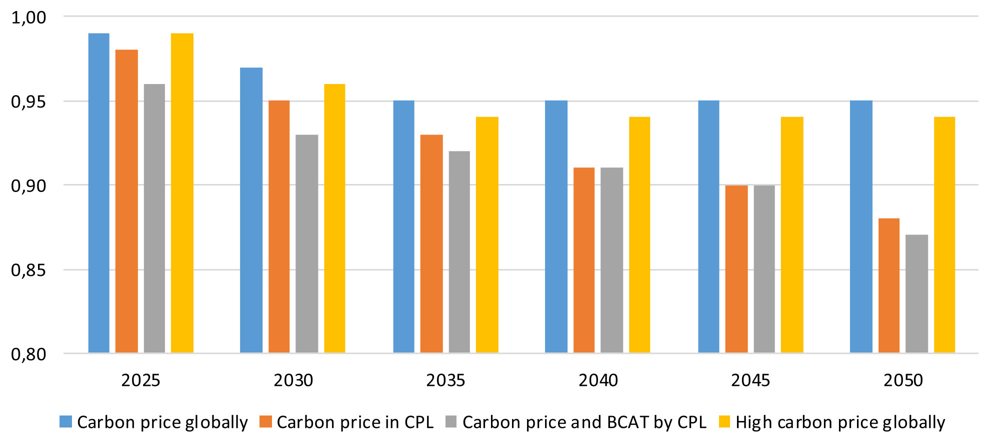
**Figure 18. Change in aggregate Russian exports of coal, oil, gas, and petroleum products by scenarios, % change relative to the reference scenario**




*Source: developed by the authors based on Peszko et al. (2021).*

Reductions in Russian exports of fossil fuel contribute to the overall deterioration of terms of trade, which are much more negatively impacted under unilateral mitigation efforts than under global climate cooperation (Figure 19). Negative impacts on terms of trade increase over time, as by 2050, the price of aggregate exports from Russia drops by up to 12–13% relative to the price of imports. BCAT further increases the gap between export and import prices, as not only fossil fuels, but also energy-intensive manufacturing commodities (including chemicals, metals, and non-metallic minerals) experience lower global demand. While aggregate exports of fossil fuels from Russia decrease under all scenarios, a regional re-allocation of exports takes place under unilateral climate mitigation away from climate leaders and toward fossil-fuel dependent countries (Annex B). It should be noted, however, that because only a small share of Russian coal, oil, gas, and petroleum exports is directed toward fossil-fuel dependent economies, such reallocation has a minor impact on overall trade patterns.

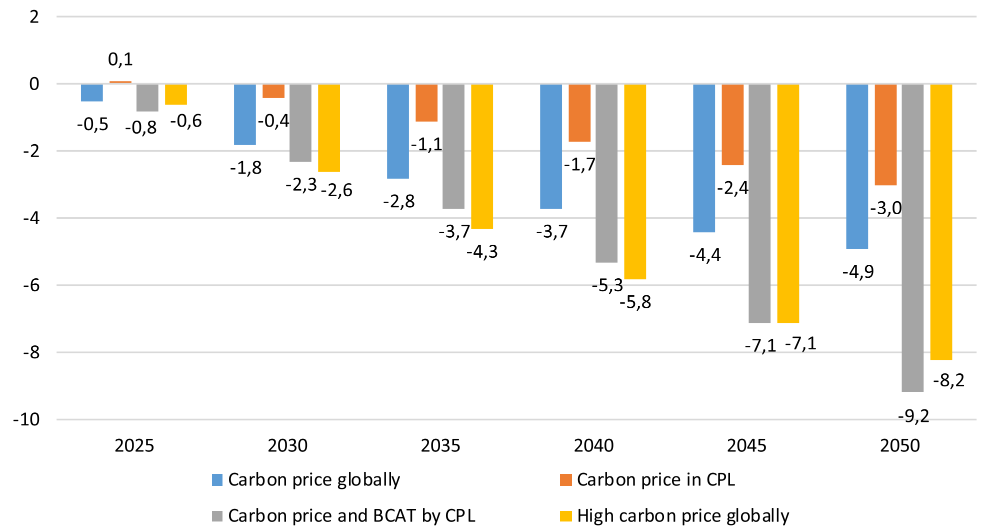
**Figure 19. Terms of trade effects for Russia measured via Fisher price index***




*Source: Based on data from Peszko et al. (2021).*
** Fisher Price Index, also called the Fisher's Ideal Price Index, is a consumer price index used to measure the price level of goods and services over a given period.*

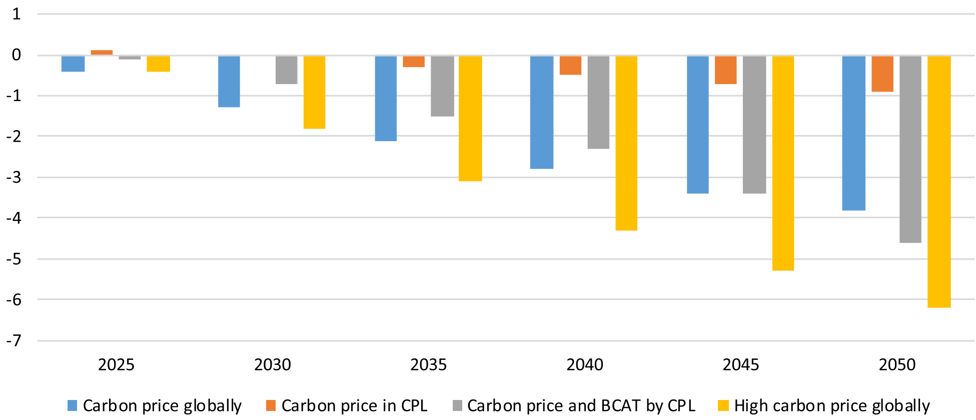
Reduction in prices of and demand for fossil fuels globally, along with terms-of-trade impacts, leads to a sizeable GDP and welfare reduction in Russia (Figure 20 and 21). While in the case of unilateral mitigation efforts without the BCAT implementation, freeriding results in the smallest impact on households' real income, the BCAT implementation by climate leaders has much more significant negative impact on the welfare and GDP in Russia (Figure 22 and 23). If BCAT is implemented, a more efficient strategy for Russia would be to join global cooperative

**Figure 20. Change in welfare by scenarios, % relative to baseline**




*Source: Based on data from Peszko et al. (2021).*
*Note: Changes in welfare are measured using Hicksian equivalent variation measure.*

**Figure 21. Change in GDP by scenarios, % relative to baseline**




*Source: Based on data from Peszko et al. (2021).*

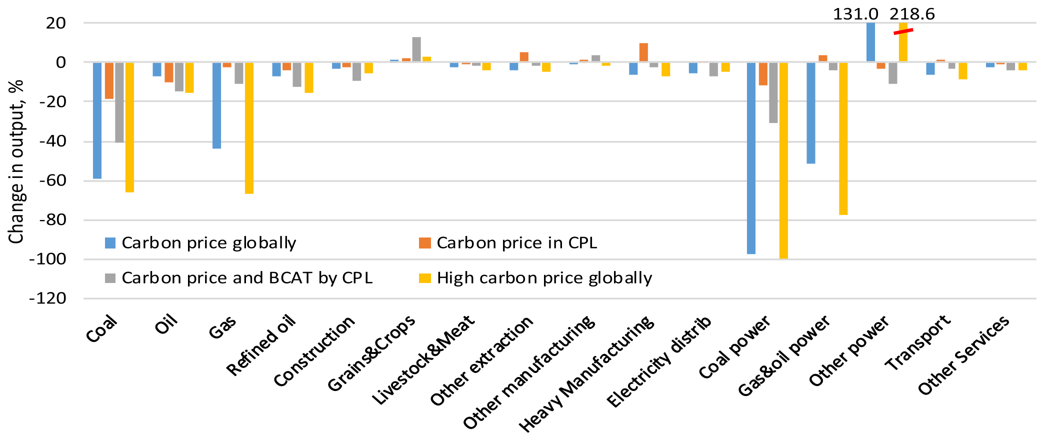
climate mitigation efforts. This would allow Russia to reduce the negative impacts on welfare in the country by over 45% in 2050, and on GDP and aggregate export by about 20% in 2050 (compared to the "Carbon price and BCAT by CPL" scenario). Even implementation of the high-ambition cooperative scenario would be less costly for Russia's economy, compared to facing the border carbon adjustment tax under the unilateral climate effort.

## 2.3.3. Sectoral Impacts

As global fossil fuel demand decreases, output of coal, oil and gas, and refined petroleum products experiences the greatest impact (Figure 24). Output of fossil fuels is impacted much more severely under the cooperative effort scenarios. In these scenarios, Russia also implements ambitious climate mitigation policies, which significantly decrease domestic demand for fossil fuels and reduce the output of coal and gas by 44–66% (Figure 22).

Implementation of BCAT has substantial impact on the output structure of Russia's economy. Under the unilateral scenario without BCAT, impact on the fossil-fuel extraction sectors in Russia is rather limited, as domestic demand is even higher than in the baseline scenario due to lower fossil fuel prices. Implementation of BCAT impacts output structure in two ways: first, through the reduction in fossil fuel demand and prices; and second, by increasing barriers on exports of carbon intensive commodities, such as chemicals, metals, and non-metallic minerals. As a result, output in these sectors decreases. Some moderate increases are observed in Russia's economy in output of the agriculture and food sectors, as well as light manufacturing, under the unilateral climate mitigation scenarios because of reallocation of resources to these activities from the shrinking sectors.

**Figure 22. Changes in the sectoral output in 2050, % relative to baseline***

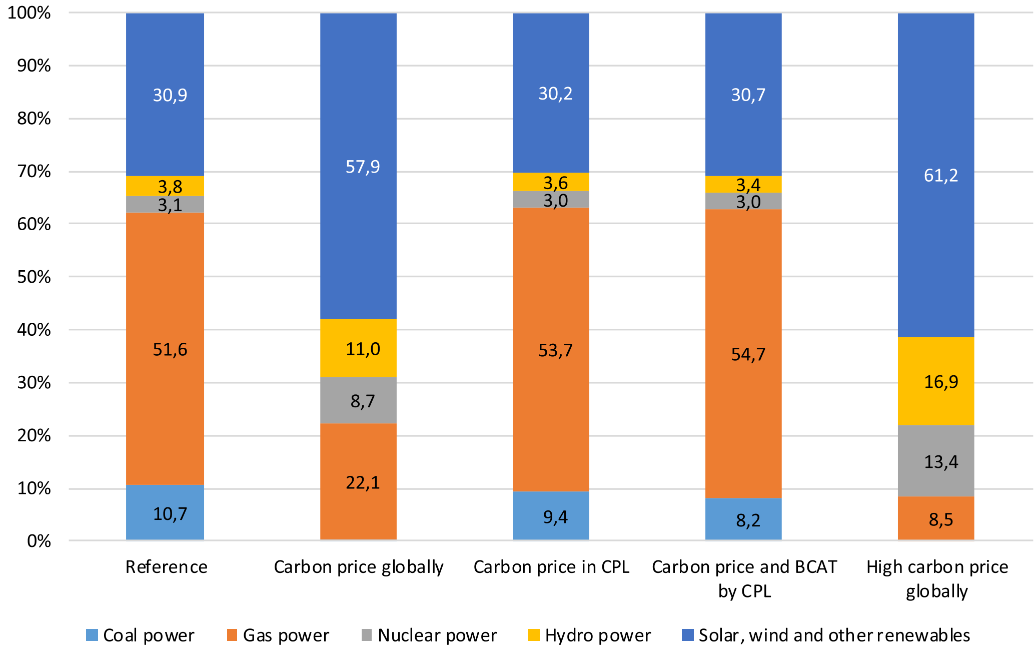



*Source Based on Peszko et al. (2021).*
*Note: Households are not listed as a non-producing sector.*
** The list of sectors and their mapping to the original GTAP sectors is provided in Appendix A (Table A.3) of the report. Notes under the table provide a reference to the GTAP sectors description https://www.gtap.agecon.purdue.edu/databases/v10/v10_sectors.aspx#Sector65 including mapping to the CPC/ISIC codes https://www.gtap.agecon.purdue.edu/databases/contribute/concordinfo.asp.*

Changes in electricity generation will be noticeable in Russia even in the baseline scenario but will be much more significant in the “Carbon price globally” scenarios. Measures to reduce costs of renewable energy generation implemented in the baseline scenario lead to a substantial increase in the share of renewables by 2050 even without any climate mitigation policies (Figure 25). Neither unilateral climate mitigation scenario has any major impact on the electricity and heat generation mix. Under the “Carbon price globally” scenario, the share of natural gas-based electricity decreases by more than two times in 2050, while the share of coal power generation reaches 0.2%. Coal power is eliminated under the “High carbon price globally” scenario, while the share of gas power and heat generation decreases to 8.5% (Figure 23).

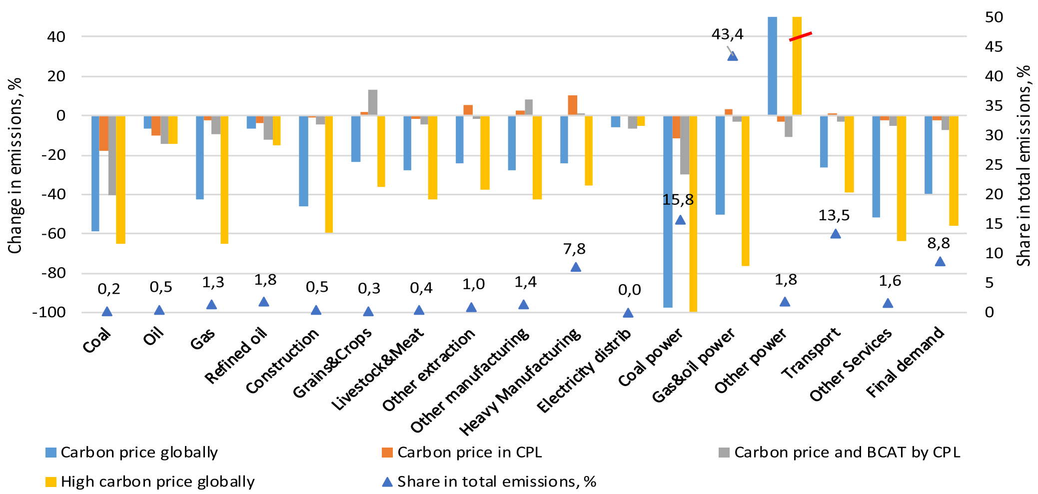
At the sectoral level, key emission reductions under the cooperative scenarios come from the generation of gas and coal power. Together, these contribute almost 60% of all $CO_2$ emissions in 2050 under the baseline path, as both domestic and international demand for the corresponding fossil fuel commodities drops sharply under “Carbon price globally” and “High carbon price globally” (Figure 24). Somewhat lower emission reductions are observed in other large emitting activities, such as transportation, heavy industry and final demand. The only sector with increasing emissions under the cooperative mitigation scenarios is “other power and heat generation,” which includes some emissions from the combustion of biomass and waste. Output from this activity significantly increases under cooperative scenarios, as it serves as a substitute to coal power and gas and oil power generation, both much more carbon intensive than “other power.”

### Figure 23. Electricity and heat generation mix in 2050 by scenarios




*Source: Based on Peszko et al. (2021).*

### Figure 24. Changes in sectoral $CO_2$ emissions in 2050, % relative to baseline

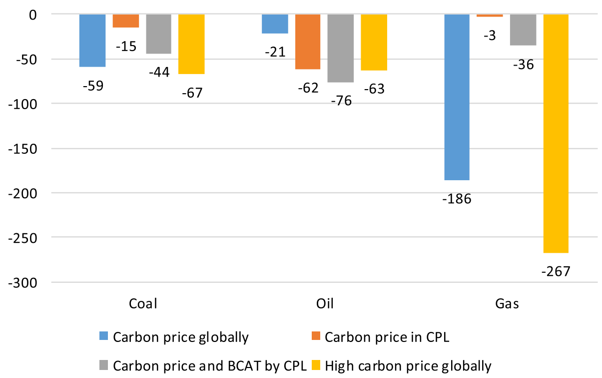


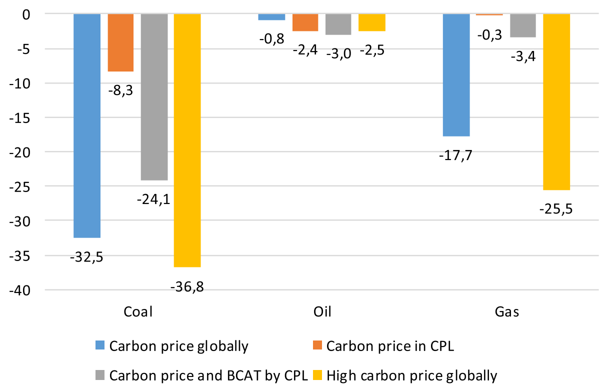

*Source: Based on data from Peszko et al. (2021).*

## 2.3.4. Implications for the Value of Sub-Soil Fossil Fuel Assets

In relative terms, the sub-soil value of coal assets in Russia is impacted the most under both cooperative and unilateral climate mitigation scenarios (Figure 25). In absolute terms, the value of gas assets suffers the most under cooperative scenarios, while the value of oil assets is impacted the most under unilateral climate mitigation. Under cooperative scenarios, the sub-soil value of gas drops by US$186–267 billion between 2018–2050, or by 17.7–25.5% (relative to baseline), as gas accounts for 67–70% of the total reduction in sub-soil fossil fuel assets in Russia. This drop is mainly a result of the sharp reduction in domestic demand for natural gas that does not take place under unilateral mitigation scenarios. The "High carbon price globally" scenario leads to around a 49% greater drop in total value of fossil fuels compared to the lower ambition cooperation case ("Carbon price globally"). The border carbon adjustment tax (under the "Carbon price and BCAT by CPL" scenario) leads to almost a doubling of the fossil fuel asset value loss compared to the unilateral scenario without BCAT—from US$80 billion to US$155 billion. Under all scenarios, the value of the oil assets is the least impacted, as even in the higher ambitious mitigation pathways (e.g., "High carbon price globally"), a significant share of the transportation sector still relies on petroleum.

