



Center for energy efficiency – XXI

Igor Bashmakov



**Russia's foreign
trade, economic
growth, and
decarbonisation.
Long-term vision**

Moscow, April 2023

Table of contents

INTRODUCTION	4
1 EXECUTIVE SUMMARY	5
1.1 RUSSIAN ECONOMY IN 2022 AND 2023: THE ANGLE OF INCIDENCE.....	6
1.2 RUSSIA'S "OPERATION" IN UKRAINE: IMPLICATIONS FOR RUSSIAN IMPORTS AND EXPORTS IN 2022.....	8
1.3 LONG-TERM EFFECTS OF SANCTIONS ON RUSSIAN FOREIGN TRADE: "NEVER BEFORE – AND ONCE AGAIN"	10
1.4 GLOBAL DECARBONIZATION AND RUSSIAN FOREIGN TRADE: LONG TERM EFFECTS	12
1.5 EFFECTS OF SANCTIONS AND DECARBONIZATION TARGETS AND POLICIES ON RUSSIA'S ECONOMIC DEVELOPMENT AND ATTAINABILITY OF THE 2060 CARBON NEUTRALITY TARGET	15
2 RUSSIAN ECONOMY IN 2022: THE ANGLE OF INCIDENCE	21
2.1 GDP DECLINE IN THE STATISTICAL MIST	22
2.2 FEDERAL AND CONSOLIDATED BUDGET: THE LARGEST DEFICIT SINCE 1992	23
2.3 INFLATION – BACK TO DOUBLE DIGITS	24
2.4 INDUSTRIAL PRODUCTION – SANCTIONS ON RUSSIA'S BASIC MATERIALS EXPORTS WORK	24
2.5 FOREIGN TRADE: US\$ 100 BILLION ADDITIONAL NET INCOME	25
2.6 LAST QUARTER OF 2022 AS A SCRATCH OF THE 2023 ECONOMIC PICTURE.....	28
3 RUSSIA'S "OPERATION" IN UKRAINE: IMPLICATIONS FOR RUSSIAN IMPORTS AND EXPORTS IN 2022	29
3.1 OIL AND GAS EXPORTS AS A BASIS FOR ECONOMIC OR POLITICAL SUPERPOWER.....	30
3.2 EXPORTS GO EAST	32
3.3 FOSSIL FUELS EXPORTS.....	34
3.4 NON-FUEL EXPORTS: EASTERN MARKETS FAIL TO ABSORB THE LOSS IN WESTERN MARKETS.....	41
3.5 RUSSIAN 2022 IMPORTS: THE DOUBLE-HEADED EAGLE CAN'T FLY WITH BOTH HEADS LOOKING EAST.....	44
4 LONG-TERM EFFECTS OF SANCTIONS ON RUSSIAN FOREIGN TRADE	52
4.1 MINISTRY OF ECONOMIC DEVELOPMENT PROJECTION TO 2026: ROSE-COLOURED SPECTACLES FOR A BRIGHT FUTURE	53
4.2 "NEVER BEFORE – AND ONCE AGAIN"	54
4.3 CHANNELS OF INFLUENCE OF RUSSIA'S FOREIGN TRADE ON THE COUNTRY'S ECONOMIC DEVELOPMENT: STATIC ASSESSMENT OF THE EFFECTS OF SANCTIONS	55
4.4 OIL AND PETROLEUM PRODUCTS.....	56
4.5 NATURAL GAS.....	58
4.6 COAL	62
4.7 NON-FOSSIL FUELS EXPORT AND IMPORT PERSPECTIVES.....	63
5 GLOBAL DECARBONIZATION AND RUSSIA'S FOREIGN TRADE: LONG TERM EFFECTS	68
5.1 POST-COP27 INVENTORY OF DECARBONIZATION TARGETS AND POLICIES.....	69
5.1.1 NDCs: first baby steps on the long and thorny decarbonization pathways	69
5.1.2 Long-term commitments: roadmaps to final destinations.....	71
5.2 LONG-TERM EFFECTS OF DECARBONIZATION TARGETS AND POLICIES ON THE DEMAND FOR RUSSIAN TRADITIONAL GOODS ...	75
5.2.1 Fossil fuels: scaling down in the historical order.....	75
5.2.2 Crude oil and petroleum products: decarbonization and energy security are turning off the oil valve and blunting the oil needle.....	76
5.2.3 Natural gas: Russian pillar of the "methane bridge" to the low carbon future destroyed	78
5.2.4 Coal to peak before 2025 and never return	81
5.2.5 Basic materials: not much growth for the global markets ahead.....	83
5.2.6 Emerging markets for critical materials and new fuels.....	83
5.2.7 Machinery and equipment for low carbon technologies: can Russia hope to get a share in trillions dollars-worth markets?.....	87
5.2.8 Bridging the perspective gap in the balance of trade	90

6	EFFECTS OF DECARBONIZATION TARGETS AND POLICIES (INCLUDING SANCTIONS) ON RUSSIA'S ECONOMIC DEVELOPMENT AND ATTAINABILITY OF THE 2060 CARBON NEUTRALITY TARGET	92
6.1	LONG-TERM VISIONS OF RUSSIA'S ECONOMIC GROWTH: LOST DECADE AND BLEAK FUTURE.....	93
6.2	CENEF-XXI'S MODEL SET	94
6.3	ASSUMPTIONS	95
6.3.1	<i>Demographic projections</i>	95
6.3.2	<i>Total factor productivity</i>	97
6.3.3	<i>Oil and gas export</i>	100
6.3.4	<i>Oil and gas prices</i>	101
6.3.5	<i>Non-oil and gas exports and imports</i>	102
6.4	SCENARIOS.....	103
6.4.1	<i>Combinations of economic drivers</i>	103
6.4.2	<i>The "magic skin economy"</i>	104
6.4.3	<i>Struggle for stagnation</i>	106
6.4.4	<i>Limits of growth – is there a cap to hit?</i>	108
6.5	THE EFFECTS OF SANCTIONS AND DECARBONIZATION POLICIES ON RUSSIA'S LONG-TERM ECONOMIC DEVELOPMENT PERSPECTIVES	109
6.6	2060 CARBON NEUTRALITY TARGET: ATTAINABILITY CHALLENGE	113

Introduction

In April 2022, CENef-XXI authored a paper “The angle of incidence is not equal to the angle of reflection. Macroeconomic perspectives”, which was followed by “Russia’s carbon neutrality: pathways to 2060”.¹ These two studies were the first attempts to assess long-term carbon neutrality prospects for the Russian economy on the 2060 horizon with an account of the military operation in Ukraine. Since then, the Russian government and think tanks have not tried to address critical long-term economic problems and risks faced by the country. They keep looking at the 2025-2026 perspective. The Russian Ministry of Economy can only see a bright future to 2026 through rose-coloured spectacles. Only very few projections have a time horizon to 2035-2036.

After February 2022, global economy has seen some substantial shifts. Adopted decarbonization policies are now viewed not only as effective climate mitigation strategies, but also as energy security strategies, which are back on the political agenda. One year after the military operation began, the first effects of sanctions have manifested.

With high energy and basic materials prices in 2022, Russia has demonstrated a certain resilience to sanctions, but there is no reason to believe, that this resilience will persist into 2023 and beyond. Foreign trade is exceptionally important for the Russian economy and political system. Visions of how the sanctions and global low carbon transition will affect Russian long-term growth and the attainability of the 2060 carbon neutrality target is in the focus of this research.

Chapter 2 briefly describes Russian economic developments in 2022 and early 2023 showing the real “angle of incidence”. A detailed analysis of the implications of Russia’s “operation” in Ukraine for the Russian import and export in 2022 are presented in Chapter 3. It shows the evolution of the country’s foreign trade after the “turn-to-the-East” policy was adopted to favour the Eastern trade partners.

Chapter 4 aims to assess the long-term effects of sanctions on the Russian export of fuels and other products, on the one hand, and sanctions on Russia’s import of equipment, on the other. It shows, that in the fuel industry, long-term sanctions may impede timely access to the required technologies and, unless lifted, will not allow for a full compensation of the production decline in oil, gas and coal extraction industries. Long-term effects of the global decarbonization on Russian foreign trade are discussed in Chapter 5. Chapter 6 shows how both sanctions and decarbonization policies affect Russia’s long-term economic development and attainability of the 2060 carbon neutrality target. This chapter answers the question, whether or not Russia will have economic growth on the 2060 horizon. Like we always do in our papers, key findings of the study are given in Chapter 1, which is a summary for policy-makers.

This paper was written by Igor Bashmakov. CENef-XXI’s model set was updated with the assistance of V. Bashmakov, K. Borisov, M. Dzedzichuk, and A. Lunin. Data on Russia’s foreign trade were compiled by M. Dzedzichuk, and data on the EU, US, China, India, and Turkey trade with Russia by A. Myshak. Proofreading and translation of the report by Tatiana Shishkina, layout by Oxana Ganzjuk. Cover painting (A Thinker) by Igor Bashmakov.

Igor Bashmakov

General Director, CENef – XXI. Contacts: Tel. (499) 120-9209. Email: cenef@co.ru. Website: <https://cenef-xxi.ru>

¹ Bashmakov I. 2022. The angle of incidence is not equal to the angle of reflection. April 2022. [CENef-XXI](https://cenef-xxi.ru); Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia’s carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia-s-carbon-neutrality-pathways-to-2060>.



Executive summary

1.1 Russian economy in 2022 and 2023: the angle of incidence

GDP has declined in the statistical mist. The Russian statistical agency (Rosstat) reported a 2.1% decline in 2022 Russian GDP

In 2022, the Russian economy demonstrated higher, than expected, resilience to the sanctions

- The trust in Rosstat's data on GDP evolution is declining. There are good grounds to believe that GDP decline in 2022 was at least 0.8% deeper. Some 2.7% was added by Rosstat in GDP growth revisions since 2018.
- 2022 non-oil-and-gas GDP (NOG-GDP) was reported 2.7% down.
- Despite the sanctions, export additionally generated more than US\$ 100 billion, of which oil and gas export was US\$ 98 billion.
- Additional oil and gas revenues were the key driver behind the aggregated demand growth in 2022.
- In 2022, federal budget revenues were 10% above the 2021 level. Consolidated budget deficit was 1.4% GDP.
- The latter will substantially aggravate in 2023, as the drop in oil and gas revenues in the first quarter made the government revenues 30% short of what is required to cover the expenditures, and for the whole year consolidated budget deficit is expected to exceed 5% of GDP.
- In 2022, inflation was back to double digits: consumer inflation amounted to 14%, and GDP deflator was 14.3% up.
- This was mostly enabled by abundant oil and gas revenues, geographical switch of exports and imports, and additional demand driven up by the militarization of the economy.
- After years of growth (or relative stability) in the basic materials production in Russia, February 2022 marked the beginning of the era of decline for many of them.
- Much more severe negative effects were detected for the basic materials under sanctions.
- The results of Russian 2022 foreign trade proved the 1-year-old conclusion,² that energy price growth would overcompensate the sanctions-driven revenue loss.

² Bashmakov I. 2022. The angle of incidence is not equal to the angle of reflection. April 2022. [CENef-XXI](#).

There is no reason to believe, that this resilience will persist into 2023:

Trying to cover-up these effects, the government may want to add more statistical mist

- The reasons are as follows: decline in oil and gas revenues caused by the ban on petroleum products exports to the EU; oil and petroleum products price cap; irrelevant to the sanctions decline in gas supply; stabilization of, or decline in, energy and basic materials prices.
- With a limited ability to increase non-oil and gas exports and lower expected prices for traditional Russian exports, deterioration of the Russian trade balance will substantially weaken the ruble making imports more expensive and so less attractive, while the Russian businesses will have a very limited ability to substitute high-tech imports.
- Consolidated and federal budgets will face severe deficits, and the attempts to improve the situation will be accelerating the inflation. Using the resources of the Sovereign Wealth Fund may mitigate the 2023 financial problems at the price of having to deal with a very unstable situation in the following years. Additional fiscal pressure on the non-oil and gas businesses will act to further undermine their profitability and investment potential.
- With the military priorities in mind, very limited resources will be available to finance social programmes and stimulate domestic economy. Therefore, government investments and total investments in real terms will shrink enlarging the “angle of incidence”.
- The declining trend in private consumption in real terms, which started back in 2008, will persist. The government will only have resources sufficient to partially mitigate the aggravating decline in the standard of living.
- The continuing decline in investment and private consumption will bring down the demand for new buildings, machinery, and appliances. The militarization of the economy may only partly mitigate these effects, especially with an account of the problems related to Russian supplies to the foreign markets. All this will be pushing the industry into yet deeper recession, with production at 10-30% below the 2021 levels.
- Even if Russia is able to maintain its 2023 oil production at the maximum possible level, smaller gas and petroleum products exports and production will push OG GDP down.
- NOG GDP will be declining, as foreign and domestic demand shrinks and the country is facing problems related to tuning alternative foreign supply chains at affordable cost.

1.2 Russia's "operation" in Ukraine: implications for Russian imports and exports in 2022

In oil-exporting economies, classical schemes of economic development are largely modified, because the oil and gas sector is largely replacing the manufacturing sector in safeguarding via imports the supply of machinery, consumer and intermediate goods

Oil and gas exports are the basis for recognition as an economic and political superpower

In 2022, Russian exports of goods was about US\$ 100 billion above the 2021 level, and all this increment was generated by additional oil and gas export revenues

The gas weapon appeared to have a substantial recoil: Russian 2023 pipeline gas supply may halve compared to the 2021 level

- Foreign trade is exceptionally important for the evolution of Russian economy and political system.
- There is a strong correlation between the rates of Russian GDP evolution and real oil price fluctuations. This correlation was even stronger in 2008-2022, than in 1995-2008. After 2008, every 10% up and down fluctuations in the real oil price resulted on average in 1.1% change in GDP.
- Partial re-nationalization of oil and gas assets in Russia and establishing control over the growing inflow of oil and gas dollars in the first decade of 21st century increased the economic might of the state and worked to drive its attention away from the mobilization, effective upscaling and deployment of internal growth factors and supplies.
- The scale of Russian energy exports – about 0.7 Gtoe annually (5% of global energy use) – in 2005-2006 determined the concept of an “energy superpower”.
- 2022 was selected to use this superpower to reach political goals.
- Russia's fuel export revenues were largely driven by prices, while physical export volumes were relatively stable across the whole 2022, except for natural gas.
- EU's efforts to reduce its reliance on Russian fuel supply take time: coal imports were terminated in September 2022 and petroleum products import is scaling down. However, EU's monthly payments for Russian gas in late 2022 were much above the 2021 levels.
- EU's profound reliance on the Russian gas is the reason why no restrictions were announced on Russian gas imports, except the price cap.
- Until March 2023, Russian oil business was demonstrating high resilience to sanctions.
- EU's sanctions on petroleum products were only introduced in February 2023 (with some exceptions), so they had no impact on the 2022 and early 2023 statistics.
- In 2022, Russian pipeline gas supply (excl. Belarus, Kazakhstan, and other NIS countries) was 101 bcm, or 74 bcm below the 2021 level.
- In Q1 2023, Russian gas supply to the EU was 4-7 times below the 2015-2022 levels.
- For pipeline natural gas, the “turn to the East” may take decades; however, meanwhile China's gas market may be penetrated by other suppliers, against the background of gas use peak expected in 2030-2035 with a subsequent decline in demand.
- Russian LNG exports remain unaffected, and in 2022 were 8% up to 45.7 bcm, including 19.3 bcm to the EU.

Exports go East. In 2022, Russia's "turn-to-the-East" policy favoured trade partners, such as:

- China (+US\$ 34 billion, or +43%);
 - India (+US\$ 32 billion, or about 5-fold growth), and
 - Turkey (+US\$ 30 billion, or more than double growth).
- All of them were mostly additional markets for Russian fuels sold at a discount.

Non-fuel exports: the East failed to absorb the loss at Western markets. Geographically, the trade vector had been west-bound for many years

- Russia has failed to scale up physical volumes of non-oil and gas exports since 2000.
- In 2022, sanctions plus treating Russian goods as toxic resulted in reduced total non-fuel exports by US\$ 24 billion, including to the EU, US, UK, Japan, and South Korea by US\$ 19 billion, of which US\$ 11 billion reduction was to the EU alone.
- In 2022, China, India and Turkey failed to absorb Russian non-fuel exports lost in OECD countries.

Russian 2022 imports: the double-headed eagle can't fly well with both heads looking East. In general, export restrictions for Russia's basic materials do work, but the real short-term effect was not as severe, as initially expected, and the Russian businesses have demonstrated substantial adaptivity

- Investments, local machinery and electronics production show the greatest vulnerability to the import restrictions.
- Mostly machinery and equipment exports to Russia were prohibited. Therefore, the ban on exports to Russia may have visible effects only in the medium term (lack of spare parts) or longer term (lack of equipment for new investment projects).
- In 2022, Russian imports of machinery and equipment (for several SITC groups – data-processing, telecommunications, instruments and apparatus, transport equipment and electric machines) from 34 largest economies were nearly US\$ 14 billion below the 2021 level.
- The recent 20 years in Russia were poisoned with the abundant inflow of petrodollars and so were lost for the diversification of the Russian economy and import substitution. In 2021, the deficit in machinery and equipment trade with the rest of the world was US\$ 108 billion; in 2022, it was down to US\$ 88 billion – not because of import substitution, but driven by sanctions and the economic crisis.
- Only 38% of businesses managed to substitute the restricted goods with domestic analogues for machinery, 66% are using Chinese-made substitutions. Corresponding numbers for spare parts are 63% and 45%, and for components 54% and 53%.
- Reliance on a variety of western countries is now being substituted by a more dangerous reliance on a single eastern country – China.
- In many respects, technically Russia is lagging behind China, and without supplies from the West this technological gap is likely to increase.

In 2021, import of machinery and equipment accounted for nearly half of the overall Russian import. In 2022, machinery and equipment imports were 40% below the 2021 level

1.3 Long-term effects of sanctions on Russian foreign trade: “Never before – and once again”

Real long-term economic problems and risks faced by Russia are not being addressed by the Ministry of economic development, Russian banks and analytical centers. They do not see beyond 2026

According to the RF Ministry of Energy, import reliance for oil and gas equipment in Russia in 2014 was 60%, and for certain positions no Russian analogues were available at all. In 2020, this reliance was down to 50% and in 2022 to 40%.