**Figure 25. Change in the value of sub-soil fossil fuel assets relative to baseline, cumulative over 2018-2050**




*Source: Based on data from Peszko et al. (2021).*
*Note: To estimate the value of fossil fuel assets over 2018-2050 time frame a discount rate of 4% per year is used.*

## 2.3.5. Conclusions

Ambitious climate policies necessary worldwide for fulfillment of the 2 degrees target may have significant negative impact on the Russian economy. Climate action from fossil fuel importers, including almost all OECD countries, China, and India, could lead to a decrease in Russian exports of oil, natural gas, and coal by 20–30% by 2050 compared to the reference scenario that may also decrease welfare by 3%. If fossil fuel importers add the introduction of BCAT along with their policies to reduce emissions, the effects on the Russian welfare may be much larger–up to 9% by 2050.

Russia's active participation in global efforts to reduce emissions will mitigate the risk from the reduction of fossil fuel exports. By policy reforms, Russia can further prepare its economy to weather the anticipated drop in the global fossil fuel price and demand following tougher climate policies in all major fossil fuel-importing economies. By joining common efforts to address climate change, Russia can reduce the negative impacts on welfare in the country by more than 45% in 2050, as compared to the scenario of climate policy introduction by CPL with BCAT.

## 2.4. Comparing the Two Modeling Assessments

While both EU CBAM and Long-term global action assessments rely on a multi-region CGE modelling framework (based on ENVISAGE model), these two sets of simulations have some major differences, which should be taken into consideration when interpreting and comparing the results. Annex D provides a more detailed comparison between the two modelling approaches, outlining key underlying assumptions and reporting selected economic indicators.

First, while both models rely on the same core data input (GTAP 10 Data Base), their assumptions regarding baseline energy and emission trends in Russia differ substantially. The EU CBAM assessment assumes more ambitious mitigation measures implemented within the Reference scenario, as well as a higher penetration of renewables and energy efficient technologies (compared to the Long-term global action analysis). At the same time, the EU CBAM baseline relies on lower GDP growth projections, which assume lower emission levels.

Second, when more ambitious climate mitigation policies are modeled for Russia, the long-term global action analysis assumes that other countries (both climate leaders and followers) implement comparable mitigation efforts, while in the case of the EU CBAM assessment, climate mitigation policies in Russia are considered under an unchanging level of climate ambitions in the rest of the world. As a result, in the case of Long-term global action modeling, more ambitious mitigation efforts worldwide lead to substantial reduction in global fossil fuel prices, adversely impacting the Russian economy. This channel is not observed in the EU CBAM assessment since policy scenarios, in which Russia and other ECA countries implement more ambitious mitigation measures, assume no change in mitigation policies in the other countries (despite their level of ambition being high, as in the EU case).

Third, in terms of the representation of carbon border adjustment measures, the EU CBAM policy simulations impose a carbon border adjustment on EITE sectors only, covering either Scope 1 (or 1, 2) emissions, and assuming that CBAM is imposed by the EU (or the EU and U.S.). At the same time, Long-term global action analysis imposes a BCAT on all sectors of economy, covers Scopes 1, 2 and 3 emissions, and assumes that a larger coalition of CPL countries imposes this measure. As a result, within the Long-term global action analysis BCAT scenario, exporters, including Russia, face much higher overall carbon border adjustment restrictions compared to the EU CBAM assessment.

## 2.5. Limitations of the Analysis

The CGE approach used in this study is the state-of-the-art instrument to examine impacts of external changes, such as the introduction of EU CBAM or ambitious climate policies in major economies, on Russia's national economy. However, in using this approach, we make some significant assumptions, thus the results should be interpreted with caution. A modelling assessment provided in the report is not without limitations and potential for further extension.

The CGE approach assumes perfect competition and, therefore, homogeneity of firms within sectors. Under the CBAM analysis, we therefore suggest that the carbon footprint of all Russian companies exporting goods to Europe is equal to a sector's average carbon footprint. Given that exported goods tend to be less carbon-intensive than goods produced for the domestic market, our study may overestimate the potential losses from CBAM and underestimate opportunities for expansion that some less carbon-intensive Russian companies will have in the European market. In a similar way, our analysis ignores the opportunities for applying reshuffling strategies, when companies may redirect their less carbon-intensive goods to the European market in response to CBAM while more carbon-intensive production would stay in the domestic market.

Assumptions on the details of CBAM implementation used in our model vary to some extent from the last official European Commission proposal (European Commission, 2021). In terms of sectoral aggregation, we had to assume that the CBAM would cover all chemicals, while the existing proposals suggest covering only fertilizers within the chemical sector. In terms of the timeframe, we suggest that for some sectors, CBAM payments will already be introduced as early as 2023, and that starting in 2025, their sectoral coverage would expand. However, we believe that these inconsistencies in the timeframe and sectoral coverage are small and do not significantly affect the results. It is also worth noting that regulation itself may change in the future and the change is likely to be more ambitious.

In the assessment of long-term decarbonization, we consider $CO_2$ emissions from fossil-fuel combustion only. Therefore, the model does not consider $CO_2$ emissions from other sources (e.g., process $CO_2$ emissions or land use $CO_2$ emissions) or non- $CO_2$ greenhouse gas (GHG) emissions (e.g., enteric fermentation, rice cultivation, etc.). Inclusion of these GHG categories in the set of mitigation options might have an impact on the overall results. Although the CBAM impact analysis considers non- $CO_2$ GHG emissions, it still misses process $CO_2$ emissions.

When valuating economic impacts of decarbonization, a potentially wide range of mitigation co-benefits is not considered. A number of studies have shown that stringent climate mitigation policies are associated with significant co-benefits, including reductions in outdoor air pollution, energy security improvements, reductions in the frequency of extreme weather events, etc. (e.g. Nemet et al., 2010; van den Bergh et al., 2014; Vandyck et al., 2018). Inclusion of these categories in the overall economic impact assessment framework could deliver a more balanced assessment of the mitigation policy trade-offs.

The financial sector can have a hampering role if investors' perceptions of low risk from a missed transition and low opportunities from a transition fail to trigger a reallocation of capital into low carbon investments. This study doesn't model the financial system or investors' decisions, therefore feedback between the financial system and mitigation pathways is not taken into account. In the CGE framework, firms' access to financing is assumed to be available at no cost and with no limit, without any consideration that financing is provided by investors on the basis of assessed risk, resulting in financing costs and limits on funding. This is even more relevant in light of the result showing that coal assets face the prospect of a significant devaluation, which can affect lenders' behavior and the overall transition pathways and macroeconomic variables.

A number of simplifying assumptions have been made on the representation of labor markets. This study assumes that within the policy scenarios, national aggregate labor supply is fixed at the baseline level and wages adjust to equate labor demand with (fixed) labor supply. Therefore, while labor is allowed to reallocate across sectors, a long-term pre-defined level of unemployment is observed at the national level. While this assumption might be relevant for the long-run representation, it does not necessarily properly capture potential short- and mid-term changes that might occur in the labor market (e.g., frictional unemployment). It should be noted that the applied ENVISAGE model in general allows for a more refined representation of the labor market dynamics, as discussed in van der Mensbrugghe (2019) and implemented within the context of the climate mitigation policies in Chen et al. (2020). At the same time, such (short-term) labor market dynamics are not the focus of the current report.

Finally, this study contains the results of several modeling exercises, all of which use the ENVISAGE CGE model, but in different specifications. Sectoral and regional aggregations used for each exercise are a bit different. This means that the results presented in different sections of this report cannot be directly compared to one another. Further efforts to synchronize model specification are needed.

Even with these limitations, the CGE modeling estimates are valuable in illustrating the risks and opportunities of the green transition for Russia's economy. Scenario analysis does not generate forecasts, but rather: (i) shows the interval of possible futures; (ii) demonstrates the general logic, potential scale, and direction of challenges Russia's economy will face; and (iii) helps explain the logic of optimal response to these challenges.

# 3

# CREATING CONDITIONS FOR GREENER GROWTH AND INVESTMENTS

# 3.1. Diversification as Russia's Response to the Global Green Transition

## 3.1.1. Diversification Strategies

Diversification of the economy is indispensable to ensuring green and resilient economic growth in Russia. As discussed in the first section of this paper, the development model based on production and export of fossil fuels has not brought satisfactory rates of economic growth since at least 2012. The shrinking demand for fossil fuels caused by the green transition of the global economy would leave even less space for dynamic development of industries related to hydrocarbons, which are now the main sectors of specialization of Russia's economy. To stay resilient to the ongoing green transformation, the country's economy needs to decrease its dependence on fossil fuels.

**Box 3. Two major diversification strategies: traditional diversification and asset diversification**

- Traditional diversification suggests development of sectors that are linked to fossil fuels and offer additional opportunities for value creation. For instance, Russia may move from fossil fuel extraction to refining oil and producing petrochemicals, gas chemicals, steel, cement, and fertilizers. Russia's efforts to diversify its economy over the last two decades have been made largely in this direction. Russia has implemented this approach by keeping energy prices low and pursuing vertical industrial policy to strengthen downstream production.

- Asset diversification assumes diversification of the broader asset base and is aimed at shifting the economy towards other comparative advantages, for instance, human capital, renewable natural capital (such as ecosystem services used in agriculture, the renewable energy sector, and tourism), physical capital (such as factories and infrastructure), and institutional capital. Russia has undertaken some efforts at asset diversification in recent decades: for example, through programs of state support for the digital economy, tourism and agriculture.

Both types of diversification may create benefits for the economy; however, asset diversification is critically important for the mitigation of transition risks Russia faces. Traditional diversification may help mitigate cyclical risks through a weakening dependence on price volatility or the policies of particular importing countries. It also creates new jobs and develops more technically advanced sectors providing more significant technological spillovers. However, traditional diversification does not address the challenge of shrinking demand for fossil fuels and carbon-intensive goods, and therefore may not lead to economic growth resilient to global energy transition. It could serve as an opportunity for Russia to supply low-carbon technologies both for its internal market and externally.

*Source: Peszko et al., 2020*

Asset diversification may be pursued with two different strategies:

- Investment in strengthening assets that may be used by various sectors. For instance, investment in human capital through funding science, education and healthcare increases the human capital and productivity of sectors where human capital is used intensively. It strengthens the comparative advantages of these sectors and fosters diversification. For instance, Makarov, et al. (2020) simulate some illustrative diversification scenarios of this type for Russia. They show that the imposition of a 1-, 2-, and 3-% tax on fossil fuels and redistribution of tax incomes to the development of human capital would significantly mitigate the risks of a reduction in fossil fuel exports. At the same time, the welfare would be higher for 2050 in this case compared to no-diversification scenarios; in the short term, diversification may be painful, leading to the deceleration of economic growth during the first years of implementation.

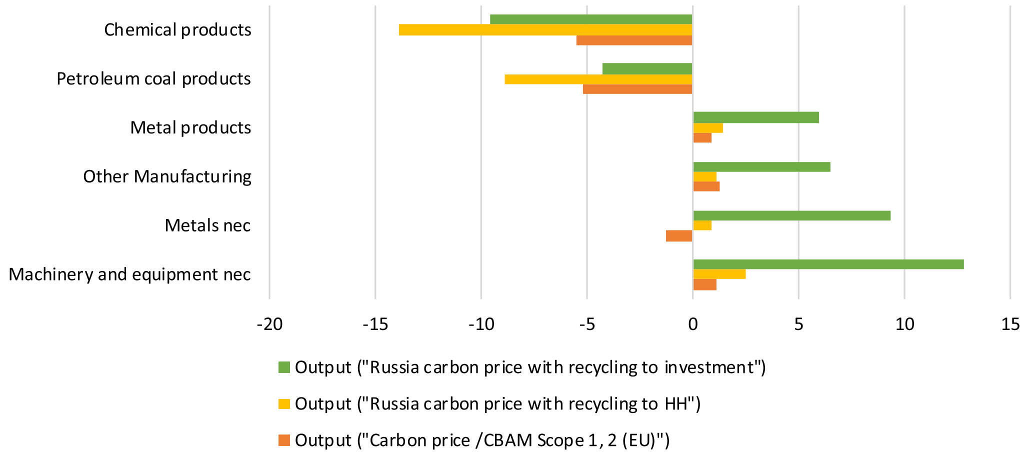
- Identifying new economic sectors, which may become the core for a new specialization in a decarbonized world, and enacting governmental policy to support these sectors. Some of the sectors relevant for low emission development of low-carbon hydrogen or production of certain minerals[11] are discussed later in this report.

Climate policies can give diversification new momentum. Climate policies create a system of incentives that push market forces to redistribute wealth from traditional industries with relatively low productivity decreasing competitiveness in a decarbonizing world toward new sectors with higher productivity and more relevance in the changing global economic and energy landscape. Carbon pricing introduced in any form is the most cost efficient way to materialize this set of incentives. It pushes companies to invest in new technologies, investors to diversify their asset portfolios, and corporate and private consumers to create demand for production in new sectors and reduce it for production in traditional ones.

Climate policy implemented as a response to CBAM (the “Russia carbon price” scenarios in the model described in Section 2.2.) not only mitigates the effects of CBAM but also leads to diversification. Analysis at the industry level shows that CBAM will have the most impact on the output of energy-intensive commodities like chemical products and petroleum coal products. These sectors are also among the most vulnerable in the European market, along with mineral products, electricity and ferrous metals. Under the scenarios implying that Russia increases climate policy ambition and raises its carbon price to the EU level, exports in these industries decrease but to a lesser extent, while output falls significantly due to domestic climate policy. When carbon pricing revenue is effectively used for investment, both exports and output in energy-intensive industries fall less relative to the scenario when all the revenue is transferred to households. More importantly, the “Russia carbon price with recycling to investment” scenario not only leads to the rise of GDP, but also implies substantial diversification of Russia’s economy towards low- or no-carbon industries like machinery and equipment, motor vehicles and parts, and other manufacturing (Figure 26).

[11] Climate Action Minerals refer to minerals and metals needed to produce low-carbon technologies, such as but not limited to, solar photovoltaic and concentrated solar power; wind turbines; geothermal, stationary, and mobile energy storage; electric vehicles; etc.

**Figure 26. Output, by industry, change in % relative to the no-CBAM baseline, 2035**




*Source: Based on Peszko et al. (2020).*

Climate policy as an instrument of economic restructuring and fostering economic growth should be considered in the global context. If climate policy is homogenous globally (for instance, in the form of a universal carbon price), its benefits and losses are determined by the structure of the economy. Clearly evidenced climate policy differences among countries have significant competitiveness implications. Overly ambitious climate policies (compared to other countries) may lead to additional problems for business due to loss of competitiveness if compensatory measures are not implemented. Overly passive climate policies make the country's companies vulnerable to various barriers in international markets (CBAM is the most illustrative example).

Therefore, international cooperation is a pivotal issue that should be considered. Results of the analysis of long-term transition risks provided in Section 2 show that freeriding may be preferential for the Russian economy compared to the involvement in global cooperative scenarios in the absence of BCAT, but it is definitely more costly for the domestic economy compared to the involvement in global cooperative scenarios, particularly when climate leaders implement a BCAT. As the next sub-section will show, additional proactive policy efforts implemented by the Russian government could further increase the economic efficiency of domestic climate mitigation policies and, in some cases, even lead to net welfare gains.

## 3.1.2. Long-Term Diversification Scenarios

This sub-section adds diversification scenarios to the analysis of the long-term effects of global decarbonization on Russia's economy. It relies on the modeling results from Peszko et al. (2020), who employed the ENVISAGE CGE model to showcase potential economic, energy and environmental implications of the diversification and cooperation strategies in the decarbonizing world. Two scenarios are considered:

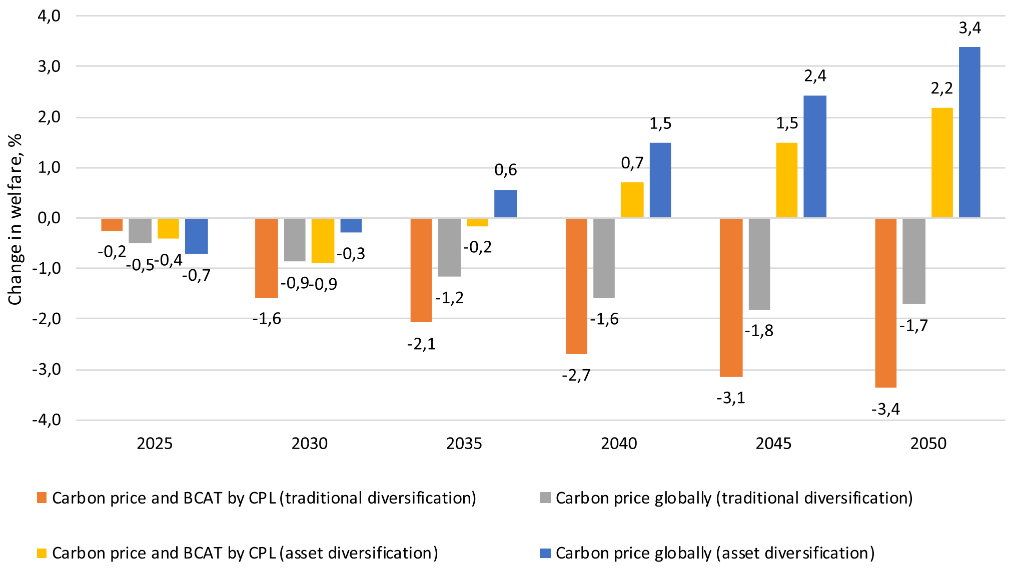
- "Carbon price and BCAT by CPL"—assumes that climate policy leaders implement unilateral emission reduction efforts and impose BCAT on imports from fossil-fuel dependent countries based on the carbon content of the country/region of commodity origin.

- The "Carbon price globally"—a cooperative scenario, where all countries and regions participate in the climate mitigation efforts and a globally uniform carbon price is implemented.