Import restrictions on the equipment required throughout the whole Russian oil supply chain may have stronger medium-term effects on oil production and export volumes, than sanctions on physical exports, but in the longer term

All of the restrictions on gas supply to Europe were imposed by Russia. In 2020, the share of domestic equipment for gas production was 55%. Back in 2014, it was 40%. There is some progress, but it might take a quarter of a century to attain full self-sufficiency. However, reaching this goal is highly unlikely

- No long-term projections have been recently published by the Ministry of economic development of the Russian Federation, and so Russia has no long-term official vision of how the military operation and subsequent sanctions might affect its economic future. Russian Ministry of economic development sees a bright future – only to 2026 – through rose-coloured spectacles.
- After adaptation possibilities, such as substantial government spending and changes in foreign trade geography, are exhausted, there is up to 6% GDP loss perspective in the medium-term.
- Import reliance in the refinery sector is much higher – nearly all of the technologies are imported.
- The long-term effects of the sanctions will depend on how successfully the Russian manufacturing sector will be progressing towards reducing the imports reliance.
- Production at Russian old oil fields is expected to scale down to 380 Mt by 2030, 280 Mt by 2040, 205 Mt by 2050, and 150 Mt by 2060. New sophisticated technologies are required to offset this decline. Sanctions prevent timely access to these technologies and, unless lifted, will not allow for a full compensation of the oil production decline in the decades to come.
- Oil and petroleum products price caps and the fact that oil prices are kept at moderate levels by maintaining demand and supply balance on the global oil markets allow it to keep oil prices at a medium or low level, and thereby aggravate the effects on Russian oil export revenues.
- Russian petroleum products export is expected to decline. The depth of the decline depends on how severe the sanctions are in the short- and medium-term and on the progress towards global decarbonization in the longer term.
- Production at Russian old gas fields is expected to scale down to 490 bcm by 2030, 370 bcm by 2040, 275 bcm by 2050, and 200 bcm by 2060. In order to offset this decline and to meet domestic and export demand, new high-tech technologies are needed to explore new fields and deliver gas to the consumers. Technological sanctions may impede meeting this demand.
- Even if all longed-for projects of re-directing gas flows to the East are successful, Russia will still need to export at least 50-60 bcm to the EU market, if it wants to get back to the 2020-2021 export volumes.
- Russia's reliance on gas turbine imports exceeds 90%.

- In LNG production, import reliance is 70-80%, in offshore operations 85%, in drilling equipment 80%.
 - Increasing LNG exports becomes the most promising option; however, some of the announced projects have faced Western sanctions in terms of access to financing and liquefaction technologies. The LNG production volume scheduled for 2035 may be 15 or more years delayed.
- Coal production in Russia will be affected by sanctions on coal import from Russia, on the one hand, and sanctions on coal mining and enriching equipment supply to Russia, on the other**
- Reliance of the Russian coal industry on imported equipment is even higher, than of the oil and gas industry, and was growing in 2014-2022.
 - The share of foreign-made mining and transport equipment in the coal industry has reached 80-85%.
 - All additional coal production since 2010 (115 Mt) was based on imported equipment. As its service life expires, coal production may be 20-25% down in 2035, due to the lack of appropriately functioning mining equipment and little progress towards import substitution.
- With the destroyed supply chains and very weak Russian competitive positions in many global machinery and equipment markets, hampered access to high-tech and financing, feasible import substitution and export expansion are unlikely**
- In 2022, sanctions led to substantial reductions in non-fossil fuels export revenues, despite the higher prices compared to 2021. In 2021-2022, the gap between imports of goods and services and non-fuel exports of goods and services was US\$ 90-100 billion.
 - The sanctions imposed on Russian imports have two major effects:
 - reduced intermediate goods supply affects output, as inventories are depleted, and
 - reduced investment goods supply, which works to reduce the ability to scale up production and hampers import substitution.
- For many machinery manufacturing subindustries, the level of localization is below 70% and showing only slow progress**
- The most successful import substitution may be expected in industries which are far from the technological frontiers.
 - The import substitution model with "rapid" use of foreign technologies (assembling) without producing "rooting" (localization) can increase the technological dependence.
- Russia can only reduce its import reliance through the re-integration into global supply chains and by pursuing thoughtful sustainable and efficient technology development policies based on competition and innovation and appropriate education and training**
- The theoretical results show, that if import substitution does not provide local products of comparable quality at comparable costs, potential GDP declines.
 - The sanctions brought machinery import down by US\$ 25 billion in 2022. In the coming years, this decline may be growing and undermining the growth and import substitution potential of the Russian economy.
 - The impact of sanctions on investment goods was already tangible in 2022. The share of machinery and equipment in the structure of gross fixed capital formation in 2022 was 3% down from its record 39.5% level in 2021.

1.4 Global decarbonization and Russian foreign trade: long term effects

If all the latest NDCs, including conditional elements, are to be implemented, global GHG emissions should peak before 2030 at 3.6% (0.7–6.6%) below the 2019 level

19 of G20 members, including Russia, have already committed to net-zero emissions

The Russian military operation has given momentum to the global decarbonization process

Decarbonization and energy security turn off the oil valve and blunt the oil needle

The conclusion made by CENef-XXI in April 2022 – that Russian fossil fuel exports and production will never return to the 2021 levels – was half a year later echoed by IEA

- In the last 30 years, global energy system failed to go through really transformational changes and to reduce GHG emissions.
- Committed low carbon transition is expected to reshape the global economy and energy landscape.
- Many of additional GHG emissions reduction commitments were made after the initial Paris Agreement pledges had been announced by Russia's major trade partners – China, Canada, the EU, US, and UK.
- WG III IPCC 6AR concluded, that global GHG emissions in 2030 associated with the implementation of NDCs announced prior to COP26 would make it likely that warming will exceed 1.5°C during the 21st century. Limiting warming to below 2°C would then rely on a rapid acceleration of mitigation efforts after 2030.
- As of September 23, 2022, 88 UNFCCC parties had made long-term net-zero pledges covering 79% of global GHG emissions.
- Net-zero targets for 53 parties cover all sectors. If these commitments are to be met, sectoral transformations have to build on deep technological change.
- In addition to closing up foreign markets for Russian fuels in the coming years, it has undermined global long-term prospects for fuel consumption and international trade.
- IPCC WGIII Sixth Assessment Report concludes, that pathways limiting the global warming to 2°C involve deep reductions in fossil fuel consumption and nearly total elimination of the use of coal without CCS.
- Energy security and affordability policies coupled with decarbonization policies forced the expected proportion of fossil fuels in global energy mix to decline much faster, than expected in 2021.
- In all of the recent long-term projections, decarbonization activities and energy security considerations force global crude oil consumption to peak or plateau before 2040 with a subsequent decline.
- Energy security concerns and increased preference for locally produced energy reduce the role of oil and natural gas imports in global energy supply.
- Anticipated growing reliance on OPEC oil supply may give an additional push to energy security considerations.

No return: Russia's natural gas production will never again get back to the formerly high levels

The hopes for the "gas golden age" or "methane era" are now bygone

Russian pillar of the "methane bridge" to low carbon future is destroyed

Global coal use peaks before 2025 and never returns

Basic materials: not much growth potential for global markets ahead

Trillion or more dollars-worth markets for critical materials and new fuels are emerging.

A glittering future is awaiting materials that are critical for global decarbonization, including nickel and copper

- In none of the available (developed after 2022) global long-term projections to 2050-2060 does Russia's petroleum products export exceed half of its 2021 level; some projections expect order of magnitude decline by 2060.
- There is no potential to compensate the declining petroleum products export from Russia with higher domestic petroleum products use; therefore, Russian oil production peak has passed, and only a decline can be expected in the coming decades.
- Global natural gas consumption will peak or plateau before 2030. This milestone is now 10 years closer and the peak or plateau level is much below the range projected in the earlier studies.
- For at least 20 years (2025-2045) Russian pipeline gas export is not expected to exceed 100 bcm, which is half of the 2017-2021 levels.
- CENef-XXI's conclusion drawn up in April 2022 that gas exports and production in Russia will never exceed the 2021 level has got a larger support.
- The Russian military operation and global economic revival after the COVID-19 pandemic temporarily created additional coal demand; but as decarbonization progresses, global coal use is expected to peak before 2025 and then steeply go down.
- International coal trade will be declining even faster – 60-90% down in 2050 – leaving few possibilities for large-scale Russian coal export.
- For traditional exports, such as iron and steel, aluminum, cement, fertilizers, wood, wood products, and food, global markets are unlikely to expand much, and Russia is unlikely to get an additional share in these markets.
- Sanctions-driven revenue loss for the Russian exports of CBAM goods to the EU can be estimated at US\$ 4.1-5.4 billion. This loss is more than half of pre-2022 CBAM goods export revenues from Russia to the EU and goes far beyond any loss that had been expected from CBAM.
- Another potential market for Russia is chemicals and petrochemicals, including pharmaceuticals.
- According to the available projections, global plastics production could more than double to 985 Mt on the 2050 horizon.
- A broader view on potential global chemicals market highlights a large potential for the production of ammonia for fueling shipping and power generation from current 185 Mt to 968-996 Mt in 2050.

For Russia, access to global machinery and equipment market is a challenge, as this product group generated only US\$ 25.7 billion in its export revenues in 2021 and US\$ 20.4 billion in 2022, or just 0.33% of global total machinery and equipment exports

Revolutionary shifts are required in technological, foreign trade, business climate and decarbonization priorities, so that evolutionary changes allow it to bridge the perspective gap in the balance of trade

China is the major Russia's competitor in low carbon technologies markets, followed by:

- Hydrogen is another large emerging market. Strong competition is expected in global hydrogen markets, because many countries have export plans, while only the EU, Japan and Korea are expected to be large hydrogen importers.
 - In 2021, global export of machinery and transport equipment (US\$ 7,653 billion) was 3 times larger, than fossil fuel export (US\$ 2,558 billion). As decarbonization progresses, this ratio will be further growing.
 - In 2022, US\$ 1.1 trillion investment in energy transition (or US\$ 1.6 trillion, if power grid, supply chain, and corporate R&D are included) for the first time in history matched fossil fuels investments despite the fossil investment growth triggered by that year's energy crisis.
 - In 2030-2050, annual investment in energy transition is expected to be twice the current volume of fossil fuel international trade.
 - Annual market for energy transition products is expected to scale up to US\$ 3-5 trillion on average in 2023-2030; to US\$ 4-7 trillion in the 2030s; and to US\$ 6-16 trillion in the 1940s.
 - The gap in Russia's foreign trade balance of goods and services anticipated for the coming decades is based on expected fossil fuels export revenues loss and sanctions.
 - It can be bridged by expanding non-fossil fuel export, higher level of localization and import substitution, which all may only be possible upon return to the global supply chains.
 - Export promotion and import substitution can only happen on condition of laxer or lifted high-tech import sanctions; competition-based incentives to invest in new technologies; and re-gained access to international financing.
 - the EU and US, which recently adopted regulations to support low carbon technologies localization.
- Russia is facing the risk of devastating reliance on China for low carbon technologies. It is better sooner, rather than later, to launch support for low carbon technologies localization.

1.5 Effects of sanctions and decarbonization targets and policies on Russia's economic development and attainability of the 2060 carbon neutrality target

Long-term visions of Russia's economic growth: lost decade and bleak future

Russia is losing its economic future – that's the overall takeaway from the first assessments of the long-term sanctions and decarbonization effects

No one can buy time, especially if the pocket is half-empty.

Factors driving the economic growth had been exhausted well before 2022

On the 2060 horizon, Russia is expected to lose one fifth to one third (17-26 million) of the working age (25-64) population

It is very likely that total factor productivity (TFP) for the Russian non-oil and gas sector will be staying below, or close to, zero in the decades to come, and there are no grounds to believe that Russia's TFP will be above 0.8%

- Russia needs realistic long-term visions of the effects of sanctions and decarbonization policies on its future economic development and attainability of the 2060 carbon neutrality target.
- From bad to worse: problems are expected to aggravate by 2025 and beyond. After the bottom of the crisis is reached in 2023-2025, Russian economy will be very slowly reviving.
- Even before the military operation began, many analytical groups expected Russian annual GDP growth rates (AAGRs) to stay below 1% till mid-21st century.
- Long-term projections updated in 2022-2023 are even more pessimistic.
- In none of the long-term projections provided since 2022 do AAGRs exceed 1.5% between 2023 and 2050-2060.
- None of the new demographic projections takes into account the mobilization and emigration from Russia.
- Negative demographic developments make it difficult to sustain the economic growth.
- A tough demographic situation in the 2030s and 2040s will severely restrict potential GDP growth rates.
- Market reforms of the 1990s – with some delay – brought TFP up to 1.6% in 1996-2010; however, gradual dismantling of these reforms – also with some delay – took TFP down to -1.2% in 2010-2022. In other words, after 2007 the economic growth has been fully extensive.
- The assumption made in 2022 for the 4D scenario that TFP in Russia may scale up to 1.5% was too optimistic. The World Bank estimates maximum level of TFP for Russia in 2022-2030 at 0.8%. Contribution to economic growth from TFP is revised down. In the model runs presented in this paper three options were used for TFP: 0%; 0.4%; and 0.8%.
- The “going East” strategy will not allow it to move closer to the technology frontier, while the former orientation to the West used to provide access to more advanced technologies and so ensured higher TFP.
- When productivity growth and cost optimization are no longer taken into account by decision-makers, poverty takes over.

CENef-XXI's last year projections³ have been updated using an upgraded set of interconnected models.

The models were updated to integrate 2022 data in the datasets used to calibrate the parameters. Assumptions for the model runs are as follows:

'Slowbalisation' will limit the Russian export potential

"Magic skin" economy

- Crude oil and petroleum products export from Russia is assumed down to 33-160 Mt in 2060.
- Gas export was assumed to collapse before 2025 with a further smaller decline to 40 bcm in 2060 or freezing at 140 bcm in 2030-2060.
- For the Russian economy, oil and gas price levels are more important, than physical export volumes. On the 2050 horizon, crude oil export prices are expected to fluctuate within the ranges observed in 2005-2022 with the price discount smoothly shrinking, but practically no chance of staying any close to the 2022 highs for any long timespan.
- It means that global trade will be lagging behind the global GDP and working to slow it down.
- Since trade-openness is important for total factor productivity, restrictions will slow down global productivity and global GDP growth.
- If the sanctions persist into the future and are added up with Russia's poor integration in the dynamic global decarbonization, they will lead, first, to stagnation and then to a drop in economic activities in the decades to come, because non-oil and gas sector will be unable to offset the shrinking oil and gas "magic skin".
- Unluckily for Russia, combinations of economic drivers (Figure 1.1) brings nearly stagnation of GDP till 2040 with a subsequent decline resulting from workforce shortage and oil and gas revenues loss.
- In an attempt to turn away from global integration to local isolation and by deploying a corresponding combination of economic drivers, Russia will lose out the race for the future.
- Russia's share in global GDP shrinks to 0.9% expressed in PPP and to 0.5%, if estimated in exchange rates.

³ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060>.

Struggle for stagnation. It is not a trivial task to have 2060 Russian GDP at the 2021 level; to this end, TFP is to be improved to at least 0.4% per year. It is only attainable through the trade openness, better quality of institutions, macrostability, improved quality of infrastructure, higher skills and better opportunities to use them, and better business climate

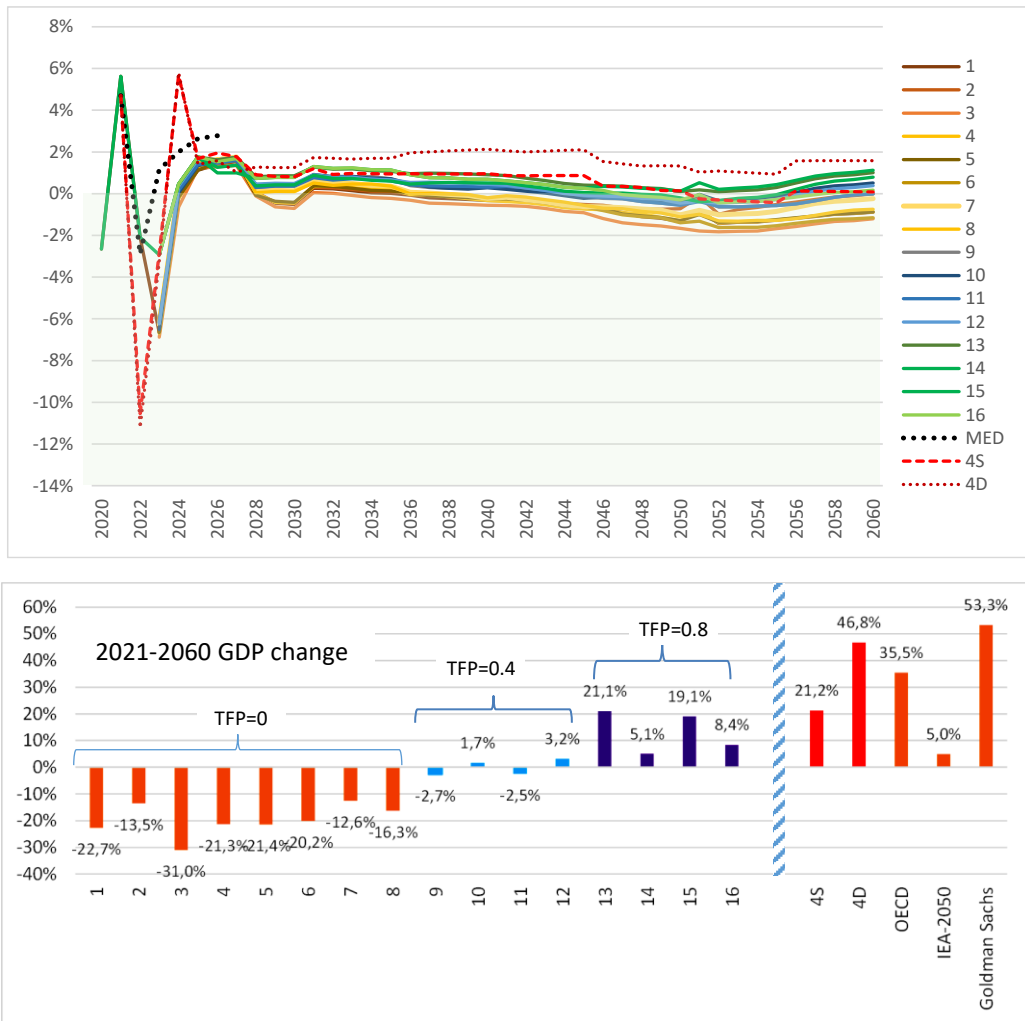
Limits of growth – is there a cap to hit?

Detected ceiling for Russian GDP growth in 2021-2060 is limited to 21%.

Russia's share in global GDP even in this favorable scenario shrinks to 1.4% expressed in PPP and to 0.7% if estimated in exchange rates.