Each of these two scenarios is considered under two diversification options. Traditional diversification assumes that all fossil-fuel dependent countries, including Russia, allocate a share of their rents from fuel extraction to subsidize energy-intensive industrial production activities. Under the asset diversification option, all fossil-fuel dependent countries, including Russia, invest a share of their rents into education and research and development (R&D). Under the asset diversification case, it is assumed that investments increase labor productivity (with a time lag) across sectors, based on pre-defined functional relationships, as discussed in van der Mensbrugghe (2018). Under both diversification options, the level of resource rents allocated for subsidies or investments equals 1% of GDP of the baseline scenario. For the policy analysis, each of the two scenarios discussed paired with two diversification options is compared with a business-as-usual scenario that lacks diversification policies.

Participation in international cooperation together with asset diversification domestically provides the best outcomes among all combination scenarios. Under the traditional diversification scenario, Russia's economy is negatively impacted under both the cooperative action and freeriding (with BCAT), while impacts under the freeriding choice are much more negative (Figure 27). With traditional diversification, Russian welfare would decrease

**Figure 27. Change in welfare by scenarios, % relative to baseline**




*Source: Based on data from Peszko et al. (2020).*
*Note: Changes in welfare are measured relative to the baseline scenario with no diversification measures.*

anywhere from 1.7% (under the cooperative action) to 3.4% (under freeriding with border tax) in 2050 relative to the no-diversification and no climate mitigation baseline. However, the implementation of asset diversification efforts, in the long run, leads to the net welfare gains, as the economy benefits from increasing labor productivity following investments in R&D and human capital (Figure 27). Due to the lag between investments into R&D and human capital, and increases in productivity, asset diversification does not result in immediate benefits, but in the long run (starting between 2035–2040) corresponding welfare gains are fully realized. While a combination of cooperative climate mitigation efforts and asset diversification policies results in the highest benefits for economy (a 3.4% increase in welfare in 2050), even under the freeriding scenario with a border carbon tax, asset diversification leads to positive macroeconomic impacts (a 2.2% increase in welfare in 2050).

### 3.1.3. Policies for Green Transition and Conclusions

Global green transition, albeit being a challenge for Russia's economy, simultaneously creates additional opportunities for its diversification. However, these opportunities are unlikely to be used without targeted government policies. Russia's economy will restructure regardless as the result of a reduction in global demand for its major export goods. This process will create winners, but also losers, primarily associated with fossil fuels. If the process of restructuring is unmanaged, these losses will take place before the new advantages are created and will involve larger shares of the population and the economy. If restructuring is managed, most of the losers from business will have time to adapt to the new energy landscape and the losses experienced by the population may be compensated. This report focused on policy measures aimed at using the opportunities of the global green transition.

Policy measures aimed at promoting opportunities for the global green transition include: (i) measures that create incentives for decarbonization to foster demand for green investments (carbon regulation and pricing); (ii) measures that establish a supportive financial infrastructure to leverage private investments for green transition ("green finance"); and (iii) measures directed at the development of new sectors in which Russia may specialize in the decarbonized world. The following sections discuss some examples of these measures as applied to Russia. This study does not cover the entire spectrum of policies required to enable a green transition (i.e., governance, innovation, jobs, just transition, social protection, etc.) as these will be covered in greater breadth and depth in the Country Climate and Development Report (CCDR) and follow-up studies.

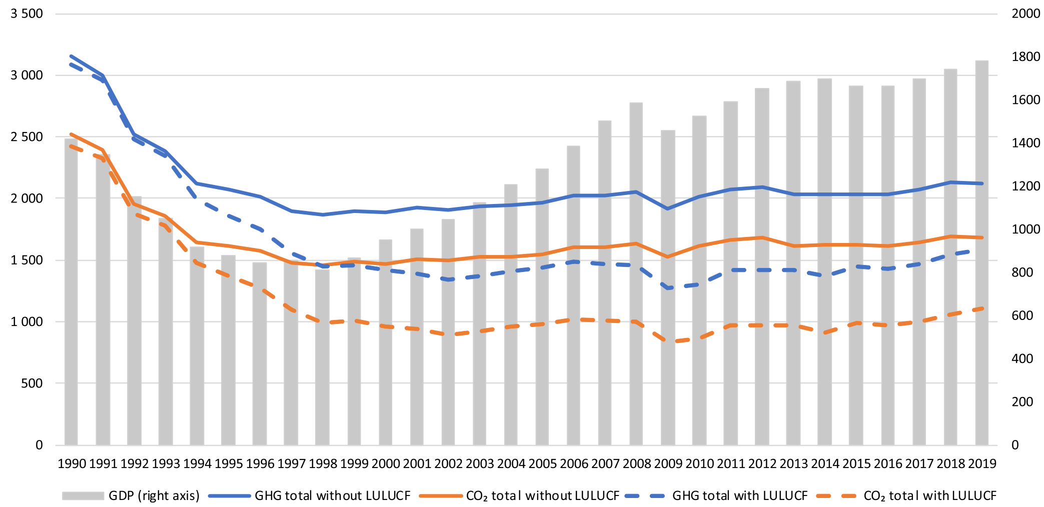
## 3.2 Creating Incentives for Green Growth

### 3.2.1. Climate Policies and Carbon Pricing

While one of the largest GHG emitters in the world, Russia has achieved the largest absolute emissions reduction since 1990 among all countries. Among national economies, Russia ranks fourth in GHG emissions, after China, the U.S. and India. Taking into account land-use, land-use change, and forestry (LULUCF) as well, Russia also ranks behind Brazil and Indonesia. Russia's emissions have decreased significantly since the collapse of the Soviet

Union, primarily due to a deep transitional crisis in the 1990s (between 1990 and 1998, GDP dropped by more than 40%). Since that time, GDP has grown significantly and, in 2007, surpassed the 1990 level. However, Russia has achieved decoupling of its economic growth and emissions: despite high rates of economic growth (7.1% per year in 1999–2007), GHG emissions only increased modestly. The market reforms of the 1990s boosted incentives for saving energy and materials. The economy has been restructured and significantly innovated. Energy intensity of GDP has decreased by 5% each year. The dynamic development of nuclear and hydropower generation as well as modern gas-fired power plants made possible the significant reduction of emissions per unit of electricity and heat production (Bashmakov, 2020). Since 2010, Russian emissions have plateaued. The rise of energy efficiency and the rise of productivity both decelerated dramatically. Yet, as a result of the transition crisis and further modernization of the economy, GHG emissions in Russia are now 32.9% lower than in 1990 without LULUCF, or 48.7% lower with LULUCF (Figure 28).

**Figure 28. GHG emissions (Mt, left axis) and GDP (2010 US$ billion, right axis) in Russia in 1990–2018**




*Source: Based on data from UNFCCC and World Bank.*

Russia is a part of the international climate change cooperation and joined the Paris Agreement in 2019. Its nationally determined contribution (NDC) suggests a 2030 emissions target at 70% of the 1990 level, "subject to the maximum possible account of absorbing capacity of forests and other ecosystems" (Russia NDC, 2020). The statement about forests and ecosystems may be interpreted in different ways. Even without taking it into consideration, Russia's NDC is lower than the business-as-usual scenario and is very likely to be fulfilled with no additional efforts (Climate Action Tracker, 2020; Makarov et al., 2020).

In recent years, the Russian government has made serious efforts to develop domestic climate legislation. While the first climate policy document, Climate Doctrine, was adopted in 2009 (President of the Russian Federation, 2009), the first practical steps to implement climate policies were taken in the last few years. They include the National Plan of Measures of the First Stage for Adaptation to Climate Change until 2022 (adopted in 2019); the Presidential Decree on the Reduction of GHG Emissions (adopted in 2020); and the Federal Law on the Control of GHG Emissions (adopted in 2021). Moreover, the long-term, low-emission development strategy was prepared by the Ministry of Economic Development and adopted on October 29, 2021 (see section 1.3). In 2021, President Putin declared the objective to achieve carbon neutrality by 2060.

With these regulatory documents in place, Russia will finalize legislation recommended within the Paris process.  However, these documents are not yet integrated into the country's long-term visions of economic development; this process is initiated by developing a draft long-term emission reduction strategy, which has not yet been adopted. The presidential decree sets the emissions reduction targets likely to be achieved at the NDC level without any additional efforts. The national regulation program does not include any policy instruments directed at emissions reduction; it instead focuses on monitoring and verification of GHG emissions by Russian companies. The National Adaptation Plan states that sectoral and regional adaptation plans should be prepared by 2022 by responsible ministries and regional administrations. Despite the increasing number of climate-related normative documents, Russian domestic policy aimed at reducing emissions and coping with climate change at the national level remains fragmented.

The interest of Russia's regions in self-regulation of GHG emissions, such as Sakhalin oblast, where a pilot emissions trading system (ETS) will be launched in 2022–2025, is an important phenomenon that may become a model for development of emissions regulation in fossil-fuel dependent countries. The regions consider implementing emissions regulation plans to mitigate transition risks from climate change and to leverage transition opportunities. Export-oriented regions acknowledge the potential barriers their companies would face in international markets and may wish to give them the opportunity to reduce their carbon footprint in the region of their allocation. Checking the feasibility and effectiveness of the regulatory framework would be one of the transition steps to attract investment in low-carbon projects by the companies located elsewhere wishing to reduce their carbon footprint.

To be more effective, fragmented elements of the Russia's climate policy would need to be systematized and integrated in the country's economic strategy, while framework legislation would need to be supplemented by more specific regulations and, ultimately, integrated into a comprehensive system. Various climate-related strategies and plans would need be followed by roadmaps with milestones, costing, and responsibilities. GHG emissions reduction plans should be coordinated with other green policies, including those promoting energy efficiency, development of renewables, and the hydrogen economy. They should also be integrated into Russia's energy strategy and the programs and forecasts for economic development.

At the national level, the Russian government has not yet set a price for carbon, but it may do so in the future. Many countries with abundant fossil fuels have gained significant experience and lessons that may be useful for implementing carbon pricing in Russia (see Box 4).

### Box 4. The Experience of Fossil-Fuel Dependent Countries with Carbon Pricing

Although challenging, the introduction of a carbon price is becoming increasingly common in fossil fuel-dependent countries. So far, a carbon price in the form of a carbon tax or emissions trading system (ETS) has been introduced in about a dozen national and subnational entities that rely on substantial fossil fuel reserves and specialize in fossil fuel exports (World Bank, 2021a). These economies include Australia, Cambodia, Canada and its provinces of British Columbia and Alberta, Kazakhstan, Norway, and South Africa.

Although there is some concern that carbon pricing could lead to a reduction in the competitiveness of carbon-intensive industries or negatively affect low-income groups (Arlinghaus, 2015), these potential downsides can be effectively managed through an appropriate design of the carbon pricing mechanism. The literature (Stepanov and Makarov, 2021) and empirical evidence suggests that the impact of carbon pricing and overall mitigation efficiency depend on how the regulatory design accounts for the specifics of the particular economy where the regulation is being introduced.

Carbon offsets may be used to expand the set of available options to reduce emissions. For instance, the Alberta ETS provides emitters with an option to cover part of their allowances through offset credit units generated by third-party projects. A system of offsets is also used to support the South African carbon tax as well as the California ETS.

A variety of measures are implemented to reduce the impact on international competitiveness for firms that are particularly emissions-intensive and trade-exposed, such as free allocation under ETS or rebates under carbon taxes.

Finally, carbon pricing systems often ensure compensatory mechanisms for redistribution of revenue generated from carbon taxes or ETS. Stepanov and Makarov (2021) describe the cases of British Columbia, Canada, and Norway, where carbon revenues are recycled in whole or in part back to the economy. These revenues are recycled back either in the form of income and corporate tax cuts or as subsidies for vulnerable households.

First, carbon pricing is an instrument to mitigate the adverse effects of emissions regulation at the border executed by trade partners. EU CBAM suggests that if an exporting country has domestic carbon regulation, the corresponding carbon price may be excluded from CBAM payments. It is highly likely that other border carbon adjustments that may appear in global markets will be organized in a similar way. Russian companies would get incentives to finance carbon-reduction projects in Russia if they know that it would help them to reduce their carbon footprint and minimize CBAM payments.

Second, carbon pricing is a means of diversifying the national economy (see Section 3.1). It stimulates both traditional diversification, creating incentives for reduction of carbon footprint and thus maintaining competitiveness of energy-intensive manufacturing, as well as asset diversification, favoring zero-carbon or low-carbon solutions. Carbon pricing redistributes wealth from the less carbon- and energy-efficient companies and sectors to the most energy-efficient ones, meaning those best adapted to the new energy landscape.

Third, carbon pricing would help Russia attract green investment from global markets. Limited previous efforts to reduce emissions, domestic imbalances (including high cost of capital, absence of carbon pricing, and wide use of fossil fuel subsidies) have not created any incentives to realize low-carbon projects. Thus, Russia has significant opportunities for emissions reduction at a modest cost.

A large share of $CO_2$ emissions can be abated at a relatively low cost. Reducing emissions in Russia is cheaper than in most other countries (Figure 29). These cost comparisons to reduce emissions are based on estimates of the marginal abatement cost curves (MACCs) derived using the ENVISAGE model within the Energy Modeling Forum multi-comparison study discussed in Böhringer et al. (2020).[12] Estimated MACCs show that the cost of emissions reduction in Russia is among the lowest within the set of considered countries and regions, as only China's and India's MACCs are above Russia's curve (Figure 30). In OECD countries, emissions reduction is significantly more expensive as the cheapest options to reduce emissions have already been used within previous climate policy efforts. Estimates suggest that a US$40 carbon price in Russia results in a 20% reduction in emissions, while a US$15 carbon tax is associated with a 10% reduction in emissions. Cheaper emissions reduction does not necessarily mean easier reduction. The high cost of capital and institutional barriers may become significant obstacles to the realization of this potential. However, the model shows that even a modest carbon price, if well designed, can make a noticeable impact. The fact that Russia has more relatively cheap opportunities to reduce emissions than most of the other regions also means it may benefit from creating a domestic carbon market and integration into international/ regional carbon markets, including voluntary markets with the potential to attract investment to low-carbon projects.

One of the key objectives of climate policy is to make green goods/projects cheaper and carbon-intensive goods/projects more expensive by introducing a carbon price. It may have either explicit or implicit form. While explicit carbon pricing usually takes the form of a carbon tax or an emissions trading system, or a combination thereof, an implicit price on carbon implies indirect price incentives for emissions reduction in the form of changes in energy fiscal measures, including raising energy taxes, phasing out fossil-fuel subsidies, and implementing tax maneuvers stimulating energy saving and transition to a less carbon-intensive energy mix (OECD, 2021; Stepanov, 2019). According to a forthcoming World Bank study (Sanghi et al., 2021), total consumer energy subsidies in Russia are estimated to be around 1.4% of GDP, while their gradual removal will lead to a positive impact on GDP and reduction in $CO_2$ emissions. Russia's long tradition of fiscal energy policies has great potential for energy taxation system restructuring intended to stimulate low-carbon solutions. An integrated approach to carbon pricing and energy subsidies would help better align incentives for growth and emissions reduction. Effective fiscal and competition policies are preconditions for climate policies to trigger an expected response from polluters and energy users.

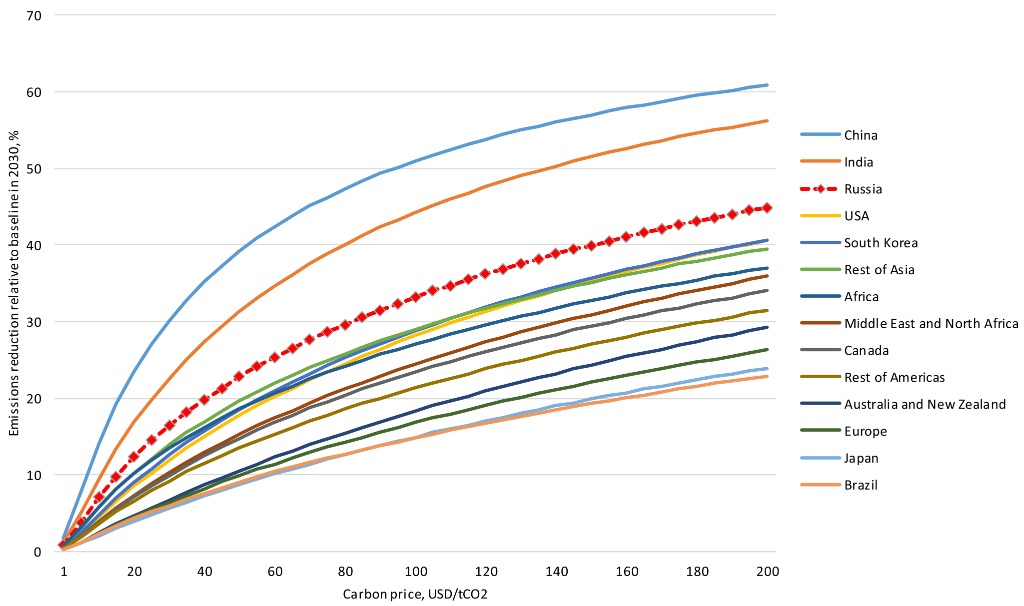
The impacts of carbon pricing on the Russian economy will depend on the way it is implemented and integrated into the overall system of economic incentives already in place. To strike the right balance between potential benefits in the form of external risk mitigation, economic

[12] Specifications on the corresponding version of the ENVISAGE model, together with the baseline assumptions, can be found in Chepeliev et al. (2021). Corresponding MACCs have been derived by imposing a carbon price on all agents within the model (intermediate and final users) in a dynamic modeling framework with gradual introduction of prices over the years and reaching the target price in 2030. Such simulations were performed for each country and region in the model (one by one) with the price varied from US$1/t$CO_2$ to $200/t$CO_2$ at a $5/t$CO_2$ step. Change in $CO_2$ emissions were then measured relative to the baseline emissions level in 2030.

diversification, etc. and the costs like possible adverse social impacts and challenges to competitiveness of national producers, a number of issues should be addressed. They include the choice of the adequate scope and coverage of carbon pricing, its specific form (carbon tax, ETS, hybrid instruments or implicit carbon pricing integrated to energy taxation), point of regulation (downstream, midstream, upstream), and many others. Much will depend on the way the carbon revenues are distributed, e.g., part of the revenues could be spent to support most vulnerable social groups and/or industries. This study does not predict the impacts of a carbon price's specific design or make judgments on what polices are more likely than others, but gives economic insight into stylized cases, such as recycling to investments, or household transfers, or in long-term broad CBAM scenarios – recycling to R&D and education. Actual policy action with a specific revenue recycling mechanism could be implemented after detailed multicriteria analyses and public consultations, which are beyond the scope of this analysis. These and other related issues fall outside the scope of this report and will be analyzed in more detail in the Country Climate and Development Report (CCDR) and follow-up studies for Russia.

In addition to fiscal instruments, a package of measures including standards, certificates, monitoring, and financial support are often needed to make even economically viable green investments happen. Programs to support energy efficiency improvements are among most effective climate policies around the world with a large potential in Russia (see Box 5).

**Figure 29. Marginal abatement cost curves by regions in 2030, % change relative to the Reference scenario**




*Source: Based on simulations reported in Chepeliev et al. (2021) and Böhringer et al. (2020).*

## Box 5. Energy Efficiency in Russia

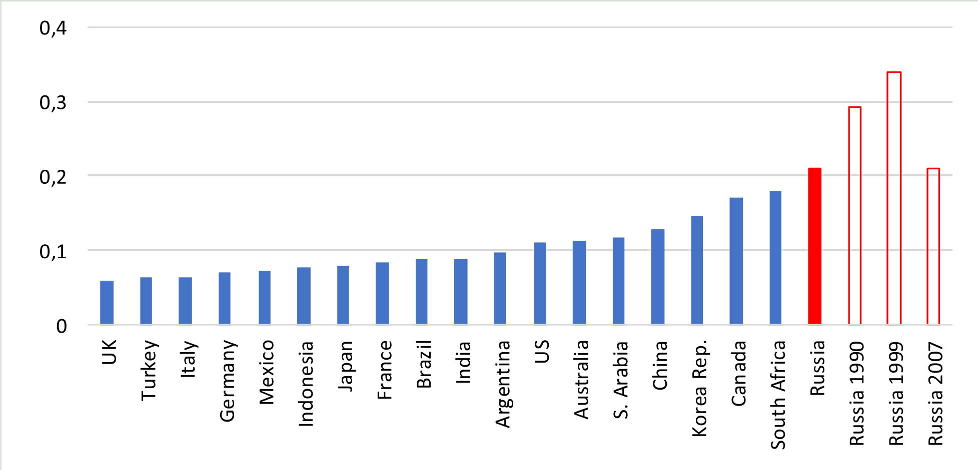
Improving energy efficiency is one of the key win-win directions for green development of Russia's economy. Russia has experienced only one period of rapid economic growth in modern history, in 1999–2008. This was also the period when the economy's intensity decreased rapidly. Decoupling of emissions and economic growth is achievable through structural changes and technical renovation. World Bank (2014) estimated that Russia's current energy inefficiency is equal to the annual primary energy consumption of France. Achieving Russia's full energy efficiency potential would cost a total of US$320 billion to the economy and result in about US$80 billion in annual costs savings to investors and end users, paying back in just four years. Benefits to the total economy are much higher: US$120-150 billion per year of energy cost savings and additional earnings from gas exports. Therefore, such investments have substantial gains that could be additionally incentivized by climate policies. Upgrading and modernizing factories, public infrastructure, buildings, public lighting, etc. can improve competitiveness, lower company/public/household expenditures, reduce local/global pollution, and create tens of thousands of jobs.

Earlier efforts to promote energy efficiency in Russia were mixed. In 2009, Russia passed a law on saving energy and improving energy efficiency in the economy. The law set the goal of decreasing GDP energy intensity by 40% by 2020, over the 2007 level. However, results have been constrained by limited reforms in energy markets, tariff reforms, universal metering, etc. Moving to full cost-recovery tariffs, phasing out subsidies on fossil fuels, expanded metering (particularly for district heating), and transition to consumption-based billing, are all expected to better incentivize efficiency improvements, but these have been slow to materialize. In 2015, all of the budget support for energy efficiency measures was cut due to the sequestration of the federal budget, and the energy efficiency program failed to achieve its goals. Today in Russia, energy intensity of GDP (in constant prices) is equal to the 2007 level and is far behind every other G20 economy (Figure 30). While Russia's large territory, cold climate, and obsolete technologies contribute somewhat to its lack of progress in energy efficiency, the main cause is the Russian government's use of subsidies to keep domestic energy prices low.

Russia is now starting a new stage of its energy efficiency policy implementation. In 2020, the Ministry of Economic Development defined new priorities for energy efficiency policies, with the objective of decreasing GDP energy-intensity 30% by 2030, over 2017 levels. According to the Ministry's draft plan, the major driver of this process will be the modernization of energy generation capacities, boiler houses and heating networks. In the transport sector, the policy calls for support of hybrid and electric vehicles and tightening fuel standards; and, in construction, for new standards for materials and lighting (Ministry of Economic Development, 2020). These measures are to be supported by a system of preferential loans, energy service contracts, and white certificates. According to the Russian Ministry of Economic Development, this is expected to lead to saving of 326 Mtoe of energy and a resulting reduction of emissions by 900Mt $CO_2e$ by 2030 (Ministry of Economic Development, 2020).

**Box 5.**

**Figure 30. Energy intensity of GDP in 2019, ktoe/US$2015p**




*Source: Based on statistics from Enerdata.*

# 3.3. Green Finance for Green Transition

To take advantage of the green transition opportunities, Russia requires substantial investments to support its needed transformation. The country's ability to improve resource efficiency and manage environmental, social, and climate-related risks, all while reducing the country's carbon footprint— one of the highest in the world— depends on its ability to cover the cost of required investments. The costs of implementing best available technologies (BAT) across industries are estimated at 4-8 trillion Russian rubles (US$55-82 billion). According to the Russian government estimates, the investments required for the energy transition under the intensive scenario by 2050 are estimated at a total of 90 trillion Russian rubles, 3.2 trillion Russian rubles annually (3% of GDP) (Kommersant, 2021).

Having a robust green finance system—to increase the attractiveness of green investments, and better understand and manage climate-related risks—is important for enabling Russia's green recovery and transition. Greening the financial system will mean increasing financing flows into sectors that contribute to climate and environmental objectives while also managing related risks—both in transition, related to rapid devaluation of the carbon intensive assets, as well as in physical climate risks. As the scale of investment needed to finance the green transition far exceeds the public sector capacity, private investment will be an important source of funding for this transition. Green and social bonds, loans, and other instruments designed to further environmental and social outcomes have an important role to play in mobilizing the private-sector resources necessary for Russia to meet its sustainability goals, provided the necessary market infrastructure and right incentives are put in place.

Despite the fact that Russia has started seeing some emerging interest in green finance—primarily green bonds —from both the private and public sector, current volumes remain modest by international comparison. Since the Moscow Exchange established its Sustainability Sector for green and social bonds in 2019, there have been 14 domestic green bond issuances by 10 issuers totaling over 100 billion Russian rubles (US$ 1.39 billion). This also includes an inaugural sub-national green bond issuance by the Moscow government (MOEX, n.d.), which may set a precedent for other Russian regions. By comparison, green bond issuance in countries like Brazil, India and China (Climate Bonds Initiative, 2021) have been exceeding Russia's volume many-fold. A growing number of jurisdictions have been using a range of policy measures to support development of their green bond markets, including financial incentives (see Box 6). The ongoing efforts of the Russian authorities, including the recent adoption of the national green finance taxonomy and verification guidelines, development of green bond incentives and soft Central Bank of Russia (CBR) regulation on responsible investment and ESG disclosures, could potentially stimulate further issuance of green bonds.

Green loans or sustainability-linked loan products have been nascent, although recently some Russian companies and banks started demonstrating interest in green loans or loans tied to environmental and social governance (ESG) factors. In particular, the precious metals mining company Polymetal received a US$125 million green loan from Société Générale to finance projects for the transition to a sustainable and low-carbon economy; Moscow Credit Bank (MKB) attracted a US$20 million ESG-linked loan from German Landesbank Baden-Wuerttemberg; and mining and metallurgical company Metalloinvest has amended the terms of its €200 million syndicated loan, under which the interest rate is linked to the company's key performance indicators (KPIs) for sustainable development. In 2019, RUSAL, the largest aluminum producer, tied a US$1.085 billion pre-export financing deal to sustainability KPIs (Infragreen, 2021).

### Box 6. Policy areas supporting the development of a green bond market

A growing number of jurisdictions have been using a range of policy measures, including financial incentives, to support development of their green bond markets. These policy measures are aimed at incentivizing issuers and investors and could be broadly grouped into the following categories:

- Tax incentives (for issuers and investors)
- Subsidies aimed at lowering issuing costs (for issuers)
- Public guaranty schemes aimed at enhancing the risk profile of green bonds (for investors)
- Risk-weighting adjustments and different capital requirements for green/brown assets (for investors)

Green bond financial incentives are aimed at increasing investor attractiveness (beyond ESG target achievement) or issuer motivation. In some countries, green bonds have tax benefits to the issuer or investor. The former may receive direct subsidies to lower

**Box 6.**

costs and the latter would receive either tax credits or exemptions. Other measures could include compensation for accredited verification or other similar expenses and guarantees covering specific risks (e.g. on green infrastructure projects) provided by public institutions or development finance institutions. Credit guarantees can provide default risk coverage for a portion or the whole debt obligation subscribed by private investors. Through this mechanism, the issuer is able to improve the credit worthiness of the project, thereby attracting a wider range of investors and potentially achieving better terms for the issuance. One important principle underpinning most of the incentives such as grants, subsidies or tax benefits, is that they may need to include clawback requirements in case of failures to meet defined standards or objectives such as measurable green benefits.

Governments can foster the development of new instruments by providing a tax-advantaged treatment of interest and other income received by investors when proceeds are used for eligible sustainable activities. There have been some bonds where private investors provide financing to traditionally publicly financed green projects, and the tax benefits are granted to these bonds. Clean Renewable Energy Bonds (CREBs) and Qualified Energy Conservation Bonds (QECBs) in the U.S. are often cited as examples of how tax incentives may be used for green finance instruments; and they may provide some evidence on the effectiveness of these measures. Governments could extend existing tax-exemption mechanisms to also cover green bonds or could establish specific tax incentives for green bond issuers or investors (relevant types of tax incentives include preferential rate for withholding tax, investor side income taxes, and issuer side tax incentives). Globally speaking, however, it is rare that tax incentives are used as a policy tool to develop the green bond markets. Tax exemptions can be applied in a more targeted manner to the eligible project directly rather than by reducing the financing costs by green bonds.

In some countries (e.g. Japan, Singapore, Malaysia) the authorities subsidize issuance costs for green bonds, covering green certification and other costs or reducing interest rates. Typically, these subsidies are capped not to exceed a specified amount and are also time bound and tend to decrease over time.

Risk-weighting adjustments for green/brown assets is an emerging area of debate by financial sector regulators and has not yet been applied in practice. The concept behind this is that the regulators could allow differential risk weighting for green and non-green assets (loans and bonds) by enacting regulatory changes to increase capital requirements for financial institutions who hold “brown” assets that are unfavorable to the green transition (i.e. brown penalizing factor) and/or introducing a prudential bonus for green assets–a so-called “green supporting factor.” Recently, some of the central banks, such as Bank of England and Banque de France, have started examining the case for a brown penalizing factor by conducting climate change related stress tests. Yet, the risk-weighting adjustment approach has not been implemented by any financial sector regulator yet, in part because there is no strong enough evidence that green assets are less financially risky than brown ones.

## 3.3.1. Regulatory and Institutional Architecture of Russia's Green Finance

Recent progress in the development of the green finance governance system in Russia (2019–2021) has put it on a path to creating a robust institutional architecture to stimulate flow of financing required for green transition. The Interagency Working Group was formed under the Ministry of Economic Development with the aim of consolidating and coordinating efforts among the various stakeholders involved in the development of green finance initiatives in Russia, including the federal executive bodies, the Central Bank of Russia (CBR), development institutions, business, and the professional community. Russian state development corporation Vnesheconombank (VEB) has been assigned the role of a green finance methodology center to create a framework for the Russian national green finance system. As a component of developing the foundations of the Russian green finance system, in September 2021, the Russian government adopted a package of measures to set the standards for green finance: (i) taxonomy of green and adaptation projects and (ii) verification requirements (Ministry of Economic Development of the Russian Federation, 2021).

The Russian Central Bank has been supporting greening of the financial sector, following global regulatory trends. In 2019, the Bank of Russia joined the Network for Greening the Financial System (NGFS) and set up a working group with a focus on sustainable finance agenda, which produced the initial concept for green finance development in Russia. As a capital market regulator, CBR Introduced specific regulations for issuing green and social bonds at the Moscow Exchange (MOEX). Most recently, it introduced a soft regulation on ESG (environmental, social and governance) disclosure and risk evaluation for public companies, in line with the TCFD (Recommendations of the Task Force on Climate-Related Financial Disclosures) and GRI (Global Reporting Initiative Standards); following earlier recommendations on responsible investment for institutional investors. Most recently, the CBR initiated a stress testing exercise to analyze the impact of energy transition on the Russian economy and financial sector and to develop supervisory guidance on managing climate-related physical and transition risks.

The Russian government has started developing green finance incentives to enable companies to implement their environmental programs. For example, Government Decree No. 541 (April 30, 2019), provides a framework for subsidizing interest on green loans and bonds, under which the government would compensate 60–90% of interest payments for companies that attract green loan financing. However, to qualify, projects must first undergo a rather complicated selection procedure, which was only launched in July 2021. To date, no companies have been able to take advantage of the subsidy (Mukhamedshin, 2021). Other proposals in the draft government roadmap on green finance incentives include more options, such as tax incentives for green bond investors and project verification costs for the issuers for up to one million Russian rubles per project.

## 3.3.2. Russia's Green Finance Taxonomy

A robust taxonomy, aligned with both financial and environmental regulations, is a key part of the architecture of a sustainable finance system and the country's overall regulatory framework. Attracting investments to support a green transition requires consistent guidelines that can be used to define and classify economic activities and appropriate financial instruments to enhance market transparency and facilitate the alignment of capital flows with environmentally sustainable economic activities. A well-substantiated taxonomy can increase investor confidence by minimizing the potential for greenwashing, provide a clear mechanism for assigning the "green" designation to investment funds and other financial products and increasing their visibility, contribute to creating demand for them, and enable the choice between "green" and "brown" investments. The taxonomy is a foundational component for development of additional regulations to meet the needs of the emerging instruments and market spaces and can contribute in a meaningful way to improving the integrity of such markets (Ermohin, 2021).

Russia's national taxonomy includes both green and adaptation projects, along with supporting methodologies and implementation standards. In developing its taxonomy, Russia adopted a "transitional approach" and introduced "adaptation" projects (for information on different approaches used around the globe, see Box 6). Such projects are aimed at enabling Russia's economy to adapt to climate change while simultaneously helping companies transition from high to low carbon intensity and environmental impacts that help the country reduce emissions to the extent necessary to meet its reduction targets. These are generally expected to be for industries and sectors in which de-carbonization is technologically or economically infeasible, but which have a mid-term target for reducing GHG emissions. Transition finance would allow them to support the journey to lower carbon, an understandable approach as there is a need to transition away from "brown" economic activities that cause significant harm to environment and climate.

### 3.3.3. Strengthening Russia's Green Finance Framework

While the Russian authorities have already made some considerable efforts aimed at greening the financial system, they should continue expanding their toolkit of policy measures. Building on recent efforts—such as the establishment of an interagency working group and a green finance methodology center, participation in green finance-related international networks, adoption of the national taxonomy and verification guidelines and development of a green bond market infrastructure—authorities could undertake further actions to promote green finance and manage climate-related and environmental risks. Among the priority actions would be stepping up efforts related to climate-related risk assessment and management, developing and implementing climate-related and environmental disclosure and reporting standards, incentivizing development of a wider range of financial instruments and greening Russian public finance institutions by reallocating their capital to support green transition.

Assessment and management of climate-related risks has been becoming an important consideration for financial sector stability and therefore its capacity to finance green transition. Climate change could pose risks to financial systems and the economy. In the context of climate change, a rapid transition to a low carbon economy could translate into significant transition risks for the financial sector; and in Russia in particular, financial institutions have large exposure to carbon-intensive and other transition-sensitive sectors. The physical impacts of climate change could also translate into risks for the financial sector. Not only would climate change create new sources of risks for financial stability, the lack of understanding or awareness of climate risks by financial institutions could also delay the low carbon transition.

Since the perceived level of risk has a direct impact on investment decisions, increasing awareness and managing climate and environmental risks through financial supervision can play an important role in changing financial behavior and driving capital towards green goals (World Bank, 2021b). The Central Bank of Russia has already initiated a number of steps related to climate risk assessment, including conducting a stress test to estimate the potential scale of the risks and considering development of a supervisory approach to managing climate-related risks. In parallel, some of the largest Russian banks started adopting ESG strategies, which also envision identification and management of climate-related risks. Further efforts may be required to gradually incorporate climate-related risks into supervisory practice of the Central Bank and strengthen capacity of the financial institutions to identify and manage these risks.

Development and implementation of the climate-related and environmental disclosure and reporting standards will be critical for enhancing market transparency and understanding of climate-related and environmental risks and opportunities. As mentioned above, the financial sector authorities have initiated the steps towards encouraging the ESG reporting and incorporating ESG principles in the investment decisions (Central Bank of Russia [CBR], 2020; CBR, 2021). Investors and lenders need adequate information on climate-related and environmental risks and opportunities to understand, price and manage the risk in their portfolios and operations, climate-related and environmental financial disclosure of both financial institutions and corporations in the real economy is imperative to providing the necessary information for financial market actors to consider climate or environmental-related risks and opportunities and align their capital accordingly. These disclosures have many uses in the investment process. For example, the information disclosed can be integrated into a valuation model, used for screening, to inform thematic investments, or to measure the impact of companies and/or funds. Public disclosure will be an additional incentive for firms to step up their efforts in this space. Key international initiatives have already laid the foundations to start implementing disclosure and reporting regimes. To the extent possible, disclosure guidance should continue to be aligned with international frameworks, particularly the recommendations of the Task Force on Climate-Related Financial Disclosures (TCFD) to enable harmonization and comparability of institutions' climate disclosure or sustainability reporting (World Bank, 2021b).