- Such developments would allow it to keep Russian 2060 GDP and NOG GDP close to the 2021 levels.
- Progress towards termination of Russia's military operation in Ukraine would allow for relaxed sanctions and enable Russia to regain some of its lost positions in the global value chains.
- Relaxed or lifted high-tech import sanctions, competition-based incentives to invest in new technologies, and regained access to international financing will improve TFP to 0.4% per year.
- Democratization and competition will develop, as the role of the oil and gas sector and the government sector will be shrinking, and reliance on a wider political and social spectrum will become key for sustaining social stability and inspiring business activity. This would reduce the emigration of qualified workforce and attract skilled professionals from abroad. It will reduce corruption and provide incentives for investment and rewarding based on skills, rather than on loyalty.
- Proactive decarbonization policies in Russia will help to get a market niche in some global regions for a variety of low-carbon products and get access to the hardware and software essential to produce them.
- Growing potential to increase low carbon products/services production will accelerate phasing out obsolete capacities and boost modernization of the remaining assets.
- If Russia fails to bring TFP up from the negative values registered in 2010-2022 to positive values in 2023-2060, then:
 - Russia's per capita GDP may stay unchanged for the next four decades or even decline.
 - Russia's per capita GDP in 2060 will be 65% below the global average, 82-90% below that for advanced economies, 70% of China's and 38% of India's.
 - In 2060, Russia's per capita GDP will be similar to that of Ghana and Ethiopia.
- On this trajectory, Russia will obviously lose its status of a developed country.

Figure 1.1 Growth (decline) rates for Russian GDP: 2020-2060



№	Sanctions	TFP	Employment	Fiscal policy*	Foreign trade policy	Oil and gas export	Oil and gas prices	Carbon price
1	strong	0	low	relaxed	weak import substitution	low	low	low
2	strong	0	low	real 2%		low	low	low
3	strong	0	low	zero deficit		low	low	low
4	strong	0	low	relaxed		low	medium	low
5	strong	0	low	relaxed		low	high	low
6	strong	0	low	relaxed		high	medium	low
7	strong	0	high	relaxed		medium	medium	low
8	strong	0	medium	relaxed		medium	medium	low
9	relaxed	0.4	medium	relaxed	stronger import substitution	medium	medium	low
10	relaxed	0.4	high	relaxed		medium	medium	low
11	relaxed	0.4	medium	relaxed		medium	high	low
12	relaxed	0.4	high	relaxed	stronger import substitution and non-fuel export promotion	high	high	low
13	relaxed	0.8	high	relaxed		high	high	high
14	relaxed	0.8	high	zero deficit		high	high	high
15	relaxed	0.8	high	relaxed		medium	medium	high
16	relaxed	0.8	low	relaxed	medium	medium	high	

Sources: CENef-XXI; Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichok, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060>; IEA. World Energy Outlook. 2022; Goldman Sachs. Daly K and T. Gedminas. Global Economics Paper. The Path to 2075 — Slower Global Growth, But Convergence Remains Intact. 6 December 2022; OECD (2018), GDP long-term forecast (indicator). doi: 10.1787/d927bc18-en (Accessed on 29 March, 2023) [Domestic product - GDP long-term forecast - OECD Data](#). Scenario conditions of the economy of the Russian Federation and basic projection parameters of Russia's social and economic development for 2024 and up to 2025 and 2026. Ministry of economic development of the Russian Federation (economy.gov.ru).

There are no pros in cons. Even if Russia succeeds in bringing TFP up to zero, then any combination of other economic drivers will result in 12-31% decline in 2060 GDP from the 2021 level

- It is quite a challenge for Russia to bring TFP from its negative (-1.2%) value recorded in 2010-2022 even to zero, while the sanctions force both heads of Russian national emblem eagle look East.
- If the sanctions are relaxed, and more access to new technologies becomes available along with more effective import substitution, a higher level of TFP – 0.4% per year – might be attained, and 2060 GDP will be close to the 2021 level.
- If the economy is to show more visible growth, TFP should reach 0.8% per year, and this requires some relaxation of sanctions, effective import substitution, and non-fuel export promotion to the new non-fuel markets.

Steady decline in oil and gas GDP (OG GDP) is one important factor impeding economic growth; it was initially associated with sanctions and energy security considerations and later with the effects of global decarbonization

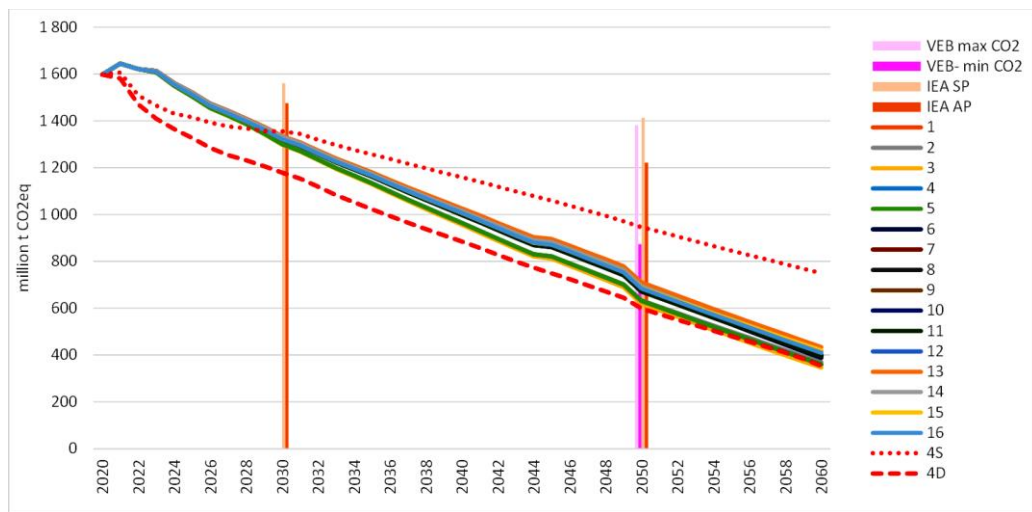
- As the share of OG GDP in GDP declines from 17.4% in 2016-2020 to 5% in 2051-2060, NOG GDP will be increasingly setting the pattern for overall GDP evolution.
- If TFP is at zero, NOG GDP per capita will stagnate to 2060 at the 2021 level, as the expected decline in NOG GDP nearly matches the decline in the population.
- Access to the best available technologies on condition that sanctions are relaxed and democratization and strong competition are promoted, may bring TFP up to the maximum expected 0.8% per year, and so 2060 NOG GDP will be 15-35% above the 2021 level.

The trajectories to attain carbon neutrality by 2060 have changed their shapes

- The assessment made by CENef-XXI in 2022⁴ remains the only research which tested the attainability of Russia's announced carbon neutrality target by 2060.
- In the short-term, the Russian economy demonstrated a better, than expected, resilience to sanctions, and this resulted in a higher level of emissions driven by economic activity, than projected in 2022 (Figure 1.2).
- In the medium-term, hampered access to low carbon technologies delays their uptake and so keeps GHG emissions at higher levels.
- The 2060 carbon neutrality target is still attainable, yet expected energy-related emissions in 2060 will be up to 80 MtCO₂ above the 4D (2022) scenario level. This is how many additional sinks in the LULUCF sector will be required for the 2060 carbon neutrality. However importantly, the decline in carbon absorption in the LULUCF sector accelerated in 2021 (73 Mt CO₂ down), which makes hopes for this sector as a magic pill increasingly delusive.

⁴ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia-s-carbon-neutrality-pathways-to-2060>.

Figure 1.2 Evolution of energy-related GHG emissions



Sources: CENef-XXI.

The forthcoming CENef-XXI’s research “Low carbon technologies in Russia. Present status and perspectives” will show whether Russia will have access to technologies that will enable carbon neutrality by 2060

- The critical condition for dynamic GHG emissions reduction is the availability of low carbon technologies (either domestic, or imported from countries which have not imposed or have lifted sanctions on such technologies supply to Russia).
- This will be the subject of a special research – “Low carbon technologies in Russia. Present status and perspectives” – which will follow later this year with a detailed sector-by-sector and technology-by-technology analysis.

2

Russian economy in 2022: the angle of incidence

2.1 GDP decline in the statistical mist

The Russian statistical agency (Rosstat) reported a 2.1% decline in 2022 Russian GDP.⁵ This is well below the projections made right after Russia had started its military operation in Ukraine: the projections made in March 2022 ranged between -5% and -15%. The country's GDP was expected to drop as a result of the export and import sanctions and of demand reduction effects.⁶ However, in 2022, the Russian economy appeared to be more resilient to sanctions, than expected, and showed a smaller exports loss and partial imports substitution, and the demand was driven up by the militarization of the economy and large oil and gas revenues.

The trust in Rosstat's data on GDP evolution is declining. In 2022, the components of GDP expenditures exceeded GDP outputs by 2.4%, which is the largest ever reported statistical discrepancy. GDP growth rate was revised upward for 2018 by 0.3%, and for 2019 by meaningful 0.7%. In late 2022, Rosstat revised 2021 GDP growth rate to 5.6% from the previous 4.7% estimate. However, it could not provide any convincing explanation for such significant revisions. The 2022 GDP decline was initially expected at 2.9%, then was corrected for 2.5% in late December 2022,⁷ but shrank to just 2.1% in mid-February 2023. In all, some 2.7% was added in revisions to the GDP growth since 2018, which is one third of the GDP growth reported since 2008. The World Bank's estimate of 3.5% decline in the Russian 2022 GDP looks much more robust.⁸

In the recent Rosstat's reports, GDP is split into oil and gas (OG-GDP) and non-oil and gas GDP (NOG-GDP). For 2022, OG-GDP is reported 1.4% up. This is a strange estimate, since crude oil production is reported 1.9% up, refinery outputs 3.2% down, and gas extraction 12% down.⁹ Based on the physical volumes, the evolutions as reported above are only possible, if the contribution of crude oil to OG-GDP is 95%, oil refinery only 2% and natural gas 3%. However, the actual contributions are 57%, 22%, and 21% respectively. With such proportions, the 2022 OG-GDP should be 2.2% lower, and so it is overestimated by 3.6%. According to Rosstat, in 2021, OG-GDP amounted to 17.9% of total GDP. So, the 2022 total GDP is overestimated by 0.64%. Corrected for this gap, the 2022 GDP decline is -2.7%, which is close to the late December estimates (-2.5 to -2.9%).

2022 NOG-GDP was reported 2.7% down. Some growth in gross value added is shown for agriculture (+6.6%) and for public administration and military security (+4.1%). Manufacturing value added is 2.4% down and that for trade is 12.7% down from the 2021 levels. Increased military spending drove GDP up and slowed down the decline in manufacturing. Government consumption in 2022 was 15.6% up, household consumption 10.9% up, and fixed capital formation 20% up, mostly driven by government investment in the infrastructure construction.

⁵ Rosstat. 2023. Social and economic situation in Russia. 2022. [Rosstat — Statistics \(rosstat.gov.ru\)](https://rosstat.gov.ru).

⁶ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality-pathways-to-2060>.

⁷ https://www.rbc.ru/rbcfreenews/639b119d9a794750cba22383?from=article_body.

⁸ International Bank for Reconstruction and Development / The World Bank. 2023. Global Economic Prospects. January 2023.

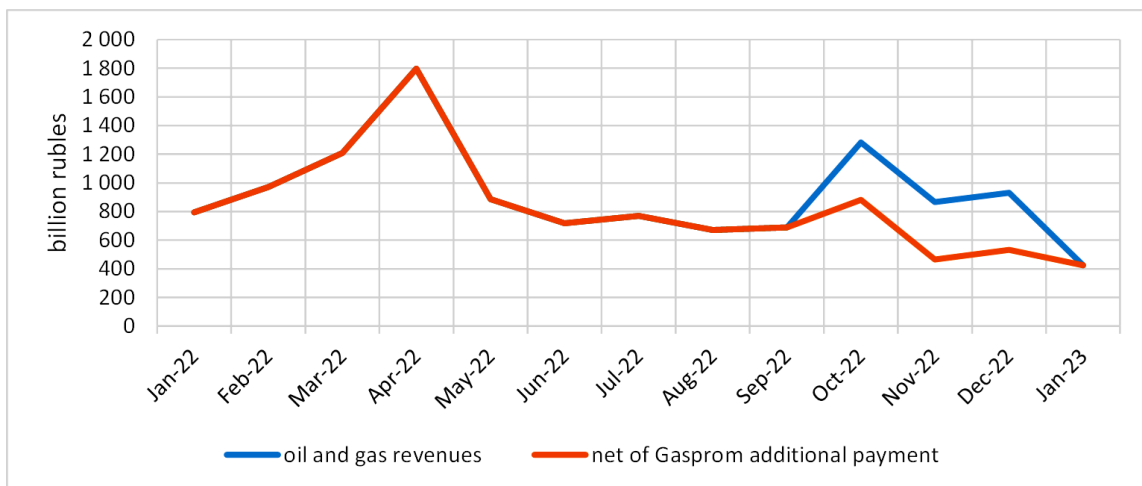
⁹ [Russian fuel and energy sector 2022: challenges, performance, and perspectives – Energy Policy \(energypolicy.ru\)](https://energypolicy.ru).

2.2 Federal and consolidated budget: the largest deficit since 1992¹⁰

In 2022, federal budget revenues amounted to 27 825 billion rubles and so were 10% above the 2021 level. This growth was exclusively due to the fact that oil and gas revenues skyrocketed 28% up and reached 11 586 billion rubles. Non-oil and gas revenues amounted to 16 239 billion rubles (frozen at the 2021 level).¹¹ With an account of the inflation they were 14% below the 2021 level. Historically, non-oil and gas revenues have always shown a significant correlation with NOG-GDP. However, while the former (in real terms) are now 14% down, and the latter only 2.7% down, it is safe to say that the accuracy of real NOG-GDP decline, as reported for 2022, is questionable.

Additional oil and gas revenues were the major driver for the aggregated demand growth in 2022. However, they peaked in April 2022 and have been scaling down ever since (Figure 2.1). In order to balance the financial demand with the revenues, the government requested Gazprom to donate additional 1,2 trillion rubles to the federal budget during October-December 2022. Had it not been for this additional Gazprom donation, the federal budget would have run a 4.5 trillion rubles deficit (amounting to 3% of GDP), rather than 3.3 trillion rubles deficit, as reported by the RF Ministry of Finance.

Figure 2.1 Oil and gas contribution to the consolidated budget



Source: [RF Ministry of Finance \(minfin.gov.ru\)](http://minfin.gov.ru).

In November 2022–January 2023, average monthly oil and gas revenues equaled 475 billion rubles. If they could stay at this level over the whole 2023, they would amount to 5 694 billion rubles, which is only half of the 2022 level nominally and -40% in real terms. If 2023 federal budget expenditures are to stay at the 2022 level (31 131 billion rubles), then additional 25 437 billion rubles will be required. January-February 2023 oil and gas government revenues were 0.95 billion rubles, or 46% below the January-February 2022 level.¹²

To fill the gap, the government is already trying to collect 300 billion rubles (initially proposed as ‘voluntary contributions’) from large businesses, who benefitted in 2022 from windfall profits from the exports of many basic materials, the prices of which have gone through the roof. Just like pointed out by the authors back in 2022, the shortage of revenues is forcing the government to

¹⁰ Except 2020 COVID year.

¹¹ [Russian Ministry of Finance \(minfin.gov.ru\)](http://minfin.gov.ru).

¹² [Минфин России \(minfin.gov.ru\)](http://minfin.gov.ru)

negotiate with the business community.¹³ The government is hoping to get about 600 billion rubles from the oil industry via a tax system reform. Even if additional ‘voluntary’ and mandatory donations from the large businesses are successful, it is unlikely that 2023 oil and gas and non-oil and gas revenues will be much above the 2022 level. Therefore, the shortage will need to be covered through the devaluation of ruble, the spending from the accumulated reserve fund (Sovereign Wealth Fund), printing money, and borrowings. The ruble/dollar exchange rate in November 2022–April 2023 alone skyrocketed from 61 to 82 as a result of the deteriorating foreign trade balance. In mid-April 2023, it was already much beyond the February 2023 consensus forecast from the Bank of Russia’s pool of experts – 72 rubles/\$ in 2023.¹⁴

By the end of November 2022, there was a consolidated budget surplus of 1 645 billion rubles. However, by the end of 2022, it turned into a 2,108 billion rubles deficit (1.4% of GDP). By February 1, 2023, the Sovereign Wealth Fund equaled US\$ 155.3 billion, or 10 808 billion rubles (7.2% of GDP).¹⁵ If the budget deficit stays between 3 and 6 billion rubles in the coming years, it will be exhausted in 2 or 3 years. In January-March 2023, federal budget deficit was 2.4 billion rubles, or 45%. The whole 2023 budget deficit was approved by law at 2.9 billion rubles. Public procurement over these 3 months amounted to 2.5 billion rubles, or half of the whole 2023-year plan. It exceeded the January-February 2022 level by 1.4 billion rubles and contributed 54% to the budget deficit. Budget revenues reduction was responsible for 40% of the deficit.

2.3 Inflation – back to double digits

In 2016-2021, Russia managed to limit the consumer inflation to single digits; in 2022, it was 14%. GDP deflator was 14.3% up, industrial producers price index 11.4% up, for investment goods 15.1% up, and transport tariffs were 14.7% up. The inflation potential was partly mitigated by a strong ruble and more abundant domestic supply (as some foreign markets were blocked by the sanctions) coupled with declining domestic demand. The situation is expected to deteriorate substantially in 2023, as the ruble is getting weaker and the monetary base is inflated to meet the budget expenditures.

2.4 Industrial production – sanctions on Russia’s basic materials exports work

After years of growth (or relative stability) in the basic materials production in Russia, February 2022 marked the beginning of the era of decline for many of them. Growing materials use for military purposes and the announced “turn to the East” failed to block the negative effects of the sanctions (Figure 2.2). Rosstat reports 2022 industrial production index at only 0.6% below the 2021 level. For mining and quarrying, it is plus 0.8%, while for manufacturing minus 1.3%.

Much more severe negative effects are detected for the basic materials under sanctions. Cardboard and paper production are 3.1% down (16.7% decline in December 2022 compared to December 2021); ammonia is 14.4% down (-13.7%); fertilizers 11.3% down (-9.9%); plastics 7.3% down (-12.4%); synthetic rubber¹⁶ 12% down (-29.2%); cement 1.7% up (14.3%); pig iron 4% up (6.2%); rolled steel 8.1% up (15.9%). Primary aluminium (not under sanctions) showed 18.1% growth (+27.3%). Australia was the only government to impose sanctions on Russia's aluminium

¹³ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichok, A. Lunin, I. Govor, 2022. Russia’s carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality-pathways-to-2060>.

¹³ https://www.rbc.ru/rbcfreenews/639b119d9a794750cba22383?from=article_body.