While the role of the capital markets and green bonds is essential in facilitating green financing flows, it is equally important in supporting development of the loan market. Given the dominance of the banking system in the Russian financial sector, it is important to gradually stimulate origination of green loans and sustainability-linked loan products. A prerequisite for the successful development and integrity of the green or sustainability-linked loan market is the adequate and correct labelling of these products. This provides lenders with the ability to track green lending activity and creates transparency and clarity on the demand side. Alignment with international standards on green or sustainability-inked loans and green taxonomy is strongly advisable to ensure consistency and comparability across asset classes and instruments (World Bank, 2021b). The green loan market provides significant potential to scale up green finance activity. This can be a core aspect of increasing banks' involvement in the green finance market and simultaneously supporting the demand side. The banking sector's green lending activity is still often limited, and labels for green lending products are missing. A key category of green loan products are green mortgages—a green mortgage pilot is currently under development by the CBR and DOM.RF.[13] Other examples of the main categories include loans for energy efficiency improvements, renewable energy, sustainable agriculture practices, climate change adaptation or clean transportation financing. There is some emerging interest in introducing green loan products among the largest Russian banks, and the introduction of definitions, standards and principles for green or sustainability-linked loans along with a robust reporting mechanism to identify and track green lending activity could facilitate this market development. Russian public finance institutions (in addition to VEB, others such as DOM.RF, SME Corporation and SME Bank) could be leveraged to develop the green loan market and increase the supply of green loans by establishing a mandate including green or sustainability-linked loan inclusion.

The adoption of the green taxonomy has been an important milestone for market development, yet there remains some scope to further harmonize with international practices. For example, fossil fuels are not considered green under the EU approach, while Russia's green taxonomy sets categories of green projects like "production of heat from natural gas combustion" and "electricity generation based on natural gas." Support for nuclear power as a clean source of energy also needs to be clarified to specify support for development of the next generation of small and advanced reactors and not large generation facilities. Missing in the Russian taxonomy is a clear articulation of how the identified projects (both green and adaptational) contribute to climate or broader environmental objectives, making it difficult to understand on what basis the activities have been identified. The objectives and targets are necessary to clarify for issuers to what extent performance would have to be improved to transition from "brown" to "transition" and from "transition" to "green," and would help investors understand how they are contributing to Russia's goals.

It is important for Russia's national system of green finance to enable projects that conform to the current environmental and social policies, or "Safeguard Policies," and lay the foundation for ensuring sustainability of green projects. The EU taxonomy, for example, specifically outlines such policies to ensure that project design, implementation, and operation do not cause environmental or social harm. To be taxonomy-aligned, an activity should be implemented "in alignment with the OECD Guidelines for Multinational Enterprises and United Nations (UN) Guiding Principles on Business and Human Rights, including the International Labor Organization's (ILO) declaration on Fundamental Rights and Principles at Work, the eight ILO core conventions, and the International Bill of Human Rights" (EU Technical Expert Group on Sustainable Finance, 2020).

Long-term sustainability of green projects is particularly important for using green finance instruments in the forest sector. For example, forest carbon projects involve initiatives that help account for the carbon-depositing ecosystem function of forests and, in some cases, monetize it in carbon markets.

The Russian financial sector can also play an important role in facilitating the country's green transition by channeling capital to "adaptational" projects. Russia, with its reliance on fossil fuels, has to forge its own pathway towards net zero, which needs to be financed. The development of separate "green" and "adaptational" taxonomies is an important step in bringing transparency to this area. In practice, it will be also important for the Russian authorities to be careful about how they label financial instruments related to "adaptational" projects. For example, bond issuers should be fully transparent about what the bond proceeds will be used for and what their transition strategy is with regards to internationally

[13] The Russian Federation Government's Integrated Housing Development Institution.

established decarbonization pathways. Yet "Transition Bond" is not a label encouraged by the International Capital Markets Association. The consensus is that issuers who wish to finance transition activities should use Sustainability-Linked Bonds. Some believe Transition Bonds are Green Bonds (light shade) that finance hard to abate sectors such as aviation or shipping where no low carbon alternatives exist and where the issuer has a clear decarbonization strategy. Both requirements must be met; otherwise, issuers should not use the Green Bond label to finance activities that conflict with the Paris Agreement targets. An example of such a discrepancy is gas flaring, or lock-in in carbon-intensive assets, such as natural gas without carbon capture and sequestration, or biofuels. The reduction of gas flaring could be used as a KPI for sustainability-linked bonds (ICMA, 2020). Long-term R&D towards low/de-carbonization could be included as a transition activity.

# 4

# NEW OPPORTUNITIES – NEW SECTORS FOR GREEN TRANSITION

This chapter illustrates a number of opportunities Russia can embrace to integrate green transition into its development goals. The selected sectors, outlined below, are not exhaustive of such opportunities in Russia and only demonstrate the numerous opportunities the country has to diversify from the fossil-fuel dependent economy. Moreover, there are many synergies between decarbonization and broader sustainable development objectives (e.g., enhancing natural capital, air pollution reduction, and green jobs in the renewables and forestry sectors) that are not highlighted in the report. These opportunities will be explored further in the Country Climate and Development Report (CCDR) and follow-up studies to streamline climate agenda and its co-benefits into development policies. As illustrative examples, this report highlights a growth potential for renewable energy generation, other low-carbon technologies, climate-smart mining, and climate-smart forestry.

*Renewable energy generation* in Russia has a significant untapped potential for growth. However, the limited scale and specifics of the current national renewable support program do not create sufficient incentives for noticeable changes in the conditions of inter-fuel competition favoring solar, wind and other renewable sources of energy. Among other things, remote regions of Russia represent a very attractive market segment for the expansion of renewable energy solutions. These regions, however, do not fall under the government support program, which only covers the wholesale market.

*Other low-carbon energy technologies* have substantial opportunities for their development and scaling. These technologies are both traditional and well-established in Russia, like nuclear or hydro energy, and new ones, including hydrogen and carbon capture and storage (CCS). Importantly, there is a huge synergy potential in terms of joint technology solutions. Particularly, nuclear electricity generation could be used to produce carbon-free hydrogen, while gas-based hydrogen may be accompanied by CCS to help reduce emissions.

*Adopting climate-smart mining* practices to supply climate action minerals (for lithium, nickel, cobalt, or rare earth metals) may become one of the major contributors to the country's economy to meet rising global demand for minerals to produce batteries for electric vehicles, wind and solar energy equipment, electricity networks, or the like. The minerals used for low-carbon solutions could become the basis for the reproduction of added value, a crucial condition for the modernization and diversification of Russia's economy.

*Climate-smart forestry* can provide an important double dividend for the country's economy and climate policy in support of its green transition to a warmer and decarbonizing world. Russia's forests represent a vast and largely untapped renewable natural capital, yet currently they are performing below their full economic and carbon sequestration potential. Maintaining or strengthening the long-term carbon sink of Russia's forest lands in line with the Paris Agreement would require: (i) introducing improved forest management practices (particularly shifting from clear cutting to selective logging, sustainable intensification approaches to optimize harvest rates, and promoting multi-purpose forestry); (ii) strengthening resilience to natural disturbances (particularly investing in forest fire prevention and management); (iii) expanding forest landscape restoration with future-adapted species; (iv) enabling a forest-based circular bioeconomy with a focus on long-lived and other wood products that substitute energy-intensive materials; (v) reclaiming abandoned agricultural lands; and (vi) strengthening forest carbon monitoring and accounting systems.

## 4.1. Renewables

Russia has significant opportunity to develop renewables on its territory. With the removal of fossil fuel subsidies and rationalization of energy tariffs, renewable energy sources are cost competitive with many other energy sources. The technical potential of renewables in Russia is estimated at 133,935 Mtoe (Ermolenko, G. et al., 2017), which is a sufficient substitute for all the fossil fuels used for energy generation (Ermolenko, B. et al., 2017). However, to date, this potential is far from being used. The Law on Energy Savings and Improving Energy Efficiency of the Economy (2009) sets the goal for the share of renewables (excluding large hydro) in electricity generation at the level of 2.5% by 2015 and 4.5% by 2024. This goal has not been achieved yet and the share of renewables in the electricity mix remains well under 1%.

Both nature and government policy have contributed to the low level of development of renewables in Russia. The cost efficiency of solar and wind energy relative to fossil fuel generation is much higher for electricity than for heat, and Russia uses lots of heating. For example, in 2020, heat generation in Russia amounted to 135% of electricity generation (in energy units). For comparison, in Germany this number was just 20% and in Sweden 35% (IEA, 2021). On the policy side, the limited scale, high cost of capital, and the specifics of the current renewable energy state support program do not create sufficient incentives for solar, wind, and other renewable sources of energy.

The way in which government support is organized for developing renewables in Russian has no analogs in the world. The plan for development of renewables appeared in 2013 in the form of a capacity-based renewable energy support scheme (CRESS) – the innovative instrument based on annual auctions and a guaranteed rate of return on investments. The government defined the volumes of newly installed renewable energy capacity that should be erected on the wholesale electric power and capacity market each year from 2014 to 2024. The Administrator of the Trading System (ATS) holds annual auctions and chooses renewable energy projects (solar photovoltaics, wind, and small hydro) that will receive support based on the criterion of the lowest capital costs. The remuneration amount is calculated as an annuity to provide a 12–14% return on investment during 15 years of a capacity contract. Guarantee of this remuneration is not given from the budget but is arranged as part of the capacity market, where the capacity price for all wholesale electricity buyers includes the part paid to renewables (Kozlova et al., 2021). Under the first stage of CRESS, projects with a total capacity of 5.4GW that were auctioned in 2014–2019 are to be built by the end of 2024. In 2019, phase two of CRESS was declared: in 2024–2035 an additional 10GW of renewable energy capacity will be built.

The scale of the renewables design mechanism is not sufficient to set any ambitious targets; it is an instrument of industrial policy rather than climate policy. The volume supported is very small (over two stages of CRESS, just about 3% of electricity consumed in the country is to be generated by renewables) and thus does not allow for economies of scale to decrease generation costs. The high costs of capital in the country makes it difficult for renewables to compete with other energy sources (Lanshina 2018). Local content requirement within the CRESS further increases costs (Kozlova et al., 2021). CRESS is highly beneficial for investors as it guarantees renumeration. Guaranteed remuneration of investors in combination with a local content requirement, makes the renewables support program an instrument of industrial policy rather than a climate policy. CRESS's major objective is to create an industrial export-oriented sector in Russia and avoid a gap in technological development in this sector vs. other countries. Yet CRESS does not seek to make electricity generation from renewables competitive in the domestic market. Even despite all these obstacles, the first auction recently held under phase two of CRESS shows a significant reduction in the costs of energy declared within the supported projects. Levelized cost of energy (LCOE) of Russian projects is now comparable with the best world practices. This shows the significant underused potential for deployment of renewables across the country that would be further incentivized with climate policies addressing forest issues.

While the CRESS mechanism concerns only the wholesale market, Russia also has a program to support renewables in retail electricity markets. The government order “On Amendments to Some Acts of the Government of the Russian Federation on the Promotion of Renewable Energy Sources in Retail Electricity Markets” issued in 2015 states that if a renewable facility is included in the regional program for development of the electric power industry and if such a facility passes the qualification procedure, it may qualify for a special lower tariff aimed at compensating it for its network losses for 15 years. In 2020, the government resolution “On the Promotion of Renewable Energy Sources, Amendments to Some Acts of the Government of the Russian Federation, and the Annulment of Some Provisions of Certain Acts of the Government of the Russian Federation” clarified the above rules in order to increase their transparency and mitigate some of the investors’ risks (Lanshina, 2021).

The retail electricity market for Russia’s remote areas may be most attractive to investors. Renewables in the off-grid regions of the Russian Far East and the Arctic may be an alternative to the Northern Delivery System, which is very costly: the costs of energy transportation and supply in these regions may reach 80% of the total end-user price (IRENA, 2017). The government resolution “On Amendments to Certain Acts of the Government of the Russian Federation on Regulation of Prices (Tariffs) for Electric Energy (Power) Supplied in Technologically Isolated Territorial Electric Power Systems and in Territories not Connected to the Unified Energy System of Russia and Technologically Isolated Territorial Electric Power Systems, and Annulment of Certain Acts of the Government of the Russian Federation” (2019) guarantees the electricity tariff remains unchanged for five years for generation facilities in these region if they save on fuel costs. This resolution has increased the economic attractiveness of hybrid generation projects in remote areas. However, given the inertia and high cost of capital in the country, this resolution alone is hardly sufficient to boost the development of renewables in these regions even in conditions economically more efficient than conventional generation. Full-scale support is necessary for renewables in Russia’s remote areas.

## 4.2. Other Low-Carbon Energy Technologies

Russia has opportunities to be involved efficiently in the new global energy system, even though this new system would require fewer fossil fuels. Low-carbon technologies are not limited to solar and wind energy but include a wide range of solutions in different subsectors of the energy industry. Russia is among global leaders in the development of some of these technologies. Two low-carbon energy technologies already highly developed in Russia will be important for the country’s decarbonization strategy.

While nuclear and hydropower are already widely used in Russia, other technologies determining the Russian decarbonization pathway still need to be developed. One of them is CCS. Its development is associated with great uncertainty, but preliminary estimates show the significant technical and economic potential of CCS in some regions of Russia, including coal-dependent territories, such as Kuzbass, the Krasnoyarsk Region and the Komi Republic (Cherepovitsyn et al., 2018). Oil companies in Russia have started to discuss the opportunities to implement CCS. For some of these companies, CCS projects represent a chance at survival in the decarbonizing world. While the 2020 CCS global status report does not mention a single CCS project in Russia, globally there are already 65 commercial CCS facilities of this type (CCS Status Report, 2020). The crucial reason CCS research and development lags behind in Russia is the lack of incentives: Russian oil companies do not face any carbon price that would push them to develop CCS.

Russian oil and gas companies may also search for new opportunities to diversify their production portfolios towards gas and petrochemical industries. These industries are less vulnerable to the trends of decarbonization. First, they use half of consumed hydrocarbons without burning and thus without associated GHG emissions. Second, their products have fewer substitutes than the raw oil and natural gas used in the power or transport sector. Third, these industries provide many opportunities to integrate low-carbon solution in the use of hydrocarbons (Skolkovo, 2021). While today Russia controls only 2.5% of the global petrochemical market, according to the Ministry of Energy estimates, Russia has the potential to control 7–8% of the global petrochemical market by 2030 (TASS, 2021).

Hydrogen is a crucial potential element of specialization for Russian energy companies in a decarbonized world. In the International Energy Agency (IEA) Net Zero scenario, global hydrogen use rises from less than 90 Mt in 2020, to more than 200 Mt in 2030 (Bouckaert et al., 2021); 70% of this hydrogen would be low carbon. In Russia, nuclear and hydropower may be a good means for producing hydrogen which is carbon neutral and relatively cheap. In some regions such as Karelia or the Magadan Region where these sources of energy dominate in the electricity mix, hydrogen maybe be produced by electrolysis and have almost no carbon footprint even without solar and wind power plants (Skolkovo, 2019). Relatively low-carbon hydrogen may also be produced from natural gas: Russian companies build on technologies for producing hydrogen by using the adiabatic conversion of methane. Gas-based hydrogen may be accompanied by CCS, which would make it nearly zero-carbon, but large efforts are still needed to commercialize this technology (Skolkovo, 2019).

In 2020, the Russian government adopted a roadmap for development of hydrogen energy by 2024. In 2021, the Ministry of Energy prepared a draft concept of development of hydrogen energy by 2024. According to this document, Russia plans to increase its hydrogen exports from the current five tons to 200,000–1 million tons. By 2035, Russia is to export between 1–7 million tons, exceeding 20% of the global market. Most of this hydrogen would be produced by Russian nuclear and gas companies, which will establish four export clusters. However, though most forecasts predict that the most rapidly expanding segment of the hydrogen market would be green hydrogen produced with electrolysis based on solar and wind energy, Russia has no plans at this time to develop this segment. Nor does it have plans to develop domestic demand for hydrogen. This situation creates the same risks as with renewables: that support for an export-oriented industry without making it very competitive within the country may not lead to success either domestically or globally.

# 4.3. Mining for Low-Carbon Energy System

Green transition requires building a new energy system on a global scale and establishing a new base of raw materials including minerals to support the new system. These minerals will include aluminum, lithium, nickel, copper, cobalt, manganese, and graphite for electric batteries; rare earth metals for magnets used in wind and solar energy equipment; copper and aluminum for electricity network; copper and zinc for wind turbines; and silicon, for PV solar panels. Based on the World Bank's analysis, more than 3 billion tons of minerals and metals—an equivalent of approximately 300,000 Eiffel Towers—will be needed to deploy wind, solar, and geothermal power as well as battery storage to achieve a 2-degree scenario (World Bank, 2020). A recent analysis by the IEA confirmed the former findings and estimated that since 2010, the average amount of materials per unit of power generation capacity has increased by 50% due to the expansion of renewables (Bouckaert et al., 2021). In the future, the rise in demand for materials is expected to be much larger, with the new energy system as their main consumer.

Russia may be one of the major beneficiaries of the rising demand for climate action minerals as it is extremely well endowed with several of them. Current production of some minerals required for the development of new and low-carbon energy technologies is not sufficient to meet the growing demand and is unevenly distributed among countries. Russia is abundant in most of these minerals and the green transition may make them one of the drivers of Russian economic growth. It is already among the leaders in terms of production of some of these minerals and has large reserves of some of these minerals to expand its production dramatically. For instance, Russia is seventh in the world in terms of copper production and the fourth in terms of its reserves (7% of global reserves). Russia is the third largest producer of primary aluminum. It is also the third largest nickel producer and the fourth in the world in terms of nickel reserves. In both production and reserves of platinum, Russia is second in the world. In zinc production, Russia shares the eighth position in the world but in terms of reserves it is third in the world (with a 9% share of global reserves). Russia is the fourth largest producer of cobalt and fifth largest country in terms of cobalt reserves. It is the fourth largest graphite producer. Russia takes seventh place in the world in terms of rare-earth metals production and is fourth in terms of their reserves.

While the production of some minerals (like copper, aluminum, nickel, and platinum) is based on the already-developed technologies and has a long tradition in Russia's mining sector, others may substantially enhance Russian positions in global value chains. For instance, though it has one of the largest fields of rare-earth metals in the world, Tomtor field in Yakutia Republic, Russia now has a small share in production of these minerals. The Tomtor deposit is unique in its composition and concentration of traditional minerals (iron, phosphorus, titanium, vanadium) and rare elements (lanthanum, yttrium, scandium, and others) (Delicyn et al., 2015). Their reserves are huge and can meet needs dozens of times higher than those of Russia (Pohilenko et al., 2014). Global green transition may give this sector a new life.

Although Russia is already producing many of the minerals and metals needed for the energy transition, it will need to improve the sustainability along its mineral supply chains to maintain its competitiveness and access to markets. Most consuming markets, such as the EU, have adopted higher carbon and ESG requirements for their minerals and metals products. Traceability along these mineral supply chains is growing and driving changes in practices along the whole supply chain, from extraction to end use. The adoption of climate-smart mining practices will be crucial if Russia is to maintain its comparative advantage as a lead supplier of these resources.

International best practices show that natural resources industries have ceased to be perceived as attributes of economic backwardness, but rather have turned into a source of innovation and high-tech production in both developed (e.g. Australia, Canada) and developing countries (e.g. Brazil, Chile, Malaysia). Russia's natural wealth— especially in the resources used for low-carbon solutions—could become the basis for the reproduction of added value, a crucial condition for the modernization of the whole economy.

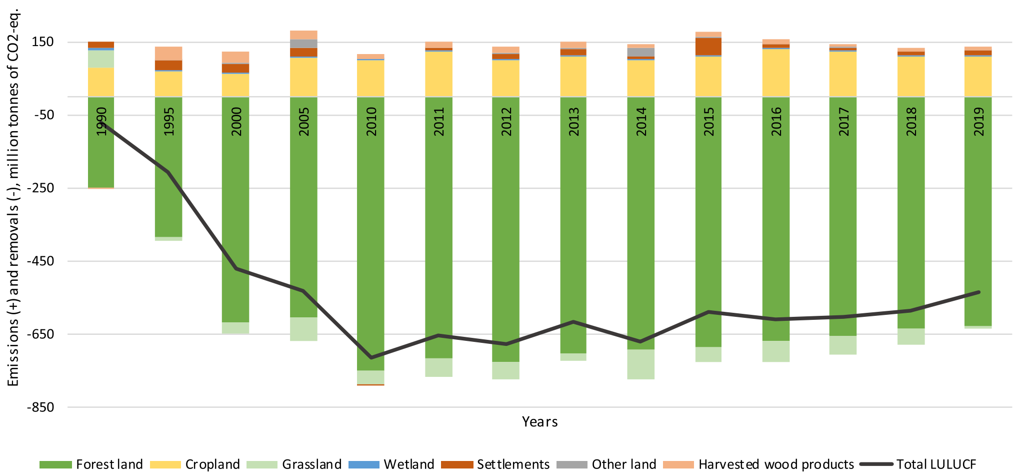
Institutional changes will be required for Russia to remain competitive in developing new and innovative mineral production technology (high-tech) while ensuring their successful commercialization throughout the mining sector (Kryukov, V. and Kryukov, Ja., 2019). Globally, large mining operations are increasingly becoming a system integrator of services, with their main activity largely reduced to gaining access to the mineral source and financing, as well as organizing production processes. For example, exploration and extraction activities are increasingly being carried out by contractors instead of mining operators. To efficiently integrate the country's mining sector into low-carbon technology value chains requires the development of a competitive segment of high-technology services companies serving larger mining companies in Russia. More importantly, this new high-technology segment should operate in a sustainable and responsible manner through the adoption of climate-smart mining practices.

## 4.4. Forests and Russia's Green Transition

Russia's forests represent a vast and largely untapped renewable natural capital that can contribute to the country's green transition to a warmer and decarbonizing world, but are performing below their full economic and carbon sequestration capacity. The country is home to 20% of global forests, with 49.4% of its lands under forest cover (an area 15 times the size of France and larger than the Amazon), including 31.7% of primary forests, which provide a wide range of valuable ecosystem services, such as biodiversity conservation, erosion control, and watershed protection. Boreal forests cover almost 90% of forest lands in Russia and host among the highest levels of biodiversity and endemic species among the world's boreal forests. However, forestry only contributed 0.2% to GDP in 2020 (Rosstat, 2020). In comparison, the forest sector in countries with similar forest types adds as much as 1.8% (Finland) and 0.7% (Sweden) to GDP (Eurostat, 2021); while the economic benefits of forest use in Russia are estimated at US$38 per hectare, in Finland and Sweden they are more than 13 times higher (US$512 and US$508 respectively) (World Bank, 2016). This is due in part to the fact that despite the growing forest cover and stock, only a portion of the annual increase in wood is actually available for use. Studies have shown that increasing investments in sustainable forest management could dramatically improve the sector's outlook (FAO, 2021).

At the same time, Russian forests represent a significant carbon stock and sink of international importance given their role in stabilizing global climate change. Official estimates of the average carbon sink capacity in Russian forests over the past 20 years ranged between 500 and 700 million tons of $CO_2$e per year (Figure 31), providing the majority of the carbon sink from the world's boreal forests. While this already represents a significant carbon sequestration capacity (compensating for about 30% of total national GHG emissions), recent scientific studies indicate a substantially higher potential. For example, Filipchuk et al. (2017) and Schepaschenko et al. (2021) estimate the volume of net carbon sequestration by forests, respectively, to be about 1.91 and 1.99 billion tons of $CO_2$e per year, equal to 87–91% of the total volume of Russia's GHG emissions and even compensating for the net losses in growing stock in tropical forests. However, uncertainties persist surrounding the estimates of Russia's carbon balance, with significant variation among published estimates (for a summary, see Leskinen et al., 2020) largely due to differences in methodological approaches and the effects of interannual variability of seasonal weather and natural disturbances. Strengthening forest carbon MRV systems and establishing a national forest carbon accounting framework in line with international standards would be steps in the right direction for strengthening the confidence around the potential contribution of Russia's vast forest lands towards its decarbonization pathway.

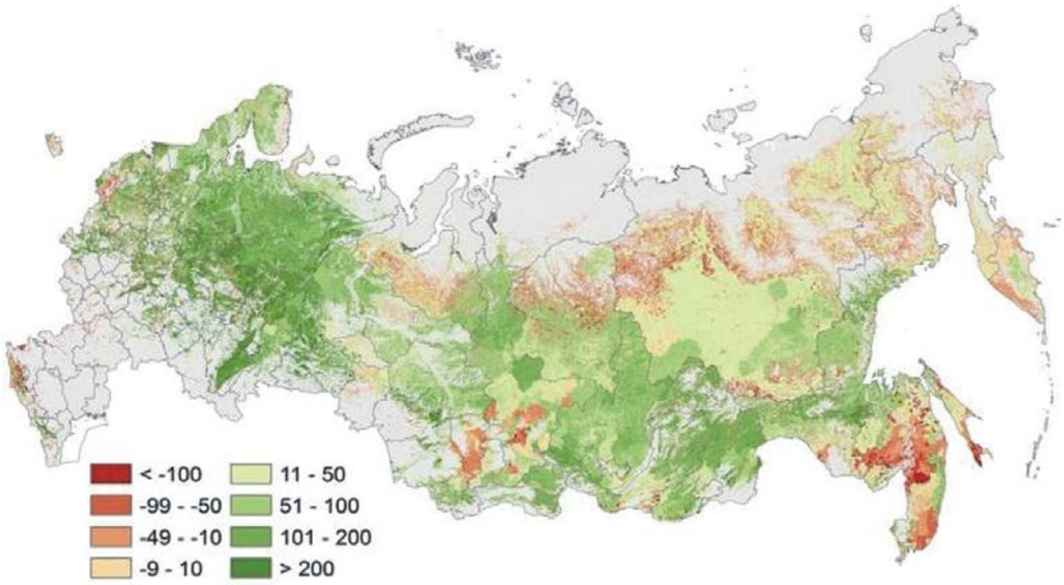
**Figure 31. GHG balance in LULUCF sector in Russia (1990-2019)**




*Source: Russian Federation. 2021 National Inventory Report (NIR) to the UNFCCC.*

Without careful management, forests can turn from a sink to a source of carbon emissions. In contrast to other sectors, GHG emissions and removals in the land use sector are not only subject to high uncertainty, but also to the effects of natural disturbances such as forest fires, pests and diseases, and other climate-related changes which can result in high temporal and regional variability. According to estimates by the International Institute for Applied Systems Analysis (IIASA) and the Siberian Branch of the Russian Academy of Sciences, the rate of carbon sequestration is uneven across the country: forests in the European part of Russia represent a net carbon sink, and some forest areas in Siberia and the Russian Far East represent a sink while others a source of $CO_2$e (Figure 32). The main drivers of carbon loss in Russian forests are extensive forest harvesting practices (i.e., clear cuts), forest fires, and other disturbances, the latter of which have already led to a slight decreasing trend in the Russian carbon sink over the last decade. Such disturbances are projected to increase in frequency and intensity under climate change, thus increasing the vulnerability of Russia's forests and placing its

**Figure 32. Net carbon balance of Russia forests**




*Source: Shvidenko and Schepaschenko (2014).*
*Notes: Green: positive $CO_2$e balance; Red: negative $CO_2$e balance; value: g/cm$^2$*year*

carbon sink under a potentially high risk of reversals. Forest fires, for example, have already increased in scale and severity reaching unprecedented levels in 2018, 2019, and 2020, destroying wildlife, human structures and engulfing cities in thick smog. Permafrost melting is another major risk for large parts of Russian forest lands where large amounts of $CO_2$ and methane are currently locked in frozen peat within the permafrost. At the same time, forest fire prevention and suppression are heavily underfinanced in the country,[14] making investments in fire management a high priority for strengthening both the mitigation and adaptation capacity of Russia's forests. A recent analysis found that preventing wildfires had the highest mitigation potential in the land-use sector in Russia at 220–420 million tons of $CO_2$e per year (Romanovskaya et al., 2020). Introducing improved forest management practices (i.e., shifting

[14] Expenditures on firefighting in Russia are equal to 3 billion rubles per year (about US$42 million) while in the United States, firefighting expenditures total US$3 billion per year according to a statement by the first deputy head of Federal Forest Agency of Russia: https://ria.ru/20181128/1533685100.html.

from clear cutting to selective logging, sustainable intensification of silvicultural interventions to optimize the level of harvesting, reforestation with more resilient species mix, promoting multi-purpose forestry models that combine harvesting with non-timber forest products and services, among others) and value chains with a focus on long-lived harvested wood products is another priority area that can contribute to maintaining or strengthening long-term carbon sinks from Russia's forest lands, in line with the Paris Agreement.

Carbon sequestration has recently been integrated in strategic documents of the Russian forestry sector and has been gaining attention in the setting of the country's climate targets. The recently adopted "Strategy for the Development of the Russian Federation Forestry Complex until 2030," is the sector's first strategic document to pay significant attention to the issue of climate change. The Strategy suggests implementing long-term measures to adapt Russian forestry to climate change and to improve the balance of GHG emissions and removals in the sector. In particular, it proposes the following measures: (i) improved forest conservation through identification of protective forests and categories of specially protected areas; (ii) establishment of an appropriate framework for the use of forest resources; improvement of forest management practices; and protection of forests from fires, pests, and diseases; (iii) combatting illegal logging; and (iv) enhancing forestry activities aimed at carbon sequestration, primarily through reforestation and afforestation. Concrete measures also have been proposed to improve forest productivity and increase carbon sequestration rates from LULUCF activities, including afforestation programs in sparsely wooded regions and the establishment of norms for the implementation of forest carbon projects. These measures could provide additional sequestration potential compared to the role of the forest ecosystems in the "Long-Term Low-Emission Development Strategy of the Russian Federation" prepared by the Ministry of Economic Development and adopted on October 29, 2021.

Investing in climate-smart forestry can provide an important triple dividend for Russia's economy and climate policy in support of its green transition. The three main pillars of climate-smart forestry are: (i) increasing carbon storage in forests and wood products while safeguarding biodiversity and ecosystem services; (ii) enhancing resilience and adaptative capacity of forest resources; and (iii) using wood sustainably to substitute for non-renewable carbon intensive materials (Nabuurs et al., 2018). The European Forest Institute (EFI) has provided key recommendations for the development of climate-smart forestry in Russia through its research based on regional pilot projects (see Box 7). Expanding such approaches could thus deliver a triple-win in terms of climate mitigation, adaptation, and sustainable productivity for the Russian forestry sector, with multiplier effects for job creation, economic diversification and growth.

Climate-smart forestry in Russia could also be an effective strategy to economically and environmentally restore vast areas of abandoned agricultural land while increasing their carbon sequestration capacity. Russia has a very large area of arable land abandoned after the collapse of the Soviet Union. According to some estimates, the absorptive capacity of forests on these lands is seven times higher than that of forests within the forest fund land.[15] Russia could benefit from restoring abandoned agricultural lands through a/reforestation initiatives and other "carbon farming" approaches, thus creating an opportunity for considerably increasing its carbon sink capacity in the medium to long term, while opening-up economic opportunities to manage abandoned arable lands in a climate-friendly manner (Ivanov et al., 2021).

[15] As per official Russian inventories, the forest fund is the land managed by the state forest authorities.

**Box 7. Recommendations for Climate-Smart Forestry in Russia**

- Integrating the circular forest-based bioeconomy into national policy, the national forest strategy, and developing national and regional action plans
- Improving the national forest inventory and forest monitoring system
- Promoting forest management on abandoned agricultural lands
- Increasing the use of wood in construction, textiles, and sustainable biofuel production

*Source: Leskinen et al., 2020*

# Conclusions and Recommendations

Russia is facing both risks and opportunities from green transition. The position of any country in the twenty-first century global economy will depend on how it adapts to the low-carbon economic and energy landscape. For fossil fuel dependent economies like Russia, decarbonization brings a special challenge: how to adapt as former competitive advantages dissipate.

The impact of decarbonization will depend on the Russian economy's ability to capitalize on the global shift to carbon neutrality. Will global markets change? Will other countries implement stringent climate policies and restrict access to their markets for carbon-intensive products? Scenarios simulated as part of this study focus on these questions, yet other questions also arise: Will leading economies push new technology frontiers through research and development (R&D) and industrial policies? Will they incorporate green terms into preferential trade agreements? Will they offer financial and technology transfers? The EU Carbon Border Adjustment Mechanism (CBAM) has played a huge role in raising Russian policy makers' awareness of the potential influence of external climate policies on the country's economic model. However, this study shows that while the introduction of EU CBAM may reduce exports in some specific sectors, CBAM itself is likely to have only a small macroeconomic effect on Russia's economy.

Russia would benefit from participating in global efforts to reduce emissions and diversify its assets beyond those related to fossil fuels and downstream value chains. If other countries make significant efforts to reduce emissions while Russia does not implement any climate policy, this may lead to emission leakage, attract carbon-intensive industries to the country, and foster "brown" economic growth. However, if more countries supplement their ambitious policies with border carbon adjustment taxes to prevent carbon leakage, opportunities for such growth disappear. Without diversification and green innovation, Russia will experience a shrinking comparative advantage in global markets. If Russia chooses to participate in global climate efforts, however, the country will minimize its risks and derive benefits from global decarbonization through development of new sectors of the greener global economy. As reducing emissions in Russia costs less than in most other regions, integration into international carbon regulation systems will help Russia attract domestic and foreign investment for low-carbon projects, provided that climate policies are in place and enabling mechanisms for such investments have been introduced.

A robust green finance system that increases the attractiveness of green investments and manages climate-related risks is important in enabling Russia's green transition. Greening the financial system will mean increasing financing flows into sectors that contribute to climate and environmental objectives while also managing related risks—both the transition risks, related to the rapid devaluation of carbon intensive assets, as well as the physical climate risks. The Russian authorities should continue expanding their toolkit of policy measures that build on recent efforts, such as establishment of an interagency coordination group and a green finance methodology center, participation in green finance-related international networks, adoption of the national taxonomy and verification guidelines, and development of a green bond market infrastructure. They could undertake further actions to promote green finance and manage climate-related and environmental risks by stepping up efforts related to climate-related risk assessment and management, developing and implementing climate-related and environmental disclosure and reporting standards, incentivizing development of a wider range of financial instruments, and greening Russian public finance institutions by reallocating their capital to support green transition.

Diversification is at the core of Russia's optimal response to the challenge of the rising global climate ambition. In the medium and long term, Russia needs new drivers of economic growth as fossil fuels and energy-intensive industries will largely cease to play this role. Our modeling shows that asset diversification may provide benefits from new opportunities generating growth in new sectors and better jobs. Simultaneous efforts to reduce emissions and diversify assets allow Russia to enjoy the most beneficial possible outcome among all global decarbonization scenarios examined in this paper.

In practical terms, diversification requires investment in human capital and R&D, and special policies to develop new sectors that would substitute oil and gas as drivers of Russian economic growth. In this study, we included a number of such sectors that may play an important role in the new global low-carbon energy system and in which Russia has strong advantages. These may include renewables, other low-carbon energy technologies, including hydro, carbon capture and storage (CCS), and hydrogen), climate-smart forestry and agriculture, and new minerals. However, this list is not exhaustive and may include other sectors not directly related to the green economy, which have not been mentioned here.

Climate policy itself may be considered an important tool for diversifying the economy. Carbon pricing, introduced explicitly or implicitly, leads to the redistribution of wealth from conventional industries linked to fossil fuel consumption and export to new sectors that are more relevant in the new energy landscape. Carbon pricing is introduced via a package of policy reforms to enable green transition and unleash economic growth. It will be most efficient if it is part of a consistent and comprehensive climate policy that aims to unlock the most cost-effective solutions for emissions reduction, restructuring the economy, and developing new greener sectors as new drivers of economic growth, while minimizing negative impacts on the welfare of the population. Comprehensive climate policy will require regulating GHG emissions, lifting fossil fuel subsidies, developing green finance infrastructure, and promoting energy efficiency and new sectors of growth. It will also require measures to protect those who may be disadvantaged by these policies and ensure the inclusiveness of green growth. As many of these measures go far beyond the objectives of GHG emissions reduction, climate policies and strategies should be integrated in the country's strategy of long-term economic development and vision for its competitive advantages in a new greener world. This study does not cover the entire spectrum of policies for green transition (i.e., governance, innovation, jobs, just transition, social protection, etc.). These will be covered in more breadth and depth in the Country Climate and Development Report (CCDR) and follow-up studies.