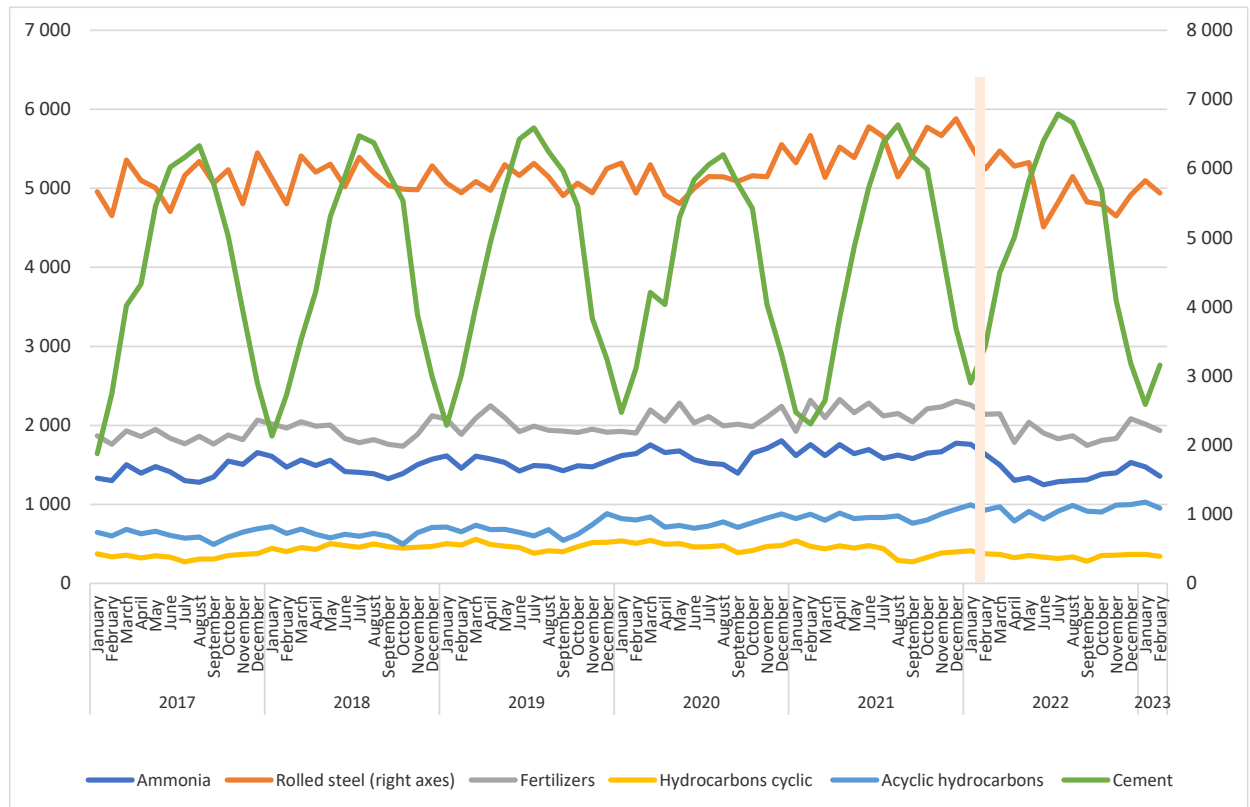
¹⁴ [Macroeconomic Survey by Russia’s Central Bank | Russia’s Central Bank \(cbr.ru\)](#).

¹⁵ [RF Ministry of Finance \(minfin.gov.ru\)](#).

¹⁶ EU imports of synthetic rubber will be banned only from mid-2024. However, in 2022 it halved from 500 thousand tons reported for 2021 (one third of total production).

industry. RUSAL no longer publishes its production data but, according to some estimates, it has increased production despite the disruptions in the raw materials supply chain.¹⁷

Figure 2.2 Monthly basic materials production in Russia in 2017-2022 (1000 t)



Source: Bashmakov I., M. Dzedzichok, A. Myshak, V. Bashmakov. Sanctions and CBAM: Implications for the Russian industry. CENef-XXI. December 2022. Based on EMISS, Rosstat. Downloaded December 22, 2022.

Comparing February 2022 to February 2021 output of sanctioned basic materials, one can see that it has shown a 10% or even a larger drop.

2.5 Foreign trade: US\$ 100 billion additional net income

The results of Russian 2022 foreign trade have confirmed the 1-year-old conclusion, that energy price growth would overcompensate the sanctions-caused revenue loss.¹⁸ In 2022, the RF Central Bank reported the balance of goods and services at US\$ 282.3 billion, and the balance of current accounts at US\$ 233 billion (see Table 2.1).

¹⁷ [Column: Russian supply uncertainty weighs on aluminium market | Reuters.](#)

¹⁸ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichok, A. Lunin, I. Govor, 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060>.

Table 2.1 Russian balance of current accounts 2018-2022

	2018	2019	2020	2021	2022
Balance of current accounts	115,7	65,7	35,4	122,3	233,0
Balance of goods and services	165,0	129,4	76,7	170,1	282,3
Trade balance	195,1	165,8	93,4	190,3	308,0
<i>Exports</i>	443,9	469,2	294,1	481,8	588,3
Oil and Gas	262,5	238,6	150,4	244,6	335,1
Crude oil	129,2	122,2	72,6	111,0	150,1
Petroleum products	78,2	67,0	45,4	69,9	79,2
Natural gas	49,8	41,5	25,8	56,4	88,1
LNG	5,3	7,9	6,7	7,3	17,8
Other	181,4	181,2	183,1	249,8	253,2
<i>Imports</i>	248,9	253,9	240,1	304,0	280,4
Balance of services	-30,1	-36,5	-16,8	-20,2	-22,2
<i>Exports</i>	64,6	62,0	48,0	55,7	48,5
<i>Imports</i>	94,7	98,5	64,7	75,9	70,7
Balance of salaries	-3,3	-3,6	-1,0	0,2	-2,5
Balance of investment incomes	-37,1	-50,0	-34,1	-43,3	-41,9
Balance of rent	0,1	0,1	0,1	0,1	0,0
Balance of secondary incomes	-8,9	-10,2	-6,3	-4,8	-8,4
Capital operation account	-1,1	-0,3	-0,1	0,1	-45,8

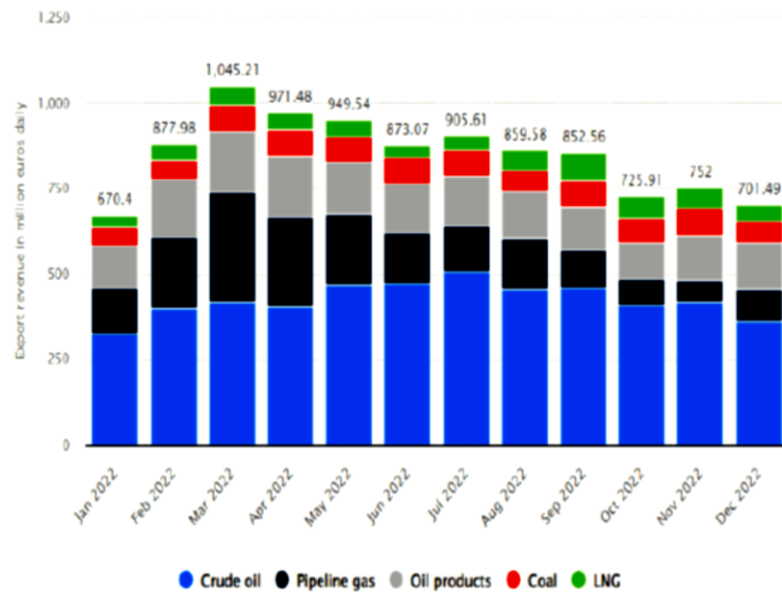
*estimates based on listed sources.

Source: Estimated by CENef-XXI based on the RF Central Bank [Foreign Trade Statistics | RF Central Bank \(cbr.ru\)](#); Russian ministry of economic development. 2022. Projections for 2023 and the 2024-2025 period as adopted at the RF Government meeting on September 22, 2022 (Minutes # 31); [Russia fossil fuel exports 2022 | Statista](#) Published by Statista Research Department, Accessed February 21, 2023; Russian foreign trade tracker. Publication date: February 17, 2023. [Russian foreign trade tracker \(bruegel.org\)](#). Federal Custom Service <https://customs.gov.ru/statistic/vneshn-torg/vneshn-torg-countries>

In 2022, oil and gas exports additionally generated US\$ 98 billion, but under the sanctions oil&and gas revenues are on a declining trend, and December 2022 values got back to the January 2022 levels (Figure 2.3 and 2.4).

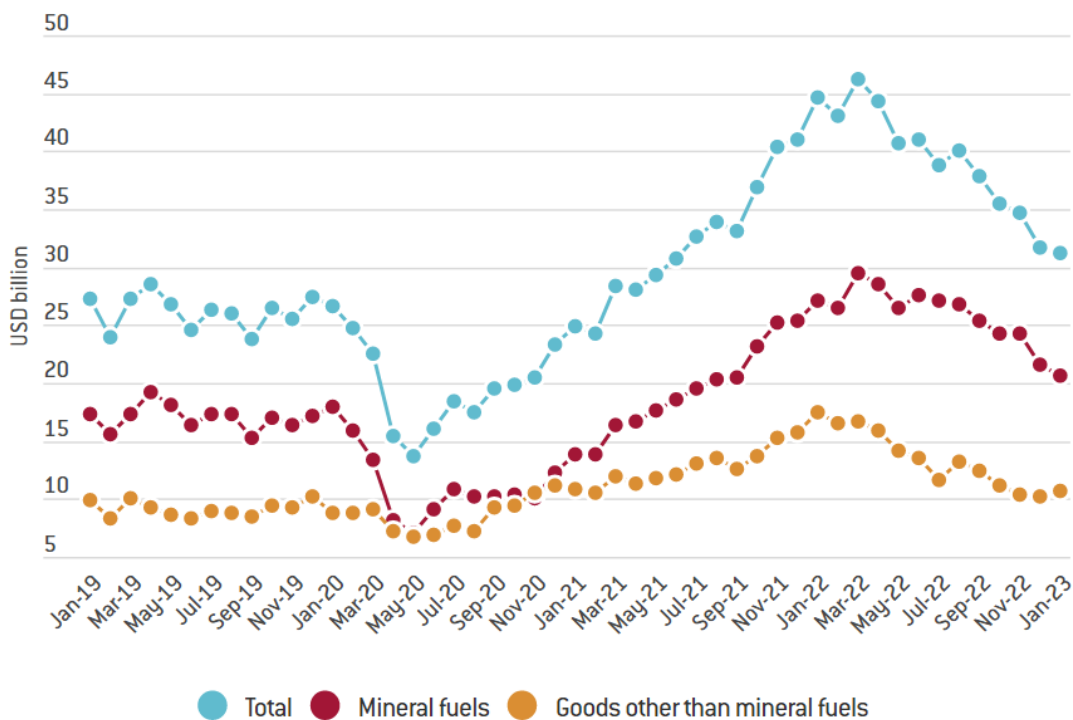
Therefore, despite the sanctions, foreign trade additionally generated more than US\$ 100 billion. After February 24, 2022, the RF Customs Service and the RF Central Bank for a long period ceased to publish exports and imports data by products and destination. Aggregated foreign trade data were only released for March 2022 (with no fuels export breakdown by fuel types). The data in Table 2.1 are from multiple sources and allow for volume and price estimates. Trade balance surplus was 74% up. Exports of goods were US\$ 97 billion above the 2021 level. Oil and gas exports were up by US\$ 107 billion, while non-oil and gas exports dropped and can no longer offset the recent decline in oil and gas exports (Figure 2.4). Substantial growth in export prices for many products allowed it to avoid a deeper drop from the 2021 level. However, prices for crude materials and food are currently declining.

Figure 2.3 Estimated revenues from Russian fossil fuel exports (million € per day)



Source: [Russia fossil fuel exports 2022 | Statista.](#)

Figure 2.4 Russian exports to 34 major countries



Source: Bruegel based on Eurostat, General Administration of Customs - People's Republic of China, United States Census Bureau, Korea Customs Service, Ministry of Finance - Trade Statistics of Japan, Ministry of Commerce and Industry - Government of India, ONS (UK), Turkish Statistical Institute. Note: The 34 countries comprise the 27 European Union countries, China, the United States, South Korea, Japan, India, the United Kingdom and Turkey, which together accounted for around 75% of both Russian exports and imports in 2019.

Source: [Russian foreign trade tracker \(bruegel.org\).](#)

The declining imports used to support the ruble and limit the effectiveness of expanding exports. In real terms, the imports declined by meaningful 22%, forcing Russian businesses to reshape their

supply chains, share their revenues with intermediaries and transport companies, consent to more complicated and costly logistics, and finally, to go for smaller-scale, lower-quality, and more expensive imports (even with a strong ruble). As trade routes change and become longer, logistics and insurance become more expensive, and the deficit of the balance of services in 2022 was US\$ 22 billion.

2.6 Last quarter of 2022 as a scratch of the 2023 economic picture

It is true, that in 2022 the Russian economy demonstrated some resilience to the sanctions. This was mostly enabled by abundant oil and gas revenues. There is no reason to believe that this resilience will persist into 2023. The 10 sanctions packages have eventually gained momentum and provided a significant impact on the Russian economy, especially in the last quarter of 2022. Late 2022 and early 2023 have heralded the problems Russia is expected to face later in 2023. Major expected effects of, and unwise reactions to, the sanctions include:

- Decline in oil and gas revenues caused by the ban on petroleum products export to the EU; oil and petroleum products price cap; not sanctions-driven decline in gas supply; stabilization of, or decline in, energy prices.
- With a limited ability to increase non-oil and gas exports and lower expected prices for traditional Russian exports, deterioration of the Russian trade balance will substantially weaken the ruble making imports more expensive and so less attractive, while the Russian businesses will have a very limited ability to substitute high-tech imports;
- Consolidated and federal budgets will face severe deficits, and the attempts to improve the situation will be accelerating the inflation. Using the resources of the Sovereign Wealth Fund may mitigate the 2023 financial problems at the price of having to deal with a very unstable situation beyond this horizon. Fiscal pressure on the non-oil and gas businesses will act to further undermine its profitability and investment potential;
- With the military priorities in mind, very limited resources will be available to finance social programmes and stimulate the domestic economy. Therefore, government investments along with the total investments in real terms will shrink enlarging the angle of incidence;
- The declining trend in private consumption in real terms, which started back in 2008, will persist. The government will only have resources to partially mitigate the aggravating decline in the standard of living;
- The continuing decline in the elements of aggregated demand, such as investments and private consumption, will bring down the demand for new buildings, machinery, and appliances. The militarization of the economy may only partly mitigate these effects, especially with an account of the problems related to Russian supplies to the foreign markets. All this will be pushing the industry into yet deeper recession, with production at 10-30% below the 2021 levels;
- Even if Russia is able to maintain its 2023 oil production at the maximum possible level, smaller gas and petroleum products export and production will push OG GDP down;
- In addition, NOG GDP will be declining, as foreign and domestic demand shrinks and the country is facing problems related to tuning alternative foreign supply chains at affordable cost;
- Trying to cover-up these effects, the government may want to add more statistical mist.

3

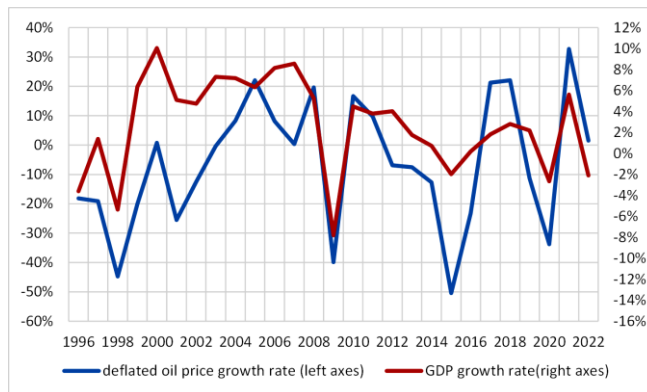
Russia's "operation" in Ukraine: implications for Russian imports and exports in 2022

3.1 Oil and gas exports as a basis for economic or political superpower

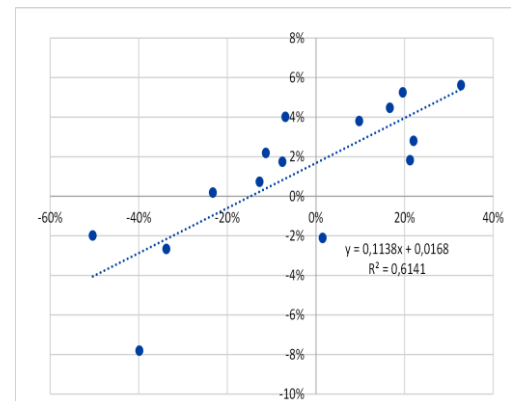
Foreign trade is exceptionally important for the evolution of Russian economy and political system. The 2021-2022 exports of goods contributed 27-28% to the Russian GDP. Low oil prices over 1985-1992 provoked the collapse of the Soviet Union. In 1998, low oil prices determined an economic crash followed by a political crisis, which was presented to the society as a failure of the market economy and democratic reforms. The first attempts to reverse these reforms were launched in 1999. However, delayed positive effects of the market reforms maintained the fast growth of GDP back in 1999-2008. A return to the command economy, which was launched in the early 2000's, slowed down the decoupling of economic growth and oil and gas exports after 2008 and even resulted in a regress on this path, bringing along several crises, which were just as severe as the one in 1998.

There is a strong correlation between the rates of Russian GDP evolution and real oil price fluctuations. This correlation was even stronger in 2008-2022, than in 1995-2008. After 2008, every 10% fluctuation in the real oil price resulted on average in 1.1% change in GDP (Figure 3.1). This means, that economic growth is not only driven by high oil prices, but it requires continuously growing oil prices, with the growth rate outpacing the inflation. Another conclusion is that physical volumes of oil and gas exports were a secondary factor; restrictions aiming to control export oil *prices* are likely to be more effective in terms of stopping Russian economic growth, than those aimed to control export volumes.

Figure 3.1 Annual GDP growth rates and real export oil price (corrected for GDP deflator)



GDP growth rates and real export oil price



GDP growth rate as a function of real export oil price growth rates (2008-2022)

Source: calculated by authors.

Partial re-nationalization of oil and gas assets in Russia and establishing control over the growing inflow of oil and gas dollars in the first decade of 21st century increased the economic might of the state and worked to drive its attention away from the mobilization, effective upscaling and deployment of internal growth factors and supplies. By 2005-2006, total control over cash flows in the oil and gas sector had been established, and this allowed the government to become economically independent from the businesses and destroy the democracy in the country. Economic independence not only gave the government the illusion of unlimited power and infallibility, but also tempted them to avoid taking decisions which required political responsibility. It also contributed to the corruption and gave momentum to apathy and mistrust in the society and

to the dominance of short-term investment decisions in the commercial sector. All of the above factors worked to hamper urgent socio-economic reforms, that were essential to diversify the economy, yet offered no new (non-fossil fuels-based) drivers for the economic growth. Control over the oil and gas sector made the “bureaucratic capitalist” elites go for investments which aimed to strengthen the reputation of the government, enhance national prestige and create a misleading impression of rapid economic growth. The willingness and pressure to diversify economy and to promote competition, localization and innovations was weak. Almost every oil exporting economy goes through this stage, which is characterized by a serious contradiction, namely: substantial reliance on the oil and gas revenues, which are not stable "money earned at home", but unreliable windfall profits.¹⁹

In oil-exporting economies, classical schemes of economic development are largely modified, because the oil and gas sector is largely replacing the manufacturing sector in safeguarding (mostly via imports) the supply of machinery, consumer and intermediate goods.²⁰ If Russia had used its oil and gas dollars to diversify the economy and develop new drivers for economic growth, it would have had a chance to get a meaningful, if not super, global economic status. However, in 2000-2022, ecstatic with the high oil and gas prices following 15 years of their stagnation (1985-2000), the government missed this opportunity. The once set target of doubling Russian GDP in 10 years following 2003 was not achieved.

Kudrin and Gurvich called such development model “the model of imported growth”.²¹ However, when oil prices are declining, it transforms into a “model of imported crises”.²² Development along this trajectory brought Russia through multiple painful crises (1998, 2009, 2015-2016, 2020 and 2022). Total associated GDP losses amount to 21%, or to 1% per year on average. Thus, the oil and gas sector was only a temporal "locomotive" of growth, which would often reverse, and so the economy hasn't gone far. During 2008-2022, with the back-and-forth dynamics, the Russian GDP showed practically no growth (just 0.3-0.5% per year), and Russia was among the slowest growing G20 economies. Even before "someone else's money" ran out, the engine of the resource-based economy had already stalled.²³ In other words, the policy targeted to become an economic superpower failed, and Russia didn't even manage to maintain its share in the global GDP: according to WDI data; after 2008, Russia lost about 1% of its share (in 2017 PPP prices).

In 2005-2006, the scale of Russian energy exports – about 0.7 Gtoe annually in the previous years (5% of global energy use) – determined the concept of an “energy superpower”.²⁴ With this concept, political factors ousted social, technical, and economic concerns, which were reduced to the role of annoying "natural constraints" that had to be taken into account to a certain (small) degree while making important political decisions and building up the Great Russia. Flexible oil markets and lack of spare oil production capacities in Russia did not let oil become a good means of building an energy superpower. While pipeline gas yielded much smaller export revenues than oil, physically it strongly connected most European consumers (including Ukraine, Belarus, and

¹⁹ Bashmakov I. Non-Oil-and-Gas GDP as an Indicator of Economic Dynamics in Russia. *Voprosy Ekonomiki*. 2006;(5):78-86. (In Russ.) <https://doi.org/10.32609/0042-8736-2006-5-78-86>.

²⁰ Bashmakov I. Specificities of expanded reproduction in oil-producing economies. // *World Economy and International Relations*. 1983. № 4. (In Russian).

²¹ Kudrin A., Gurvich E. (2014). A new growth model for the Russian economy. *Voprosy Ekonomiki*, No. 12, pp. 4—36. (In Russian).]

²² Bashmakov I.A. World energy: Myths of the past and lessons of the future. *Voprosy Ekonomiki*. 2018;(4):49-75. (In Russ.) <https://doi.org/10.32609/0042-8736-2018-4-49-75>.

²³ Manevitch V. (2017). Alternative strategies of overcoming stagnation and a “new growth model” of the Russian economy. *Voprosy Ekonomiki*, No. 8, pp. 121—137. (In Russian); Bashmakov I. A. World energy: Myths of the past and lessons of the future. *Voprosy Ekonomiki*. 2018;(4):49-75. (In Russ.) <https://doi.org/10.32609/0042-8736-2018-4-49-75>.

²⁴ [Energy Superpower — wikipedia.org](https://en.wikipedia.org/wiki/Energy_Superpower).

Turkey) to Russian gas supply. After 2004, the gas “superpower” was tested in a few local “gas wars” with Ukraine and Belarus. In 2021, it was the EU’s turn.

3.2 Exports go East

In 2021, fuels and basic materials were responsible for 80% of Russian goods exports. Geographically, the trade vector was west-bound (Table 3.1). EU, US and UK provided markets for nearly half of total Russian exports: 50% for crude oil; 61% for petroleum products; 72% for natural gas; 48% for iron ore; 65% for chemicals and 37% for metals. The list of restricted products includes oil; petroleum products; coal and other solid fossil fuels; steel, steel products and iron; gold; jewelry; cement; asphalt; wood; paper; synthetic rubber; and plastics.²⁵ In 2021, exports of these products to the EU, US and UK, taken together, were above US\$ 115 billion, or nearly a quarter of the total 2021 exports. The 2022 sanctions forced Russia to direct its trade flows to the East. China, India and Turkey, taken together, contributed 21%, or US\$ 103 billion, to Russia’s 2021 export revenues, which is below the sanctions-affected exports. In other words, the “turn to the East” goal is extremely challenging.

Table 3.1 Structure of Russian fuel and basic materials exports in 2021 (US\$ billion)

	Total	European Union	USA	Great Britain	China	India	Turkey	ROW
Total	493.3	188.1	17.5	22.3	68.0	9.1	26.5	161.8
	100%	38%	4%	5%	14%	2%	5%	33%
Coal	18.4	3.7		0.2	4.6	0.5	0.9	8.6
	100%	20%		1%	25%	3%	5%	46%
Crude oil	110.1	51.0	3.7	1.4	35.4	0.9	2.1	15.6
	100%	46%	3%	1%	32%	1%	2%	14%
Petroleum products	69.9	36.6	5.0	1.2	3.9	0.8	3.8	18.6
	100%	52%	7%	2%	6%	1%	5%	27%
Natural gas	65.2	46.3		0.7	2.8		6.9	8.5
	100%	71%		1%	4%		11%	13%
Iron ores and concentrates	3.8	1.7		0.1	1.2		0.3	0.5
	100%	45%		3%	32%		7%	12%
Chemicals	80.2	50.4	1.1	0.8	4.0	0.7	7.1	16.1
	100%	63%	1%	1%	5%	1%	9%	20%
Wood, pulp and paper	10.8	2.6	0.4	0.3	4.5	0.1	0.1	2.8
	100%	24%	4%	2%	42%	1%	1%	26%
Metals	31.7	10.1	1.7	0.1	2.5	0.1	4.7	12.5
	100%	32%	5%	0%	8%	0%	15%	39%

Source: Russian Customs Service.

In 2022, Russian customs statistics was hidden for about a year. In March 2022, some of the data were released with only partial disaggregation by product and no regional split. Some think tanks across the world started to assemble data obtained from major Russia’s trade partners. Bruegel is one such think tank, who managed to collect data from 34 major countries (Table 3.2). Aggregated trends for these countries are in line with the overall trends in foreign trade presented in Chapter 2. Total exports for 34 countries were up by US\$ 95 billion (US\$ 98 billion for all countries), fuel exports by US\$ 84 billion (US\$ 115 billion for all countries), and other goods by US\$ 11 billion (-US\$ 17 billion for all countries). For 3 trade partners – the US, UK and South Korea, which are currently referred to by the Russian authorities as “non-friendly countries” – all of the items listed in Table 3.1 show a substantial decline. The EU and Japan substantially cut their non-fuel imports

²⁵ [EU sanctions against Russia explained - Consilium \(europa.eu\)](https://www.consilium.europa.eu/en/press/press-releases/2022/03/22-eu-sanctions-against-russia/).

– metals, fertilizers, other chemicals and crude materials – but were not able to cut their payments for fuel imports.

Table 3.2 Russian exports to all countries and to 34 largest economies (US\$ billion)

Country	Goods	2019	2020	2021	2022	Increment in 2022
All countries*	Total	424.63	338.18	493.10	591.46	98.36
	Mineral fuels	265.02	176.42	268.81	383.73	114.93
	Goods other than mineral fuels	159.60	161.77	224.29	207.73	-16.56
34 countries*	Total	313.88	237.97	383.73	478.14	94.41
	Mineral fuels	213.62	139.80	239.97	345.28	105.31
	Goods other than mineral fuels	100.26	98.24	143.73	132.88	-10.85
EU27	Total	162.35	108.00	192.77	215.99	23.22
	Mineral fuels	111.61	68.12	122.45	156.80	34.35
	Goods other than mineral fuels	50.71	39.88	70.32	59.21	-11.11
China	Total	60.25	57.10	78.37	112.22	33.85
	Mineral fuels	41.86	33.28	52.68	83.45	30.77
	Goods other than mineral fuels	18.43	23.81	25.66	28.76	3.10
US	Total	22.29	16.88	29.64	14.45	-15.19
	Mineral fuels	13.23	8.92	17.50	5.13	-12.37
	Goods other than mineral fuels	9.05	8.00	12.14	9.30	-2.84
South Korea	Total	14.56	10.65	17.34	14.81	-2.53
	Mineral fuels	11.76	7.88	13.21	11.17	-2.04
	Goods other than mineral fuels	2.82	2.76	4.13	3.65	-0.48
Japan	Total	14.30	10.71	14.06	15.14	1.08
	Mineral fuels	9.97	6.38	8.64	10.36	1.72
	Goods other than mineral fuels	4.31	4.35	5.41	4.80	-0.61
India	Total	6.25	5.94	8.24	39.93	31.69
	Mineral fuels	2.90	2.05	4.21	33.31	29.10
	Goods other than mineral fuels	3.36	3.90	4.03	6.62	2.59
UK	Total	10.77	10.89	14.35	6.74	-7.61
	Mineral fuels	7.71	4.87	7.00	3.25	-3.75
	Goods other than mineral fuels	3.05	6.04	7.36	3.49	-3.87
Turkey**	Total	23.11	17.80	28.96	58.86	29.90
	Mineral fuels	14.58	8.30	14.28	41.81	27.53
	Goods other than mineral fuels	8.53	9.50	14.68	17.05	2.37

* Russian Customs Service.

** data from Russian foreign trade tracker present incorrect split by product groups for Turkey. Turkey's statistics was used to fix the problem. 34 countries totals were corrected accordingly.

Source: Russian Customs Service <https://customs.gov.ru/statistic/vneshn-torg/vneshn-torg-countries>; Russian foreign trade tracker. Publishing date: February 17, 2023; Turkey. [Foreign Trade Statistics \(General Trade System\)](https://iz.tuik.gov.tr/#/showcase/SC-7B95E2B859DFO5U?token=40f83e29ec7dd20aee6e66f5ca9072e82d5b9627) database <https://iz.tuik.gov.tr/#/showcase/SC-7B95E2B859DFO5U?token=40f83e29ec7dd20aee6e66f5ca9072e82d5b9627>.

In 2022, Russia's "turn-to-the-East" policy favoured trade partners, such as China (+US\$ 34 billion, or +43%), India (+US\$ 32 billion, or about 5-fold growth), and Turkey (+US\$ 30 billion, or more than double growth). These 3 countries became markets for additional

US\$ 96 billion-worth exports, which is about equal to the whole additional export registered in 2022. All of them were mostly additional markets for Russian fuels sold at a discount.

3.3 Fossil fuels exports

In 2022, Russian exports of goods was about US\$ 100 billion above the 2021 level, and all this increment was generated by additional oil and gas export revenues (see Chapter 2). Crude oil exports were up from 230 to 242 Mt, while petroleum products exports were nearly stable at 144 Mt, so the Russian oil business demonstrated an impressive capacity to quickly adjust to the new market conditions by increasing its petroleum products export to China and India. However, pipeline gas was not so flexible, so its 2022 exports were substantially down from 204.4 bcm in 2021 to 138.7 bcm (65.7 bcm reduction). LNG exports grew up by 8% to 45.7 bcm. Total gas exports were 25% down – from 246.6 to 184.4 bcm.²⁶ Coal exports were 7.5% down to 211 Mt.

Table 3.3 Russian revenues from fossil fuels exports to the US, EU and UK (US\$ billion)

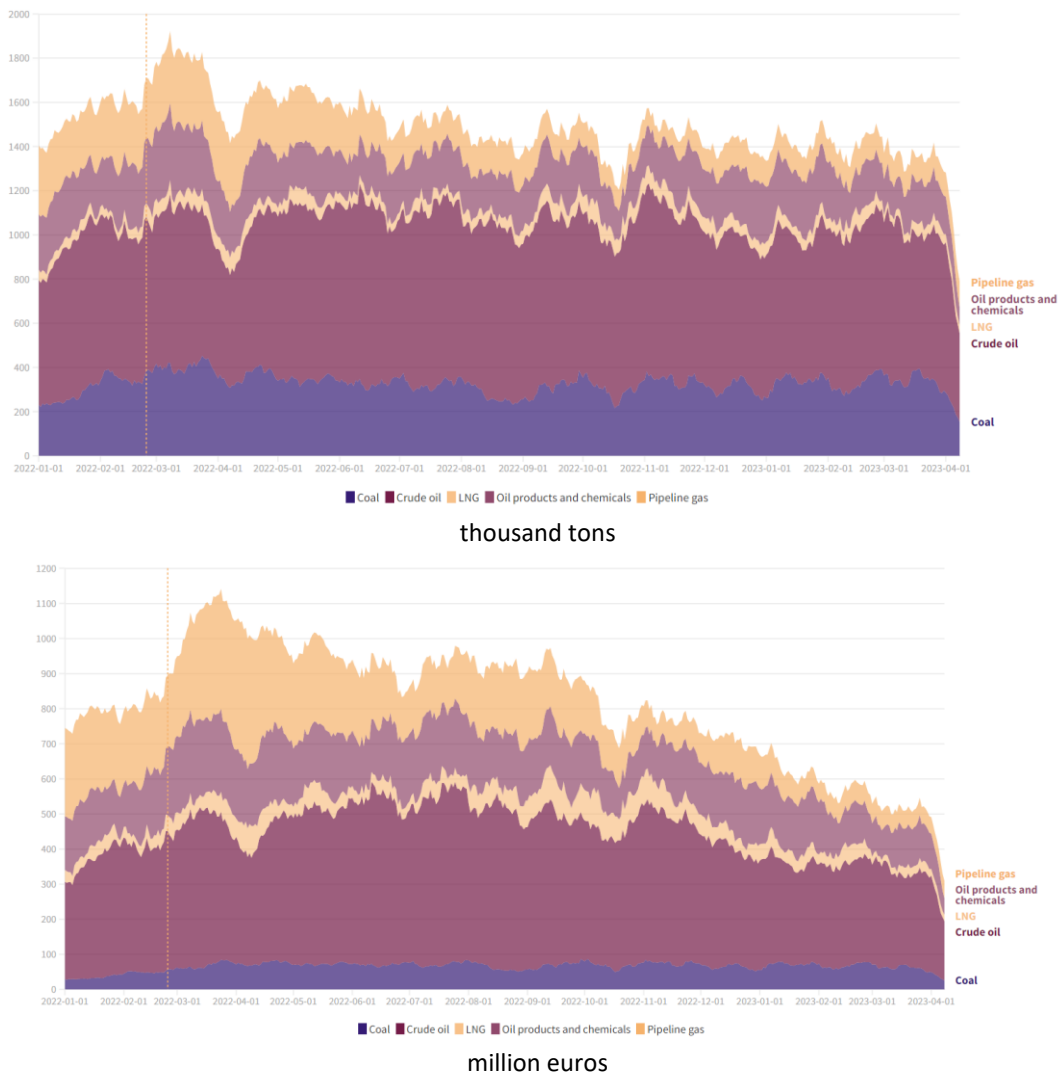
Country	Fuel	2019	2020	2021	2022
US	Coal	0.01	0.03	0.04	0.00
	Petroleum products	13.16	8.89	17.45	5.10
	Gas	0.05	0.00	0.00	0.03
	Total	13.22	8.92	17.49	5.13
EU27	Coal	5.16	3.32	6.55	6.63
	Petroleum products	90.26	54.92	86.99	98.01
	Gas	15.50	9.65	27.91	51.39
	Total	110.91	67.89	121.46	156.03
UK	Coal	0.23	0.12	0.25	0.25
	Petroleum products	7.17	4.24	5.42	2.40
	Gas	0.33	0.51	1.32	0.62
	Total	7.72	4.87	6.99	3.27
US+EU+UK	Coal	5.40	3.47	6.84	6.88
	Petroleum products	110.58	68.05	109.86	105.52
	Gas	15.88	10.16	29.23	52.04
	Total	131.85	81.67	145.94	164.43

Source: Russian foreign trade tracker. Publishing date: February 17, 2023. [Russian foreign trade tracker \(bruegel.org\)](https://bruegel.org/russian-foreign-trade-tracker/).

Russia's fuel export revenues were largely driven by prices, while physical export volumes were relatively stable across the whole 2022, except for natural gas (Figure 3.2). An abrupt reduction is only observed in 2023 and is associated with the crude oil and petroleum products export restrictions, which halved Russia's export revenues compared to the March-April 2022 peak. The US and UK managed to substantially reduce their spending on Russian fuel imports, while the EU failed to do so for any fossil fuel.

²⁶ A. Novak. Russian energy sector: challenges, results, and perspectives. 13.02.2023. [Russian energy sector 2022: challenges, results, and perspectives – The Energy Policy](https://www.bruegel.org/insights/russian-energy-sector-2022-challenges-results-and-perspectives).