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# ANNEXES

# Annex A. Methodological Framework

The Environmental Impact and Sustainability Applied General Equilibrium (ENVISAGE) Model (van der Mensbrugghe, 2019) at its core is a recursive dynamic and global CGE model. It follows the circular flow of an economy paradigm. Firms purchase input factors (for example labor and capital) to produce goods and services. Households receive the factor income and, in turn, demand goods and services produced by firms. Equality of supply and demand determine equilibrium prices for factors, goods, and services. The model is solved as a sequence of comparative static equilibria where the factors of production are linked between time periods with accumulation expressions. Production is implemented as a series of nested constant-elasticity-of-substitution (CES) functions, the aim of which is to capture the substitutability across all inputs. Production is also identified by vintage—divided into Old and New—with typically lower substitution possibilities associated with Old capital.

Income accrues from payments to factors of production and is allocated to households (after taxes). The government sector accrues all net tax payments and purchases goods and services. The model incorporates multiple utility functions for determining household demand; for this paper, the constant-differences-in-elasticities (CDE) utility function was chosen. Trade is modeled using the so-called Armington specification that posits that demand for goods is differentiated by region of origin. The model allows for domestic/import sourcing at the aggregate level (after aggregating domestic absorption across all agents), or at the agent-level.

The model has two fundamental markets for goods and services. Domestically produced goods sold on the domestic market, and domestically produced goods sold by region of destination. All other goods and services are composite bundles of these goods. Two market equilibrium conditions are needed to clear these two markets.

The model incorporates five types of production factors: i) labor (of which there can be up to five types); ii) capital; iii) land; iv) a sector specific natural resource (such as fossil fuel energy reserves); and v) (optionally) water. The labor market is allowed (though not required) to be segmented. The model allows for regime switching between full and partial wage flexibility. Capital is allocated across sectors to equalize rates of returns. If all sectors are expanding, Old capital is assumed to receive the economy-wide rate of return. In contracting sectors, Old capital is sold on secondary markets using an upward sloping supply curve.

ENVISAGE incorporates the main greenhouse gases, carbon, methane, nitrous oxides, and fluorinated gases, though in the current study, we focus only on $CO_2$ emissions from fossil fuel combustion for longer term decarbonization analysis while they are included in the CBAM impact analysis. A number of carbon control regimes are available in the model. The incidence of the carbon tax allows for partial or full exemption by commodity and end-user. The model allows for emission caps in a flexible manner—where regions/sectors can be segmented into coalitions.

Dynamics involves three elements. Labor supply (by skill level) grows at an exogenously determined rate. The aggregate capital supply evolves according to the standard stock/flow motion equation, i.e., the capital stock at the beginning of each period is equal to the previous period's capital stock, less depreciation, plus the previous period's level of investment. The third element is technological change. The standard version of the model assumes labor-augmenting technical change—calibrated to given assumptions about GDP growth and inter-sectoral productivity differences. Detailed documentation of the ENVISAGE model is provided in van der Mensbrugghe (2019).

The ENVISAGE model used in this study is calibrated to the Global Trade Analysis Project (GTAP) 10 Power Database, reference year 2014, which distinguishes 141 regions and 76 sectors (Aguiar et al. 2019; Chepeliev 2020). The latter includes 11 electricity generation technologies, as well as an electricity transmission and distribution activity.

For the purposes of the study, two variations of the ENVISAGE model are used: one to simulate CBAM's impact on Russia's economy up until 2035; the other for the estimation of long-term impacts of climate policies worldwide on Russia's economy up until 2050. They differ in sectoral and regional aggregation as well as some data inputs and technical assumptions. A brief summary of the modelling approached is presented in the Table A.1.

**Table A.1. Model add-ons depending on the activity analyzed**

| Activity | Foresight | Model/ GTAP version | Russia SAM year | Fuel reserves | Capital structure | Endogenous Innovation | Regional aggregation | Sectoral aggregation |
|---|---|---|---|---|---|---|---|---|
| EU CBAM | Recursive dynamic | ENVISAGE GTAP10 | 2019 | Standard exogenous | Vintage capital (old/ new) | Productivity fixed across scenarios | 16 regions: EU & EFTA, ECA countries, United States of America, China, India, Russia, MENA, ROW | 24 sectors; carbon-intensive industries exposed to CBAM are disaggregated |
| Global CPAT/ FFDCs | Recursive, dynamic | ENVISAGE GTAP10 | GTAP10 (2008) | Endogenous fuel extraction | Vintage capital (old/ new) | Productivity enhancing R&D investments | 16 regions: aggregation is based on the role of fossil fuels in the economy | 20 sectors; electricity produced from different renewables sources are disaggregated; manufacturing is more aggregated |

# Global CPAT/FFDCs Model

For the purposes of this study, we use an aggregation that includes 16 regions (Table A2) and 20 sectors (Table A3). For the assessment of the long-term impacts of decarbonization on Russia's economy, the ENVISAGE model was complemented with the fossil fuels extraction module, which includes three types of oil, gas, and coal reserves: (i) unproven reserves; (ii) proven reserves; and (iii) producing reserves. The model includes interactions between fossil fuel supply curves and their depletion. Under low demand and prices, the extraction module decreases production from proven reserves, leaving part of the latter in the ground. Under favorable market conditions (increasing fossil fuel demand and prices), the module increases production of underexplored proven reserves, as well as converts some unproven reserves to the proven category.

To represent the resource rents within the applied modeling framework, we rely on the World Bank Changing Wealth of Nations (CWON) 2021 report estimates for reference year 2018 and simulate the trajectory of corresponding rents based on the ENVISAGE scenario estimates (using change in value added of the corresponding fossil fuel extractive sectors by countries and regions). We use the 4% annual discount rate to discount the future value of the resource rents to convert them to the 2018 CWON reference year.

An overall modelling approach includes, first, development of the baseline scenario that represents future macro, demographic, energy, emissions, and other trends under current policy efforts. Then, a set of policy scenarios with climate mitigation policies (carbon prices) is developed and compared toward the baseline scenario to estimate the policy implementation impacts.

**Table A.2. Regional aggregation for the Global CPAT/FFDCs model**

| No. | Region code | Region description | GTAP-Power 10 regions |
|---|---|---|---|
| 1. | SAUARAB | Kingdom of Saudi Arabia | Kingdom of Saudi Arabia (SAU) |
| 2. | OTHGCC7 | Rest of Gulf Coopera-tion Council | Bahrain (BHR), Kuwait (KWT), Oman (OMN), Qatar (QAT), United Arab Emirates (ARE) |
| 3. | RUSSFED | Russian Federation | Russian Federation (RUS) |
| 4. | FFLXLAC | Fossil fuel exporters in Latin America | Mexico (MEX), Bolivia (BOL), Ecuador (ECU), Paraguay (PRY), Peru (PER), Venezuela (VEN), Trinidad and Tobago (TTO), Rest of Caribbean (XCB) |
| 5. | FFLXCAS | Fossil fuel exporters in Central Asia | Kazakhstan (KAZ), Rest of Former Soviet Union (XSU), Azerbaijan (AZE)) |
| 6. | FFLXXMN | Fossil fuel exporters in the rest of Middle East and North Africa | Iran (IRN), Rest of Western Asia (XWS), Egypt (EGY), Tunisia (TUN), Rest of North Africa (XNF)) |

| No. | Region code | Region description | GTAP-Power 10 regions |
|---|---|---|---|
| 7. | FFLXEAS | Fossil fuel exporters in East Asia | Rest of East Asia (XEA), Brunei D Cameroon (CMR), Côte d'Ivoire (CIV), Ghana (GHA), Nigeria (NGA), Senegal (SEN), Togo (TGO), Central Africa (XCF), South-Central Africa (XAC), Ethiopia (ETH), Kenya (KEN), Madagascar (MDG), Mozambique (MOZ), Tanzania (TZA), Uganda (UGA), Rest of Eastern Africa (XEC), Namibia (NAM) arussalam (BRN), Malaysia (MYS), Viet Nam (VNM), Rest of Southeast Asia (XSE), Bangladesh (BGD) |
| 8. | FFLXSSA | Fossil fuel producers in Sub-Saharan Africa | Cameroon (CMR), Côte d'Ivoire (CIV), Ghana (GHA), Nigeria (NGA), Senegal (SEN), Togo (TGO), Central Africa (XCF), South-Central Africa (XAC), Ethiopia (ETH), Kenya (KEN), Madagascar (MDG), Mozambique (MOZ), Tanzania (TZA), Uganda (UGA), Rest of Eastern Africa (XEC), Namibia (NAM) |
| 9. | COALEXP | Coal exporters | Australia (AUS), Mongolia (MNG), Indonesia (IDN), Colombia (COL), South Africa (ZAF) |
| 10. | WESTEUR | Western Europe | Austria (AUT), Belgium (BEL), Cyprus (CYP), Czech Republic (CZE), Denmark (DNK), Estonia (EST), Finland (FIN), France (FRA), Germany (DEU), Greece (GRC), Hungary (HUN), Ireland (IRL), Italy (ITA), Latvia (LVA), Lithuania (LTU), Luxembourg (LUX), Malta (MLT), Netherlands (NLD), Poland (POL), Portugal (PRT), Slovakia (SVK), Slovenia (SVN), Spain (ESP), Sweden (SWE), United Kingdom (GBR), Switzerland (CHE), Norway (NOR), Rest of EFTA (XEF), Bulgaria (BGR), Croatia (HRV), Romania (ROU) |
| 11. | USTATES | United States of America | United States (USA) |
| 12. | CANADAD | Canada, Dominion of | Canada (CAN) |
| 13. | XHYFFLM | Other high-income fossil fuel importers | New Zealand (NZL), Hong Kong (HKG), Japan (JPN), Korea (KOR), Taiwan (TWN), Singapore (SGP), Rest of North America (XNA), Chile (CHL), Uruguay (URY), Israel (ISR), Rest of the World (XTW) |
| 14. | CHINAPR | China, People's Republic of | China, People's Republic of (CHN) |
| 15. | INDIARP | India, Republic of | India (IND) |

| No. | Region code | Region description | GTAP-Power 10 regions |
|---|---|---|---|
| 16. | XLMFFLM | Other low- and middle-income fossil-fuel importers | Rest of Oceania (XOC), Cambodia (KHM), Laos (LAO), Philippines (PHL), Thailand (THA), Nepal (NPL), Pakistan (PAK), Sri Lanka (LKA), Rest of South Asia (XSA), Argentina (ARG), Brazil (BRA), Rest of South America (XSM), Costa Rica (CRI), Guatemala (GTM), Honduras (HND), Nicaragua (NIC), Panama (PAN), El Salvador (SLV), Rest of Central America (XCA), Dominican Republic (DOM), Jamaica (JAM), Puerto Rico (PRI), Albania (ALB), Belarus (BLR), Ukraine (UKR), Rest of Eastern Europe (XEE), Rest of Europe (XER), Kyrgyzstan (KGZ), Tajikistan (TJK), Armenia (ARM), Georgia (GEO), Jordan (JOR), Turkey (TUR), Morocco (MAR), Benin (BEN), Burkina Faso (BFA), Guinea (GIN), Rest of Western Africa (XWF), Malawi (MWI), Mauritius (MUS), Rwanda (RWA), Zambia (ZMB), Zimbabwe (ZWE), Botswana (BWA), Rest of South African Customs Union (XSC) |

*Notes: full list of the GTAP 10 Data Base regions is available at https://www.gtap.agecon.purdue.edu/databases/regions.aspx?version=10.211*

### Table A.3. Sectoral aggregation for the Global CPAT/FFDCs model

| No. | Sector code | Sector description | GTAP-Power 10 sectors |
|---|---|---|---|
| 1. | crp | Grains and Crops | pdr, wht, gro, v_f, osd, c_b, pfb, ocr |
| 2. | lvs | Livestock and Meat Products | ctl, oap, rmk, wol |
| 3. | coa | Coal | coa |
| 4. | oil | Oil | oil |
| 5. | gas | Gas | gas, gdt |
| 6. | xex | Other extraction | frs, oxt |
| 7. | xmn | Other manufacturing | fsh, cmt, omt, vol, mil, pcr, sgr, ofd, b_t, tex, wap, lea, lum, bph, fmp, ele, eeq, ome, mvh, otn, omf |
| 8. | ke5 | Heavy Manufacturing | ppp, chm, rpp, nmm, i_s, nfm |
| 9. | p_c | Refined oil | p_c |
| 10. | etd | Electricity transmission and distribution | TnD |
| 11. | elc | Coal-fired electricity | CoalBL |
| 12. | elg | Gas- and oil-fired electricity | GasBL, OilBL, GasP, OilP |

| No. | Sector code | Sector description | GTAP-Power 10 sectors |
|---|---|---|---|
| 13. | eln | Nuclear electricity | NuclearBL |
| 14. | elh | Hydro-electricity | HydroBL, HydroP |
| 15. | els | Solar electricity | SolarP |
| 16. | elw | Wind electricity | WindBL |
| 17. | elx | Other renewable electricity | OtherBL |
| 18. | cns | Construction | cns |
| 19. | trp | Transport | otp, wtp, atp |
| 20. | xsv | Other Services | wtr, trd, afs, whs, cmn, ofi, ins, rsa, obs, ros, osg, edu, hht, dwe |

*Notes: full list of the GTAP 10 Data Base sectors is available at https://www.gtap.agecon.purdue.edu/databases/v10/v10_sectors.aspx#Sector65 ; GTAP-Power 10 Data Base sectors are listed in Chepeliev (2020).*

# EU CBAM Model

The model specifications are same as in Global CPAT/FFDCs Model with the exception of not using depletion and R&D investments modules. Regional (Table A.4) and sectoral (Table A.5) aggregation is also different for the modeling of the impact of CBAM on Russia's economy up until 2035.

**Table A.4. Regional aggregation for the EU CBAM model**

| No. | Code | Name | Description |
|---|---|---|---|
| 1. | euft | EU & EFTA | Austria, Belgium, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, Netherlands, Poland, Portugal, Slovakia, Slovenia, Spain, Sweden, United Kingdom, Switzerland, Norway, Rest of European Free Trade Association, Bulgaria, Croatia, Romania |
| 2. | alba | Albania | Albania |
| 3. | bela | Belarus | Belarus |
| 4. | rusa | Russian Federation | Russian Federation |
| 5. | ukra | Ukraine | Ukraine |
| 6. | kaza | Kazakhstan | Kazakhstan |
| 7. | arme | Armenia | Armenia |
| 8. | azer | Azerbaijan | Azerbaijan |

| No. | Code | Name | Description |
|---|---|---|---|
| 9. | geor | Georgia | Georgia |
| 10. | turk | Turkey | Turkey |
| 11. | xeca | Rest of ECA | Rest of Eastern Europe, Rest of Europe, Kyrgyzstan, Tajikistan, Rest of Former Soviet Union |
| 12. | usax | United States of America | United States of America |
| 13. | chin | China | China |
| 14. | indi | India | India |
| 15. | mena | MENA | Bahrain, Iran, Islamic Republic of, Israel, Jordan, Kuwait, Oman, Qatar, Saudi Arabia, United Arab Emirates, Rest of Western Asia, Egypt, Morocco, Tunisia, Rest of North Africa |
| 16. | xrow | ROW | Australia, New Zealand, Rest of Oceania, Hong Kong, Special Administrative Region of China, Japan, Korea, Republic of, Mongolia, Taiwan, Rest of East Asia, Brunei Darussalam, Cambodia, Indonesia, Lao PDR, Malaysia, Philippines, Singapore, Thailand, Viet Nam, Rest of Southeast Asia, Bangladesh, Nepal, Pakistan, Sri Lanka, Rest of South Asia, Canada, Mexico, Rest of North America, Argentina, Bolivia, Brazil, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, Venezuela (Bolivarian Republic of), Rest of South America, Costa Rica, Guatemala, Honduras, Nicaragua, Panama, El Salvador, Rest of Central America, Dominican Republic P, Jamaica, Puerto Rico, Trinidad and Tobago P, Rest of Caribbean, Benin, Burkina Faso, Cameroon, Côte d'Ivoire, Ghana, Guinea, Nigeria, Senegal, Togo, Rest of Western Africa, Rest of Central Africa, South Central Africa, Ethiopia, Kenya, Madagascar, Malawi, Mauritius, Mozambique, Rwanda, Tanzania, United Republic of, Uganda, Zambia, Zimbabwe, Rest of Eastern Africa, Botswana, Namibia, South Africa, Rest of South African Customs Union, Rest of the World |

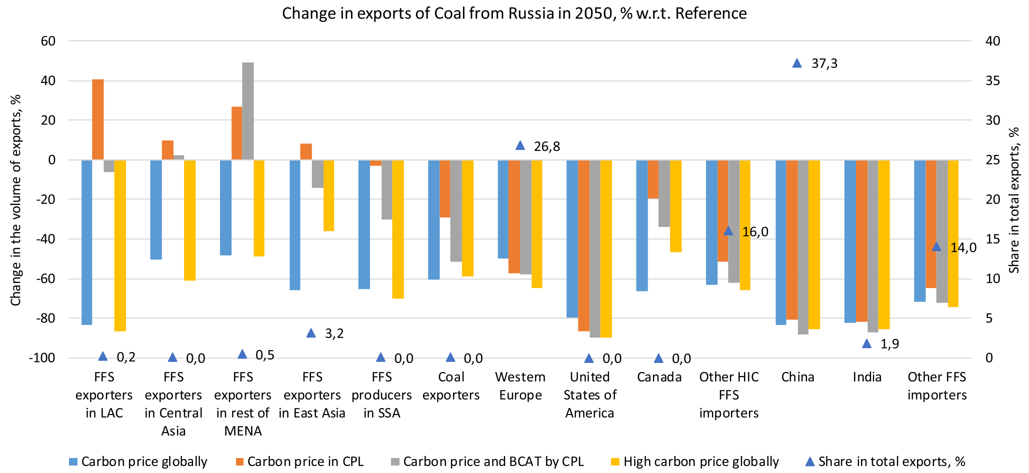
**Table A.5. Sectoral aggregation for the EU CBAM model**

| No. | Code | Name | Description |
|---|---|---|---|
| 1. | agri | Agriculture | Paddy rice, Wheat, Cereal grains nec, Vegetables, fruit, nuts, Oil seeds, Sugar cane, sugar beet, Plant-based fibers, Crops nec, Bovine cattle, sheep and goats, horses, Animal products nec, Raw milk, Wool, silk-worm cocoons, Forestry, Fishing |
| 2. | coal | Coal | Coal |
| 3. | oilx | Oil | Oil |
| 4. | ngas | Gas | Gas |
| 5. | ngdt | Gas distribution | Gas manufacture, distribution |
| 6. | xmin | Other Mining | Other Extraction |