Figure 3.2 Russian daily fossil fuels exports to 34 major countries by fuels (14-day moving average)

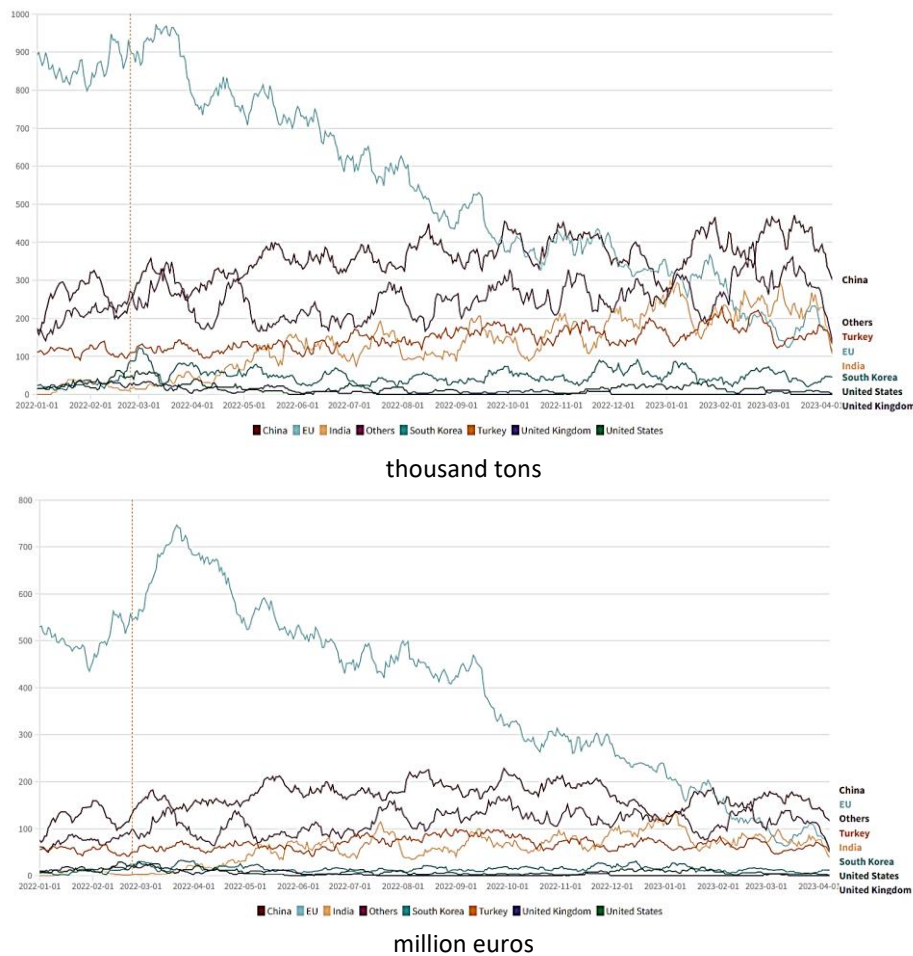


Source: [Russia Fossil Tracker – Russia's fossil fuels revenues since February 24, 2022](#)

Exports to the US, UK, and South Korea were relatively small across the whole 2022. Exports to the EU substantially dropped, while exports to China, India, and Turkey were up (Figure 3.3). The loss of revenues from the EU after March 2022 was only partly mitigated by the growing exports to China, India, and Turkey, while total fossil fuel exports dropped to the September 2021 level. In 2022, fossil fuel exports to China were US\$ 31 billion up, to India US\$ 29 billion up, to Turkey US\$ 28 billion up. Since the early 2023, both physical and monetary balances of these geographical drivers became negative.

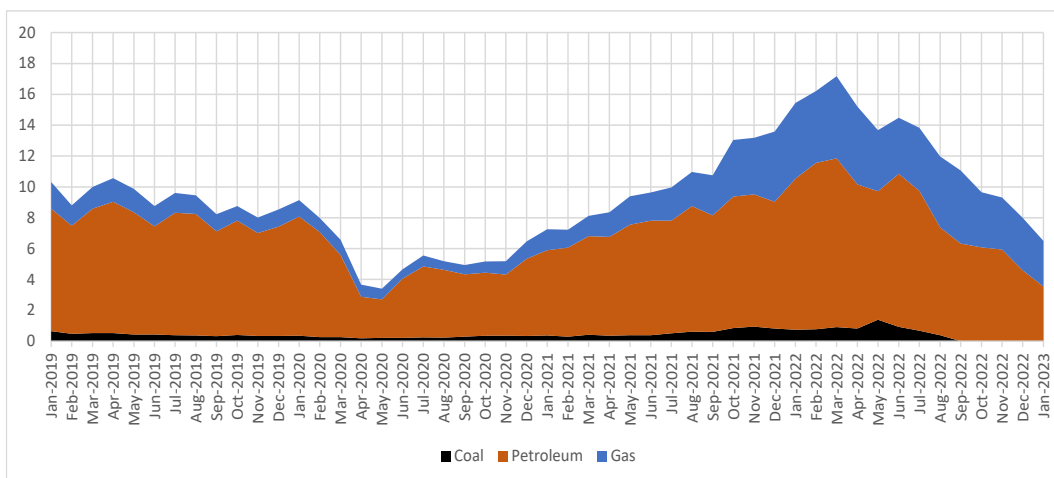
EU's efforts to reduce its reliance on Russian fuel supply take time: coal imports were stopped in September 2022 and petroleum products import is scaling down. However, EU's monthly payments for gas in late 2022 were much above the 2021 levels (Figure 3.4).

Figure 3.3 Russian daily fossil fuel exports by country of destination (14-day moving average)



Source: [Russia Fossil Tracker – Russia’s fossil fuel revenues since February 24, 2022](#)

Figure 3.4 Russian monthly revenues from fossil fuels exports to the EU (bln US\$)

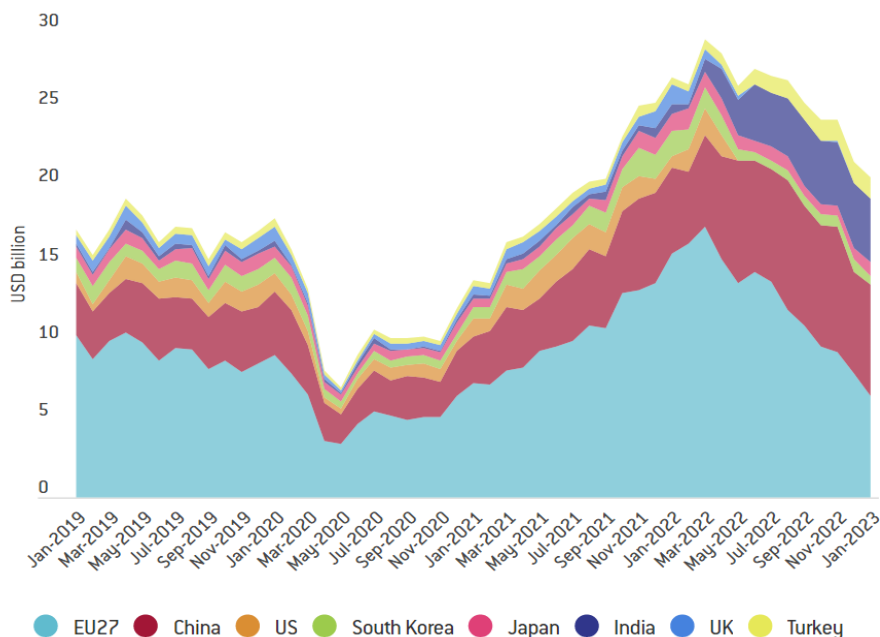


Source: Russian foreign trade tracker. Publishing date: February 17, 2023. [Russian foreign trade tracker \(bruegel.org\)](#)

Before March 2023, Russian oil business was demonstrating high resilience to sanctions. About half of Russian oil and gas export earnings in 2022 were provided by the US, EU and UK

(Table 3.3). Sanctions on Russian oil were first introduced by the US, Canada, Australia and UK – countries with relatively small reliance on Russian crude oil imports (Figure 3.5 and 3.6). In 2021, Russia sold more than a half of its crude oil exports and 70% of its petroleum products exports to the US and Europe (Figure 3.6), and the European market was responsible for over half of Russian exports of crude oil and petroleum products.

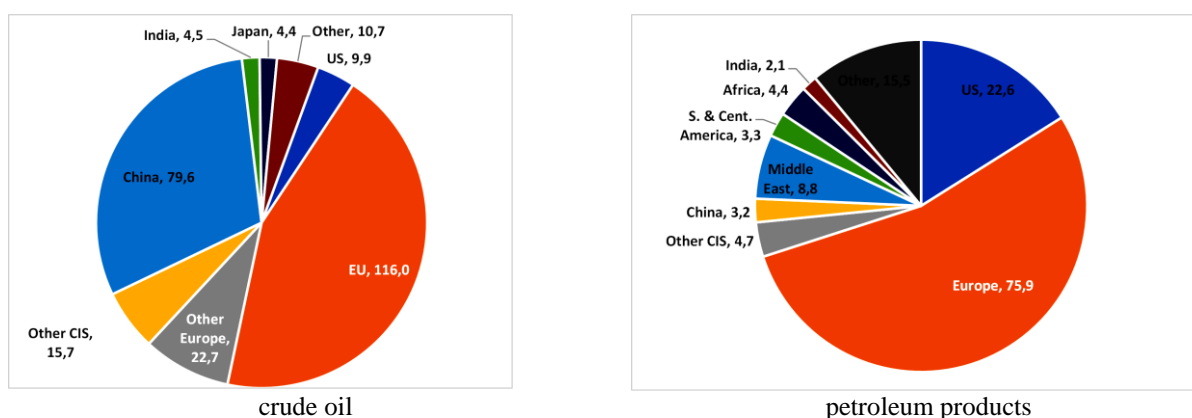
Figure 3.5 Russian monthly revenues from fossil fuel exports to 34 major countries (US\$ billion)



Source: Bruegel based on Eurostat, General Administration of Customs - People's Republic of China, United States Census Bureau, Korea Customs Service, Ministry of Finance - Trade Statistics of Japan, Ministry of Commerce and Industry - Government of India, ONS (UK), Turkish Statistical Institute

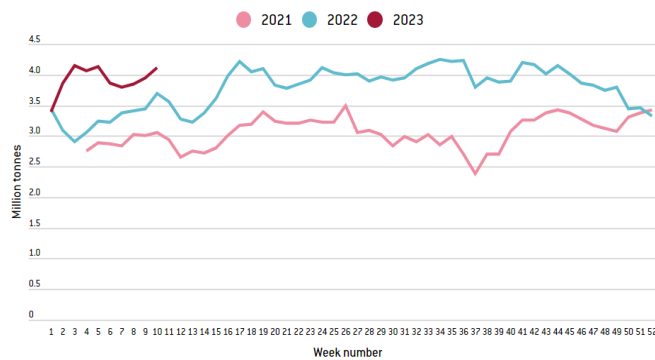
Source: Russian foreign trade tracker. Publishing date: February 17, 2023. [Russian foreign trade tracker \(bruegel.org\)](https://bruegel.org)

Figure 3.6 Russian 2021 crude oil and petroleum products exports by destination (Mt)

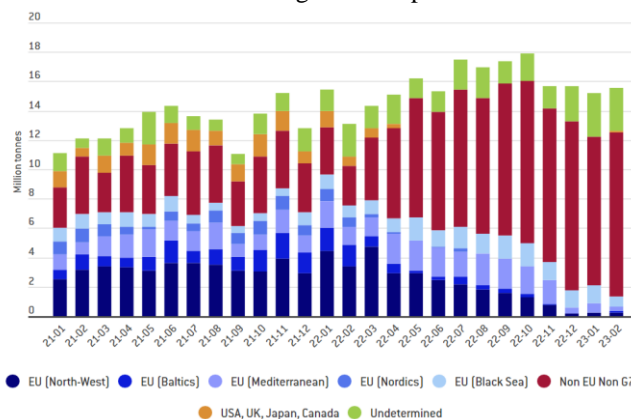


Sources: BP Statistical Review of World Energy June 2022; Russian crude oil tracker. Publishing date: February 23, 2023. [Russian crude oil tracker \(bruegel.org\)](https://bruegel.org)

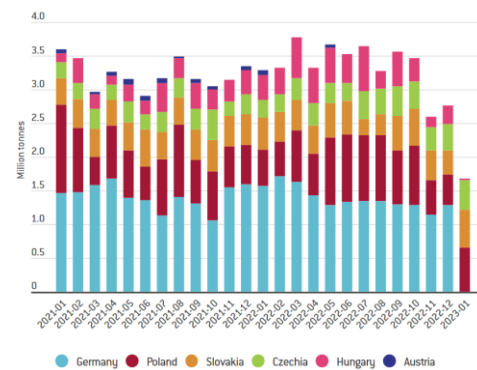
Since the EU only introduced sanctions on Russian crude oil in December 2022, Russian 2022 seaborne oil exports exceeded the 2021 level (Figure 3.7). Export volumes started to decline only in November 2022, but this decline trend was interrupted by an early 2023 growth. This growth is not yet captured in landing statistics.

Figure 3.7 Russian seaborne and pipeline crude oil exports

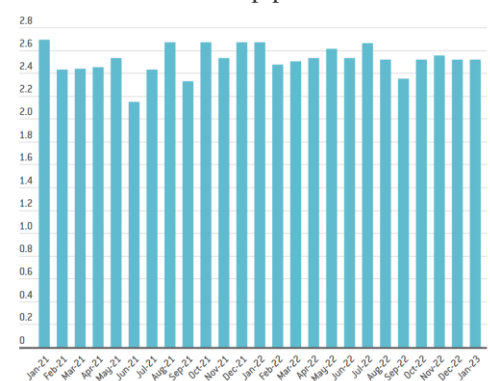
1-week moving average seaborne exports of Russian crude oil leaving Russian ports



monthly landings of Russian crude oil by region (seaborne exports)



monthly EU imports of Russian crude oil via Druzhba pipeline



monthly Chinese imports of Russian crude oil via ESPO pipeline

Source: Russian crude oil tracker. Publishing date: March 15, 2023. [Russian crude oil tracker \(bruegel.org\)](https://bruegel.org/russian-crude-oil-tracker)

The US, UK, Japan, and Canada managed to quit their Russian oil imports. Seaborne imports to the EU showed about 5-fold drop over January-December 2022. The EU imports via Druzhba pipeline was quite stable through the year showing a declining trend since November 2022. Exports to China via the ESPO pipeline was also pretty stable. Throughout the whole 2022, entire crude oil additional exports were seaborne export to non-G7 countries, mostly to China, India and Turkey. Late 2022, EU and G7 countries + Norway set a price cap of \$60 per barrel of Russian crude oil with no shipping or insurance allowed, unless the price stays below the cap. The price cap policy was later expanded to cover gasoline and diesel (\$100 per barrel), as well as mazut and naphtha (\$45 per barrel). A reaction from Russian oil suppliers followed, and in November 2022 – January 2023, the share of the EU, G7 and Norway in insurances for Russian crude oil transport was down from 73 to 57%, and for tanker ownership in April 2022-January 2023 was down from 62 to 37%.²⁷

EU sanctions on petroleum products were only introduced in February 2023 with some exceptions, so they had no impact on the 2022 statistics. These sanctions may further enlarge Russian crude oil exports. As of February 2023, no decline in Russian refineries output was yet declared.²⁸

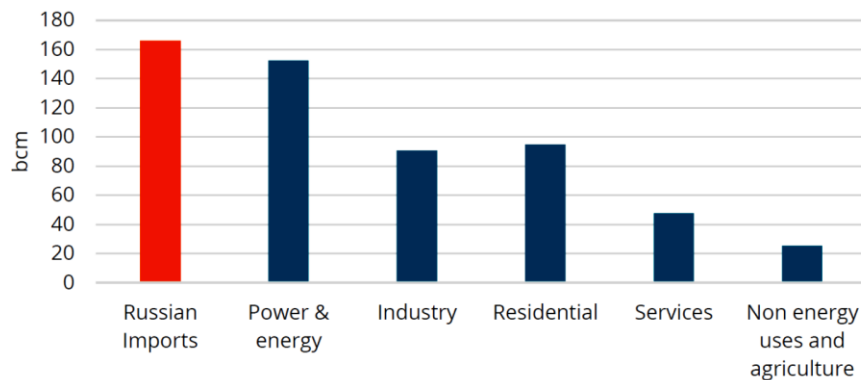
The gas weapon appeared to have a substantial recoil: Russian 2023 pipeline gas supply may halve compared to the 2021 level. EU used to be the key market for Russian pipeline natural gas (Figure 3.8), and Russia was the major gas supplier to the EU. In 2021, Russia covered 45% of

²⁷ Russian crude oil tracker. Publishing date: 23 February, 2023. [Russian crude oil tracker \(bruegel.org\)](https://bruegel.org/russian-crude-oil-tracker).

²⁸ Kommersant. 06.03.2023. p. 7.

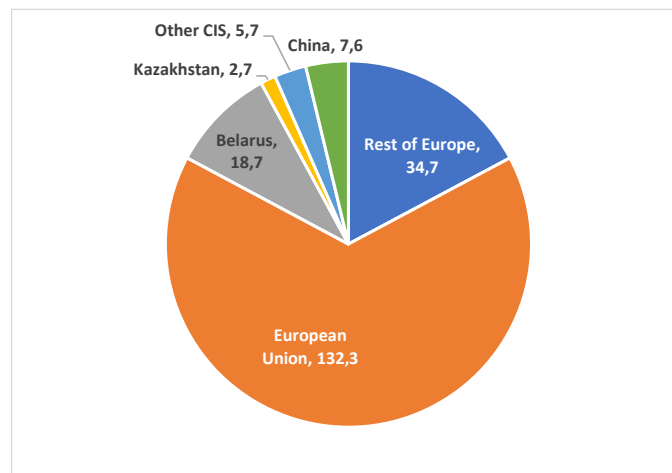
natural gas demand in the EU (40% via pipelines and another 5% by LNG). Such import reliance (Russian gas exports exceeded gas use in every key sector, see Figure 3.9) was considered by the Russian regime as a strong weapon able to significantly restrict EU's possible support for Ukraine after the Russian "operation" was launched. Recognizing this fact, Russia started exercising its gas "superpower" in 2021-2022.

Figure 3.8 Natural gas consumption in EU, 2019 levels (pre-COVID-19 year)



Enerdata. 2023. Gas supply shock: how EU's final consumers adapted? Publication – February 2023.

Figure 3.9 Russian 2021 gas exports by destination (bcm)



Source: BP Statistical Review of World Energy, June 2022.