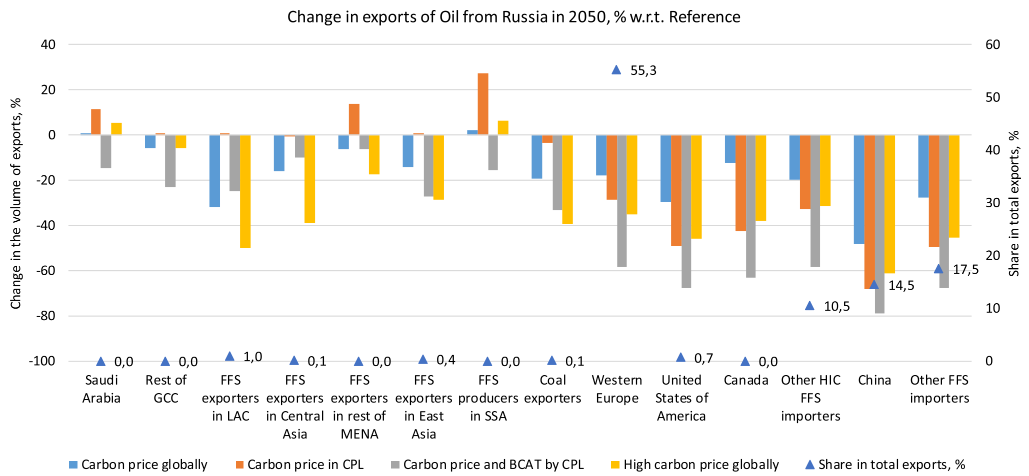
| No. | Code | Name | Description |
|---|---|---|---|
| 7. | food | Food | Bovine meat products, Meat products nec, Vegetable oils and fats, Dairy products, Processed rice, Sugar, Food products nec, Beverages and tobacco products |
| 8. | xman | Other Manu-facturing | Textiles, Apparel, Leather products, Wood products, Paper products, publishing, Computer, electronic and optical products, Electrical equipment, Manufactures nec |
| 9. | peco | Petroleum coal products | Petroleum, coal products |
| 10. | chem | Chemical products | Chemical products, Basic pharmaceutical products, Rubber and plastic products |
| 11. | mnrl | Mineral products nec | Mineral products nec |
| 12. | ferr | Ferrous metals | Ferrous metals |
| 13. | meta | Metals nec | Metals nec |
| 14. | mepr | Metal products | Metal products |
| 15. | mach | Machinery and equipment nec | Machinery and equipment nec |
| 16. | mveh | Motor vehicles and parts | Motor vehicles and parts, Transport equipment nec |
| 17. | etnd | Transmission and Distribution | Transmission and distribution of electricity |
| 18. | enuc | Nuclear | Nuclear power |
| 19. | ecoa | Coal, gas, oil power | Coal power, Gas power, Oil power |
| 20. | ewin | Renewables | Wind power, Solar power, Other power |
| 21. | ehyd | Hydro | Hydro power |
| 22. | trnp | Transport | Transport nec, Water transport |
| 23. | oser | Other Services | Water, Construction, Trade, Accommodation, Food and service activities, Air transport, Warehousing and support activities, Communication, Financial services nec, Insurance, Real estate activities, Business services nec, Recreational and other services, Dwellings |
| 24. | pser | Public Services | Public Administration and defense, Education, Human health and social work activities |

# Annex B. Change in Bilateral Exports of Fossil Fuels from Russia in 2050

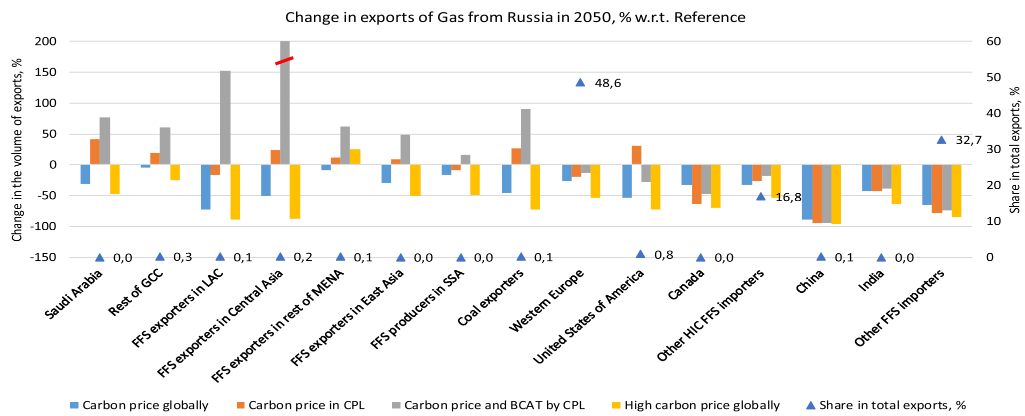
## Figure B.1. Change in exports of coal from Russia, (% change relative to baseline)



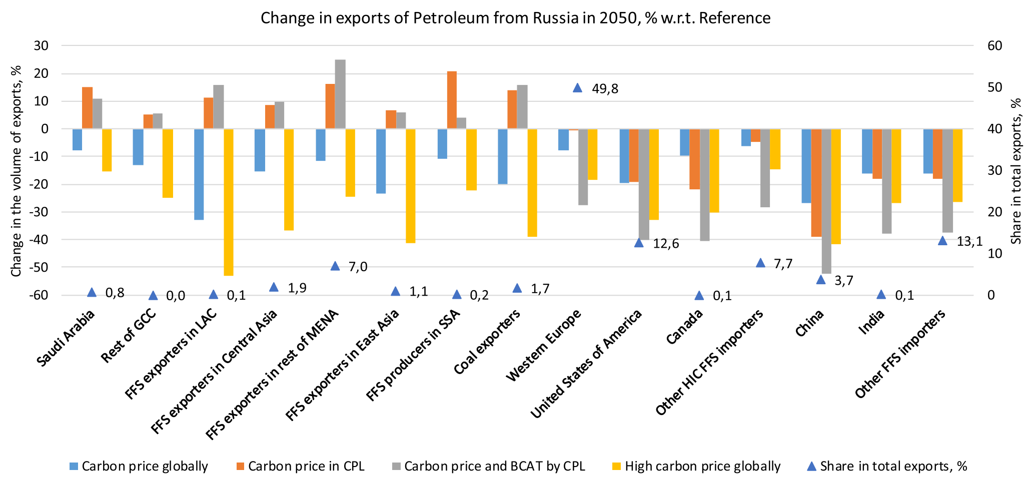

## Figure B.2. Change in exports of oil from Russia



## Figure B.3. Change in exports of gas from Russia




## Figure B.4. Change in exports of petroleum from Russia



# Annex C. How the Model Treats Technological Change and Innovation in Peszko et al. 2020

Three different specifications were used within the study:

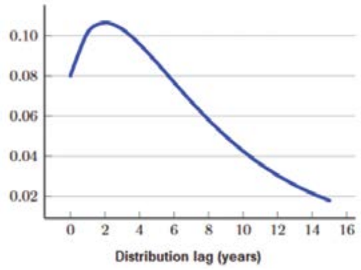
(a) For the MACCs derivation, a standard R&D specification was used, i.e., technological change rates are exogenous in the model. Some trends of efficiency change and technological improvements are assumed within the baseline scenario, but these stay exogenous within the policy scenarios. Aggregate (country average) energy efficiency can be changing due to the structural shifts, but sector-level efficiency levels are fixed at the baseline scenario level.

(b) The “Knowledge module” was used as discussed in van der Mensbrugghe (2019). In each year, there is an aggregate expenditure of R&D, which increases the stock of knowledge, though knowledge also depreciates over time. The impact of the R&D expenditures occurs with a distributed lag, which is governed by the Gamma distribution function with region-specific parameters. The knowledge module is designed to impact the labor productivity growth.

(c) Finally, R&D model runs use a different approach and assumptions. The asset diversification scenario analysis is based on the simulations conducted in Peszko et al. (2020). It is assumed that R&D investments lead to the accumulation in the stock of knowledge, which in turn increases labor productivity. The overall set up of the R&D and knowledge module is discussed in detail in van der Mensbrugghe (2018). Below, we discuss the specific parametrization used for the case of Russia.

R&D module operates similarly to the investment and capital stock accumulation. Every year, there is an R&D expenditure, which increases the stock of knowledge, though the knowledge also depreciates over time. The key difference compared to the conventional investments and capital dynamics is that the R&D impacts are distributed over time. This distribution is implemented using Gamma distribution function, which for the case of Russia is depicted in the Figure D.1. In this particular case, it is assumed that the benefits of the R&D investments are distributed over 15 years. This time lag is lower than assumed for most developed countries–the EU, U.S., and other OECD countries, where corresponding timespan in the model is between 25 and 50 years.

**Figure D.1. Gamma distribution for the R&D investments impact modelling for the case of Russia**



Another important parameter that drives the R&D impacts is the elasticity of endogenous productivity with respect to the growth of knowledge. In the case of Russia (and other regions in the model), it is assumed to be 0.3, meaning that if the knowledge stock grows by 1%, productivity increases by 0.3%. It should be noted that while the assumed elasticity value is sector- and region generic, impacts of the same relative increase of knowledge stock on the sector-specific output and value added would differ by sectors and regions, partly by the differentiated cost structures by industries and regions. Overall set up and parametrization of the R&D module used in Peszko et al. (2020) and discussed in this Appendix is largely in line with some previous literature, as discussed e.g., in Kristkova et al. (2016).

# Annex D. Comparative Description of Simulated Macroeconomic and Welfare Impacts, Impacts on Trade and Carbon Emission for CBAM and Long-Term Global Action (Russia, in 2035 Compared to the Reference Scenario)

| | EU CBAM analysis | | | | | | | Long-term global action with large BCAT coalition analysis | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Indicator / Scenarios** | **Carbon price / CBAM Scope 1, 2 (EU)** | **Carbon price / CBAM, Scope 1 (EU)** | **Carbon price / CBAM Scope 1,2, FF included (EU)** | **Carbon price / CBAM Scope 1, 2 (EU + US)** | **Carbon price / CBAM Scope 1, 2 (EU and ECA w/o Russia)** | **Russia carbon price with re-cycling to HH** | **Russia carbon price with recy-cling to invest-ment** | **Carbon price globally** | **Carbon price in CPL** | **Carbon price and BCAT by CPL** | **High carbon price globally** |
| Carbon price in CBAM/BCAT countries in 2035 | 115 | 115 | 115 | 115 | 115 | 115 | 115 | 87 | 147 | 137.5 | 128 |
| Imposition of the CBAM/ BCAT | Yes | Yes | Yes | Yes | Yes | No | No | No | No | Yes | No |
| Carbon price in Russia in 2035 | 0 | 0 | 0 | 0 | 0 | 115 | 115 | 87 | 0.4 | 0.4 | 128 |
| GDP impact | -0.1% | -0.1% | -0.1% | -0.2% | -0.2% | -0.3% | 5.1% | -2.1% | -0.3% | -1.5% | -3.1% |
| Welfare impact | -0.3% | -0.2% | -0.3% | -0.4% | -0.5% | -0.5% | -1.3% | -2.8% | -1.1% | -3.7% | -4.3% |

| | **EU CBAM analysis** | | | | | | | **Long-term global action with large BCAT coalition analysis** | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **Indicator / Scenarios** | **Carbon price / CBAM Scope 1, 2 (EU)** | **Carbon price / CBAM, Scope 1 (EU)** | **Carbon price / CBAM Scope 1,2, FF included (EU)** | **Carbon price / CBAM Scope 1, 2 (EU + US)** | **Carbon price / CBAM Scope 1, 2 (EU and ECA w/o Russia)** | **Russia carbon price with re-cycling to HH** | **Russia carbon price with recy-cling to invest-ment** | **Carbon price globally** | **Carbon price in CPL** | **Carbon price and BCAT by CPL** | **High carbon price globally** |
| Aggregate export impact | -0.9% | -0.4% | -0.9% | -1.1% | -1.2% | 1.0% | 9.3% | -7.3% | -2.7% | -7.7% | -10.3% |
| Emissions impact | -1.7% | -0.7% | -1.8% | -1.9% | -0.8% | -39.2% | -37.1% | -32.1% | -0.4% | -4.5% | -39.7% |
| CBAM base | Carbon content of the trade exposed (EITE) indus-tries | Carbon content of the trade exposed (EITE) in-dustries and FF sector (oil, gas, and coal ex-traction) | Carbon content of the trade exposed (EITE) indus-tries | | | | | Carbon content of all ex-porting activities (Scopes 1,2,3) | | | |
| Carbon tax base | $CO_2$ emissions from the fossil fuel combustion | | | | | | | | | | |

### Modeling Assumptions

| EU CBAM | |
|---|---|
| **CBAM/carbon tax assumptions** | |
| **Indicator** | **Assumption** |
| **CBAM regional coalition** | EU and EFTA |
| **Emissions coverage for BCAM/ carbon tax** | Included: $CO_2$ and non-$CO_2$ emissions from fuel combustion, non-$CO_2$ process emissions. Not included: $CO_2$ industrial process emissions. |
| **Sectoral coverage of BCAM** | EITE sectors, rather than individual CBAM commodity level (such as cement, aluminum or fertilizer). |
| **Carbon tax/ CBAM** | In calculation of CBAM rate, an equivalent of EU's free allocation in a given year is deducted. Free allocation of emission allowances in the EU effectively reduces the carbon price for energy intensive industries (until free allocation is phased out). While introducing carbon tax, Russia adopts symmetric free allocation (with symmetric phase-out) for its energy intensive industries. Free allocation is based on the EU standards (average emission intensities in a given EU industry), while excess emissions face the full tax. However, full average cost is imposed on emissions beyond the EU standard. |
| **Baseline calibration assumptions** | |
| **Indicator** | **Level** |
| **2035 baseline $CO_2$ emissions in Russia (2014=1)** | 1.13 |
| **2035 baseline global $CO_2$ emissions (2014=1)** | 1.18 |

| Long-term global action with large BCAT coalition | |
|---|---|
| **BCAT set up assumptions** | |
| **Indicator** | **Assumption** |
| **BCAT regional coalition** | Canada, U.S., Western Europe, other high-income fossil fuel importers, China, India, other low- and middle-income fossil-fuel importers |
| **Emissions coverage for BCAT** | Scope 1 + 2 +3 $CO_2$ emissions from fossil fuel combustion |
| **Sectoral coverage of BCAT** | All sectors |
| **Baseline calibration assumptions** | |
| **Indicator** | **Level** |
| **2035 baseline $CO_2$ emissions in Russia (2014=1)** | 1.51 |
| **2035 baseline global $CO_2$ emissions (2014=1)** | 1.29 |

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| **Baseline mitigation assumptions** | Countries reach NDC targets via carbon pricing. EU emission reduction more ambitious than the original NDC submission, approximately in line with the current policy targets. EU carbon tax: equal to US$115 /t$CO_2$ eq in 2035. Russia achieves the NDC already with a zero-carbon price. Average carbon tax for all ECA: US$5 t$CO_2$ eq in 2035. Relatively high carbon taxes (50-60 USD/t$CO_2$eq in 2035) implied by the NDCs in Armenia, Azerbaijan, and Kazakhstan. NDCs have been imposed on all GHG emissions available in the model, except for agricultural non-$CO_2$ emissions (for which abatement technologies are not modeled). | **Baseline mitigation assumptions** | Countries reach NDC targets via carbon pricing (carbon prices by region vary from under US$1 per t$CO_2$ in Russia to US$75 per t$CO_2$ in Western Europe) |
| **Energy efficiency assumptions** | • 1% annual autonomous energy efficiency improvement in the production sectors, 2% in the household sector<br>• Decrease in cost of wind and solar power of about 1.5% per year<br>• Additional exogenous increase in renewables (hydro+wind+solar) shares in power generation implemented as cost-neutral technological twist. The assumed 5% twist implies that all else being equal (incl. fixed relative prices of energy), the ratio of renewables to non-renewables increases by 5% per year<br>• Similar technology twists implemented facilitating substitution of fuels for electricity, gas for coal and oil, and a cost-neutral energy efficiency improvement. The latter is different from the autonomous improvement in that it implies increased capital-intensity<br>• The above assumptions applied uniformly to all countries, except the EU, for which higher rates were typically used, as a proxy for policies other than carbon taxation | **Energy efficiency assumptions** | Vary by countries and years linked to the GDP growth rates–higher energy efficiency improvements are assumed for countries with higher baseline GDP growth rates. In most country cases, energy efficiency improvements range between 1% and 2% per year. Uniform (across countries) levels of energy efficiency improvements (0.25% per year) are assumed for coal and gas power generation activities. |
| | | | Long-term global action analysis features:<br>1. Assessment uses the research and development module and the depletion module of the Envisage CGE model. Further details on both modules can be found in van der Mensbrugghe (2019).<br>2. Carbon revenue recycling mechanism: lump-sum payments to the representative household. |

WORLD BANK GROUP

HSE UNIVERSITY

2021

1818 H STREET NW, WASHINGTON, DC 20433
TELEPHONE: 202-473-1000
INTERNET: WWW.WORLDBANK.ORG

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