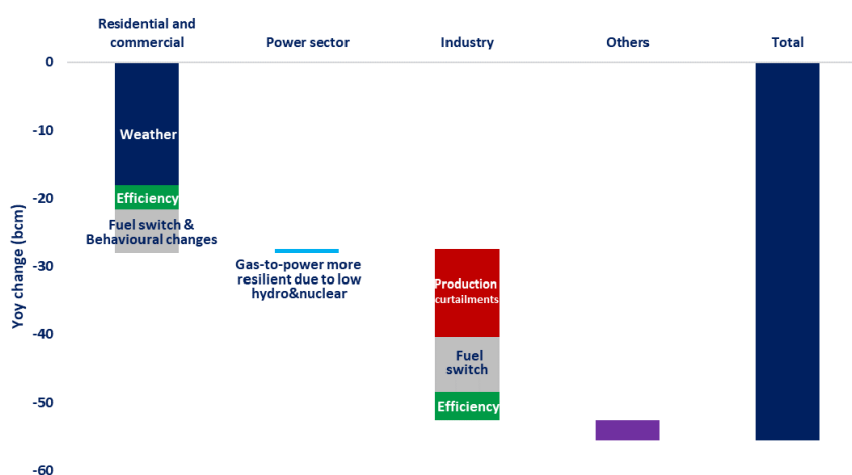
EU's deep reliance on the Russian gas is the reason why no restrictions were announced on Russian gas imports, except the price cap.²⁹ Gas supply to the EU was cut by the Russian side. In response, the EU is looking to limit Russia's gas 'superpower', and to this end has launched action to completely refuse Russian gas import by or before 2027. In 2022, this goal was not yet achieved, but in late 2022 and early 2023 the effects became visible. Improvements in the building sector energy efficiency, the mild winter, and behavioral change allowed for a 12% drop in gas use. The European industry has demonstrated more resilience, than previously expected, to gas shortages and skyrocketing gas prices via partial substitution of gas with oil or coal and some

²⁹ US and Australia (not Russian LNG importers) have banned Russian LNG supplies. On February 15, 2023, the EU launched a dynamic gas price ceiling at 180 euros per megawatt-hour (about 2,000 dollars per 1,000 cm). This ceiling requires one of two options: three days' gas price at the TTF hub in the Netherlands exceeds 180 euros per megawatt-hour, or it is 35 euros above average LNG price in the world market. This cap can be removed any time, should there be a gas shortage in the EU.

industrial relocation outside the EU – measures that jointly allowed for a 21% cut in 2022 gas use compared to 2019.³⁰

In 2022, Russian pipeline gas supply (excl. Belarus, Kazakhstan, and other NIS countries) was 101 bcm,³¹ or 74 bcm below the 2021 level. The EU market for the Russian gas has scaled down and will highly likely never be back. Russian pipeline natural gas exports to OECD Europe in 2022 was 82 bcm down (-49%), and for the EU it halved dropping by 78 bcm, of which demand reduction amounted to 55 bcm (Figure 3.10) and the rest was supplied by other gas producers.

Figure 3.10 Estimated year-on-year change in natural gas demand in the European Union in 2022



Source: IEA. 2023. Natural gas supply-demand balance of the European Union in 2023. How to prepare for winter 2023/24.

In 2023, Russian gas supply to the EU was 4-7 times below the 2015-2022 levels (Figure 3.11). If it is maintained at this level throughout 2023, it will only equal 25-26 bcm. IEA expects additional reduction in Russian natural gas use of about 30 bcm in 2023 with piped gas 35 bcm decline in 2023 to just 25 bcm. IEA expects, that EU could potentially reduce natural gas demand by 37 bcm in 2023 through improving energy efficiency, expansion of renewables, heat pumps application and behavioural changes.³² Nevertheless, the risk of gas shortage in the EU in the 2023/24 winter season persists (some 57 bcm), and price volatility may be substantial. Experts conclude, that the EU should extend its demand reduction target, which is set to expire on March 31, 2023.³³

For pipeline natural gas, the “turn to the East” may take decades; however, meanwhile China’s gas market may be penetrated by other suppliers, against the background of gas use peak expected in 2030-2035 with a subsequent decline in demand. In 2022, gas exports to China via “Power of Siberia” pipeline scaled up to 15.5 bcm. In 2023, it may reach 22 bcm³⁴ with no chance to compensate for the lost EU markets. Total Russian pipeline gas supply in 2023 may be close to 100 bcm, or half of the 2021 amount.

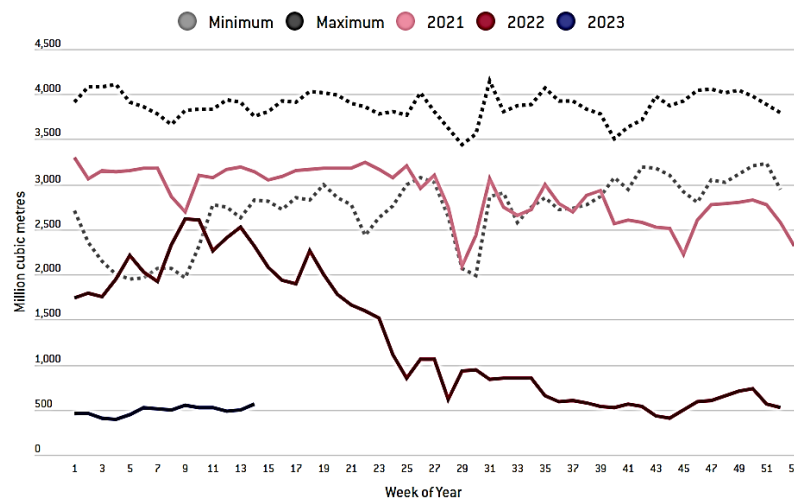
³⁰ Enerdata. 2023. Gas supply shock: how EU’s final consumers adapted? Publication – February 2023.

³¹ [Gazprom gas far abroad exports 2022 | Statista](#).

³² IEA. 2023. Natural gas supply-demand balance of the European Union in 2023. How to prepare for winter 2023/24.

³³ [McWilliams B., S. Tagliapietra, G. Zachmann and T. Deschuyteneer. Policy brief. Preparing for the next winter: Europe’s gas outlook for 2023. 02 February 2023. \[Preparing for the next winter: Europe’s gas outlook for 2023 \\(bruegel.org\\)\]\(#\).](#)

³⁴ IEA. 2023. Natural gas supply-demand balance of the European Union in 2023. How to prepare for winter 2023/24.

Figure 3.11 EU27 Natural Gas Imports from Russia*

* Minimum and maximum values are calculated from the period 2015-2020.

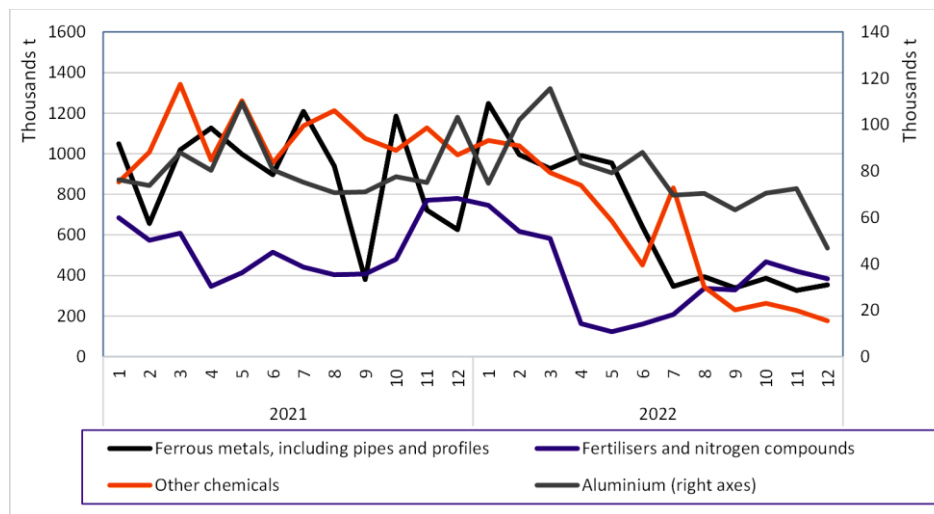
Source: McWilliams, B., G. Sgaravatti, G. Zachmann (2021) 'European natural gas imports', Bruegel Datasets, first published 29 October, available at <https://www.bruegel.org/publications/datasets/european-natural-gas-imports/>.

Russian LNG exports remain unaffected, and in 2022 were 8% up to 45.7 bcm, including 19.3 bcm to the EU. For Russia, this is kind of a relief for having lost the EU pipeline gas market.³⁵

3.4 Non-fuel exports: Eastern markets fail to absorb the loss in Western markets

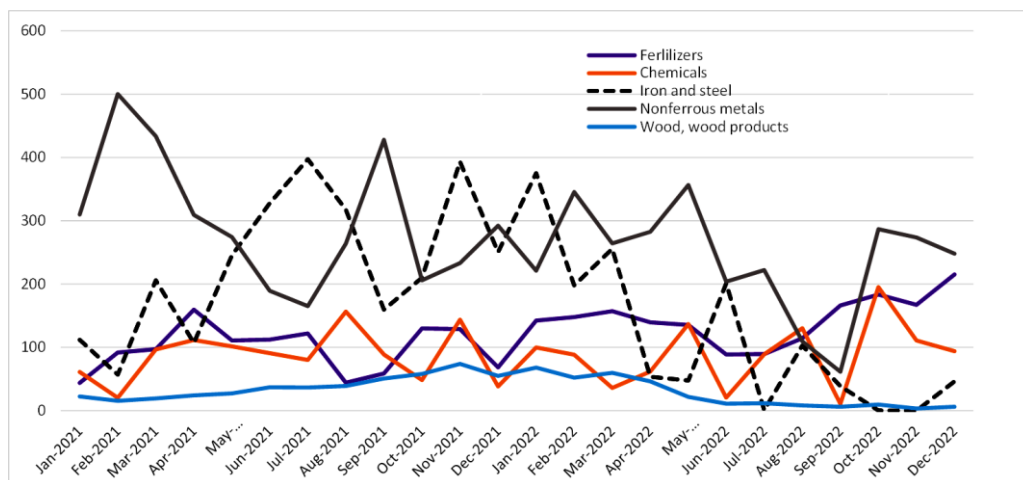
In 2022, sanctions plus treating Russian goods as toxic resulted in reduced total non-fuel exports by US\$ 24 billion, including to the EU, US, UK, Japan, and South Korea by US\$ 19 billion, of which US\$ 11 billion reduction was to the EU alone. Total 2022 non-fuel exports to 34 major countries were US\$ 11 billion below the 2021 level (Table 3.2). The largest increments were detected for China (+US\$ 3.1 billion), India (+US\$ 2.6 billion), and Turkey (+US\$ 2.4 billion). In 2021, the EU was the largest market for Russian exports amounting to 46% of the total for 34 major Russian trade partners and to 31% of exports to all countries. From February 24, 2022, onwards the EU basic materials imports from Russia were declining, even for products such as aluminum and fertilizers, for which no restrictions were introduced. For banned ferrous metals and some chemicals, the EU market shrank 3-5-fold. If average Q4 2022 import levels persist throughout the whole 2023, then the imported volumes will be 40% and 20% of their 2021 values respectively.

³⁵ McWilliams, B., G. Sgaravatti, G. Zachmann (2021) 'European natural gas imports', Bruegel Datasets, first published 29 October, available at <https://www.bruegel.org/publications/datasets/european-natural-gas-imports/>.

Figure 3.12 EU monthly basic materials imports from Russia

Source: <http://epp.eurostat.ec.europa.eu/> Interactive Database.

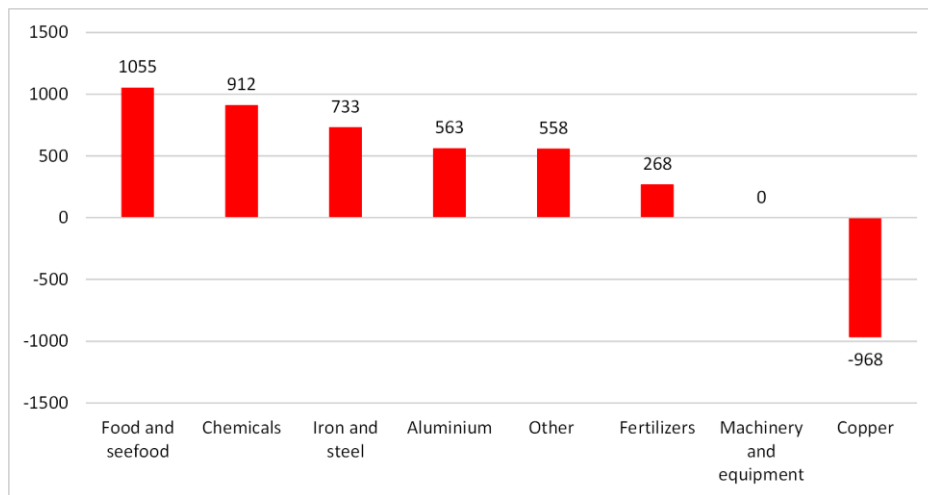
In 2021, the US market for Russian non-fuel goods equaled US\$ 12 billion. It went down to US\$ 9 billion in 2022, mostly due to the reduction in basic materials exports from US\$ 9 billion to US\$ 7.4 billion (Figure 3.13). The US imports of wood and wood products from Russia nearly stopped, and for ferrous materials (Q4 2022) they were close to zero as well. By the end 2022, the US import from Russia was dominated by aluminum, chemicals and fertilizers.

Figure 3.13 US monthly basic material imports from Russia (US\$ million)

Source: <https://www.census.gov/foreign-trade/statistics/country/site/index.html>.

In 2022, China, India and Turkey failed to absorb Russian non-fuel exports lost in OECD countries. China only absorbed additional US\$ 3 billion-worth non-fuel imports from Russia in 2022. Nearly one third of it included food, fish and seafood (Figure 3.14). China is the leading global producer of basic materials, so Russia can hardly hope to have an additional market for its basic materials there. A substantial market gain for Russian aluminum was offset by nearly US\$ 1 billion decline in copper imports. The imports of Russian machinery and electronics in 2022 was frozen at the 2021 level (slightly below US\$ 1 billion).

Figure 3.14 Additional China's non-fuel imports from Russia in 2022 (US\$ million)

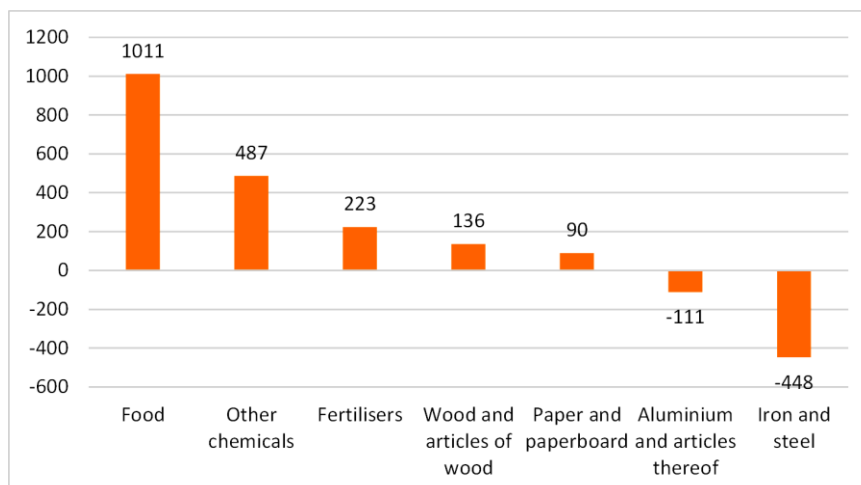


Source: <http://english.customs.gov.cn/statics/report/monthly.html>.

India's imports of non-fuel goods from Russia only amounted to US\$ 4 billion in 2021 and US\$ 6.6 billion in 2022. Of the US\$ 32 billion increment in total 2022 imports from Russia, the fuel imports were responsible for US\$ 29 billion (including US\$ 22 billion for crude oil³⁶). Traditionally, India is not a large market for Russian basic materials and other non-energy goods, and in 2022 this didn't change much.

Turkey's imports of Russian food were US\$ 1 billion up in 2022, and chemicals import was US\$ 0.5 billion up, while other product groups showed relatively small deviations from the 2021 levels (Figure 3.15). For steel there was a US\$ 0.45 billion decline. In all, additional demand for Russian non-fuel exports amounted to US\$ 2.4 billion.

Figure 3.15 Additional Turkey's non-fuel imports from Russia in 2022 (US\$ million)



Source: Turkey. [Foreign Trade Statistics \(General Trade System\)](https://iz.tuik.gov.tr/#/showcase/SC-7B95E2B859DF05U?token=40f83e29ec7dd20aee6e66f5ca9072e82d5b9627) database <https://iz.tuik.gov.tr/#/showcase/SC-7B95E2B859DF05U?token=40f83e29ec7dd20aee6e66f5ca9072e82d5b9627>.

³⁶ <https://tradedstat.commerce.gov.in/meidb/>.

3.5 Russian 2022 imports: the double-headed eagle can't fly with both heads looking East

Investments, local machinery and electronics production shows the greatest vulnerability to the import restrictions. In oil and gas exporting countries, including Russia, imports substitute much of local manufacturing in producing goods and providing services to domestic consumers. Current production levels, investments and personal consumption highly rely on imported products. In 2020, import covered 12% of total intermediate products use, ranging between 2% for coke, petroleum products, and power supply to 35% for medicals, 37% for automobiles and 38% for computers and electronics (Figure 3.16). For final demand, the import reliance is also high: 19% for the accumulation of fixed capital and 11% for personal consumption. It is quite low for government consumption (only 0.3%), so the 2022 boom in government consumption was not limited by imports.

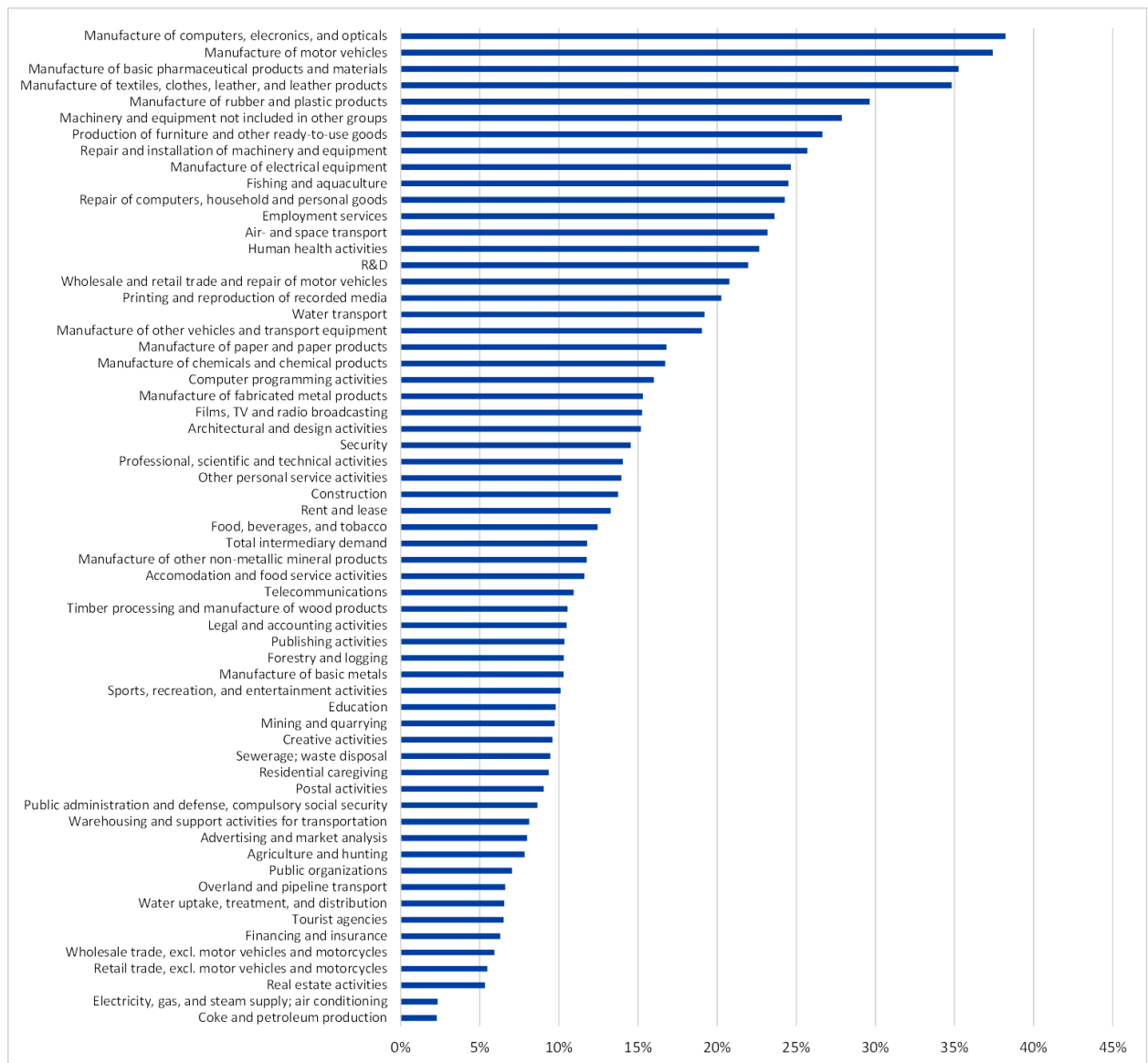
Mostly machinery and equipment exports to Russia were prohibited. Therefore, the ban on exports to Russia may have visible effects only in the medium term (lack of spare parts) or longer term (lack of equipment for new investment projects). The EU has prohibited imports of a long list of items, including cutting-edge technology (e.g. quantum computers and advanced semiconductors, electronic components and software); certain types of machinery and transport equipment; specific goods and technology for oil refineries; energy equipment, technology and services; aviation and space industry goods and technology (e.g. aircraft, aircraft engines, spare parts and any equipment for planes and helicopters, jet fuel); maritime navigation goods and radio communication technology; a number of dual-use goods (goods that could be used for either civil or military purposes), such as drones and software for drones or encryption devices; luxury goods (e.g. luxury cars, watches, jewelry); civilian firearms and other army materials.³⁷

According to the Russian Customs Service, in 2021, Russia's total imports amounted to US\$ 296 billion, including US\$ 144 billion (49%) for machinery and equipment, US\$ 29 billion for chemicals, pharmaceuticals, and rubber products, and over US\$ 17 billion for food, drinks and tobacco.³⁸ In 2022, total imports were assessed at US\$ 259 billion, which is US\$ 34 billion below the 2021 level. Total machinery import was US\$ 25 billion, or 19%, down even in current prices. 34 largest economies were responsible for nearly 60% of the 2022 Russian imports. Imports from this group were more than US\$ 49 billion down, and the EU imports declined by US\$ 46 billion. Other countries failed to offset this reduction (Table 3.4 and Figure 3.17). Imports from China were about US\$ 9 billion up, which is five times below the EU's drop in exports to Russia. The other suppliers were many of the CIS countries, which increased the 'grey' import flow to Russia.

³⁷ [EU sanctions against Russia explained - Consilium \(europa.eu\)](https://europa.eu/european-council/en/eu-sanctions-against-russia-explained).

³⁸ Russian Customs Service.

Figure 3.16 The share of imports in intermediate products by activity in 2020



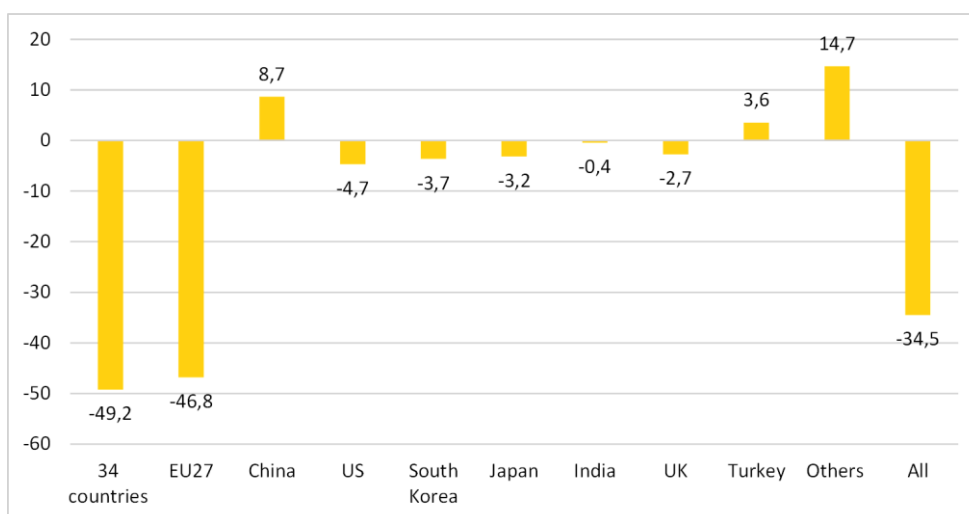
Source: [Rosstat \(rosstat.gov.ru\)](https://rosstat.gov.ru).

Table 3.4 Russian imports from 34 largest economies (US\$ billion)

Country	Goods	2019	2020	2021	2022	Increment in 2022
All countries*	Total	244.57	233.73	293.53	259.08	-34.45
	Mineral fuels	2.11	1.75	2.43	2.56	-0.13
	Goods other than mineral fuels	242.46	231.98	291.10	256.53	-34.58
34 countries	Total	184.13	168.56	210.39	161.17	-49.22
	Mineral fuels	1.45	1.08	1.48	1.42	-0.06
	Goods other than mineral fuels	182.69	167.49	208.90	159.74	-49.16
EU27	Total	98.16	90.25	105.40	58.58	-46.82
	Mineral fuels	0.69	0.67	0.93	0.50	-0.43
	Goods other than mineral fuels	97.46	89.59	104.46	58.07	-46.39
China	Total	54.78	50.61	67.59	76.27	8.68
	Mineral fuels	0.37	0.12	0.14	0.26	0.12
	Goods other than mineral fuels	54.40	50.50	67.46	75.98	8.52
US	Total	5.78	4.88	6.39	1.72	-4.67
	Mineral fuels	0.00	0.00	0.00	0.00	0.00
	Goods other than mineral fuels	5.76	4.87	6.38	1.72	-4.66
South Korea	Total	7.77	6.91	9.97	6.32	-3.65
	Mineral fuels	0.11	0.09	0.17	0.24	0.07
	Goods other than mineral fuels	7.67	6.78	9.81	6.08	-3.73
Japan	Total	7.16	5.87	7.84	4.69	-3.15
	Mineral fuels	0.11	0.00	0.09	0.09	0.00
	Goods other than mineral fuels	7.05	5.85	7.77	4.59	-3.18
India	Total	2.99	2.55	3.33	2.93	-0.40
	Mineral fuels	0.00	0.00	0.00	0.00	0.00
	Goods other than mineral fuels	2.98	2.55	3.33	2.92	-0.41
UK	Total	3.35	2.96	4.09	1.35	-2.74
	Mineral fuels	0.00	0.01	0.03	0.00	-0.03
	Goods other than mineral fuels	3.34	2.95	4.06	1.35	-2.71
Turkey*	Total	4.15	4.51	5.77	9.35	3.58
	Mineral fuels	0.12	0.12	0.12	0.27	0.15
	Goods other than mineral fuels	4.03	4.38	5.65	9.04	3.39

*Russian Customs Services.

Source: Russian foreign trade tracker. Publishing date 17 February 2023

Figure 3.17 Additional exports to Russia in 2022 (US\$ million)

Source: Russian foreign trade tracker. Publishing date: February 17, 2023; and CENef-XXI estimates for others.

In 2022, Russian imports of machinery and equipment (for several high-tech SITC groups) from 34 largest economies were nearly US\$ 14 billion below the 2021 level (Table 3.5). China compensated only US\$ 0.5 billion of this loss, Turkey only US\$ 0.4 billion, and India failed to supply any additional machinery to Russia. As a result, machinery and equipment imports were 40% below the 2021 level, and from the EU only one third of the 2021 level.

Table 3.5 does not include all equipment (it does not show power supply and road vehicles). Total machinery and equipment imports from all countries were down from US\$ 133 to 109 billion. In 2022, machinery and equipment import from the EU shrank from 59 to €25 billion. This is about three quarters of the total import decline in 2022. The import of vehicles was nearly €7 billion down.³⁹ Machinery and equipment imports from the US were more than 7 times down from US\$ 3.1 to 0.4 billion, including transport equipment 14 times down from US\$ 1.1 to 0.08 billion.⁴⁰ In 2022, China supplied 2.4 times more equipment for power supply and nearly as many transport vehicles as in 2021 (close to US\$ 2 billion).⁴¹ Power supply equipment imports from Turkey were US\$ 0.8 billion up, while in other machinery positions no substantial growth was detected.⁴²

Table 3.5 Russia's import of some types of machinery and equipment from 34 largest economies (US\$ billion)

SITC category description		2019	2020	2021	2022	Increment in 2022
34 countries	Office and automatic data-processing machines	3.67	4.01	4.94	3.23	-1.71
	Telecommunications and sound recording equipment	3.48	3.82	4.47	2.72	-1.75
	Electric machinery and parts (including semiconductors)	10.23	11.20	13.14	8.69	-4.44
	Instruments and apparatus (including lasers)	4.45	4.59	4.93	3.06	-1.87
	Transport equipment (other than road vehicles)	4.45	2.98	5.96	2.01	-3.95
	Total	26.29	26.60	33.44	19.72	-13.72
US	Office and automatic data-processing machines	0.09	0.10	0.11	0.02	-0.09
	Telecommunications and sound recording equipment	0.10	0.09	0.11	0.03	-0.09
	Electric machinery and parts	0.28	0.36	0.45	0.12	-0.33
	Instruments and apparatus	0.37	0.35	0.34	0.13	-0.21
	Transport equipment (other than road vehicles)	1.21	0.38	1.11	0.08	-1.04
	Total	2.05	1.28	2.12	0.37	-1.75
EU27	Office and automatic data-processing machines	2.21	2.25	2.44	0.48	-1.96
	Telecommunications and sound recording equipment	1.85	1.78	1.89	0.43	-1.46
	Electric machinery and parts	6.58	6.66	7.03	2.84	-4.20
	Instruments and apparatus	3.31	3.25	3.32	1.90	-1.42
	Transport equipment (other than road vehicles)	1.98	1.74	3.69	0.81	-2.88
	Total	15.93	15.67	18.37	6.45	-11.92

³⁹ <http://epp.eurostat.ec.europa.eu/> Interactive Database.

⁴⁰ <https://www.census.gov/foreign-trade/statistics/country/sitc/index.html>.

⁴¹ <http://english.customs.gov.cn/statics/report/monthly.html>.

⁴² Turkey. [Foreign Trade Statistics \(General Trade System\) database](https://iz.tuik.gov.tr/#/showcase/SC-B95E2B859DFO5U?token=40f83e29ec7dd20ace6e66f5ca9072e82d5b9627) <https://iz.tuik.gov.tr/#/showcase/SC-B95E2B859DFO5U?token=40f83e29ec7dd20ace6e66f5ca9072e82d5b9627>.

SITC category description		2019	2020	2021	2022	Increment in 2022
UK	Office and automatic data-processing machines	0.05	0.02	0.03	0.00	-0.03
	Telecommunications and sound recording equipment	0.08	0.05	0.05	0.01	-0.05
	Electric machinery and parts	0.12	0.10	0.15	0.03	-0.12
	Instruments and apparatus	0.10	0.09	0.16	0.04	-0.12
	Transport equipment (other than road vehicles)	0.09	0.09	0.11	0.02	-0.09
	Total	0.44	0.34	0.50	0.10	-0.40
Japan	Office and automatic data-processing machines	0.01	0.01	0.01	0.00	-0.01
	Telecommunications and sound recording equipment	0.10	0.09	0.08	0.02	-0.06
	Electric machinery and parts	0.14	0.11	0.13	0.03	-0.09
	Instruments and apparatus	0.05	0.06	0.07	0.03	-0.05
	Transport equipment (other than road vehicles)	0.01	0.01	0.01	0.00	0.00
	Total	0.30	0.29	0.29	0.08	-0.21
South Korea	Office and automatic data-processing machines	0.14	0.14	0.21	0.17	-0.05
	Telecommunications and sound recording equipment	0.09	0.10	0.10	0.05	-0.05
	Electric machinery and parts	0.29	0.31	0.38	0.30	-0.09
	Instruments and apparatus	0.09	0.09	0.11	0.09	-0.02
	Transport equipment (other than road vehicles)	0.19	0.12	0.17	0.15	-0.02
	Total	0.80	0.76	0.96	0.75	-0.22
China	Office and automatic data-processing machines	1.12	1.46	2.10	2.42	0.31
	Telecommunications and sound recording equipment	1.19	1.66	2.17	2.08	-0.09
	Electric machinery and parts	2.48	3.36	4.59	4.81	0.21
	Instruments and apparatus	0.51	0.72	0.90	0.81	-0.09
	Transport equipment (other than road vehicles)	0.95	0.48	0.62	0.77	0.15
	Total	6.25	7.67	10.38	10.89	0.50
India	Office and automatic data-processing machines	0.05	0.03	0.04	0.04	0.00
	Telecommunications and sound recording equipment	0.08	0.05	0.08	0.03	-0.05
	Electric machinery and parts	0.14	0.10	0.13	0.08	-0.05
	Instruments and apparatus	0.01	0.01	0.02	0.02	0.00
	Transport equipment (other than road vehicles)	0.01	0.01	0.01	0.01	0.00
	Total	0.29	0.20	0.27	0.17	-0.10
Turkey	Office and automatic data-processing machines	0.00	0.00	0.00	0.11	0.11
	Telecommunications and sound recording equipment	0.00	0.00	0.00	0.08	0.08
	Electric machinery and parts	0.19	0.21	0.28	0.49	0.21
	Instruments and apparatus	0.01	0.02	0.02	0.06	0.04
	Transport equipment (other than road vehicles)	0.01	0.14	0.24	0.18	-0.06
	Total	0.22	0.38	0.53	0.91	0.37

Source: Russian foreign trade tracker. Publishing date: February 17, 2023.

In general, the real effect of the import restrictions was not as severe, as initially expected, and the Russian business has demonstrated substantial adaptivity. The key risks are:

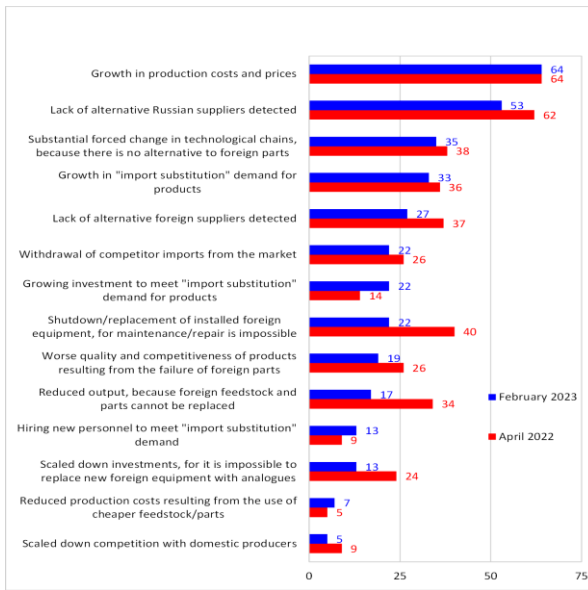
- politically dangerous reliance on imports has switched from a variety of western countries to just one country – China;
- growth in production costs and simultaneous reduction in the quality of goods;
- production and investment declines.

A survey conducted among Russian industrial companies in February 2023⁴³ shows the key effects of sanctions (Figure 3.18):

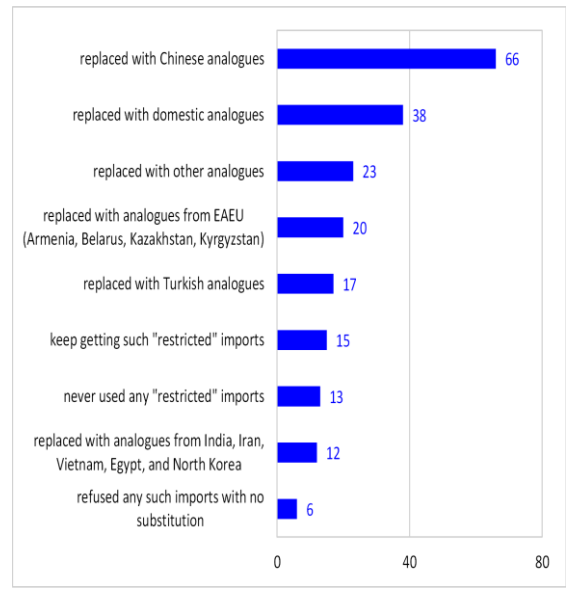
- 64% of companies report growth in production costs. This is where the February 2023 reality perfectly meets the April 2022 expectations. Only 7% of the respondents report a decline in the production costs due to cheaper supplies;
- 19% of enterprises have encountered reduction in the products quality due to the substitution of imported components. Another driver to this end was reduction in the competition with foreign suppliers (22%) and Russian suppliers (5%);
- only a third of domestic businesses were able to "participate" in the import substitution;
- only 38% of the respondents managed to substitute the restricted goods with domestic analogues for machinery, 66% are using Chinese-made substitutions. Corresponding numbers for spare parts are 63% and 45%, and for components 54% and 53%;
- over one third of enterprises were forced to reshape their technological chains, because they were unable to substitute the restricted components, while over a quarter could not find the required components in the "friendly" countries;
- parallel import of restricted goods was used by 15% of companies for machinery, 22% for spare parts, and 23% for components;
- 22% of companies can no longer run previously imported equipment, because no maintenance service is available to them;
- 13% and 17% of enterprises have cut production or investments, as they are facing shortages of foreign supplies. At the same time, 22% of companies have invested in import substitution;
- 50% of enterprises pointed out that they expect high prices of equipment and costly construction to be the main barriers to the 2023 investment activity.

⁴³ Tsukhlo S.V. Russian industry in March 2022 – February 2023. The results of 12 months' "sanctions war". Gaidar Institute for Economic Policy. March 28, 2023.

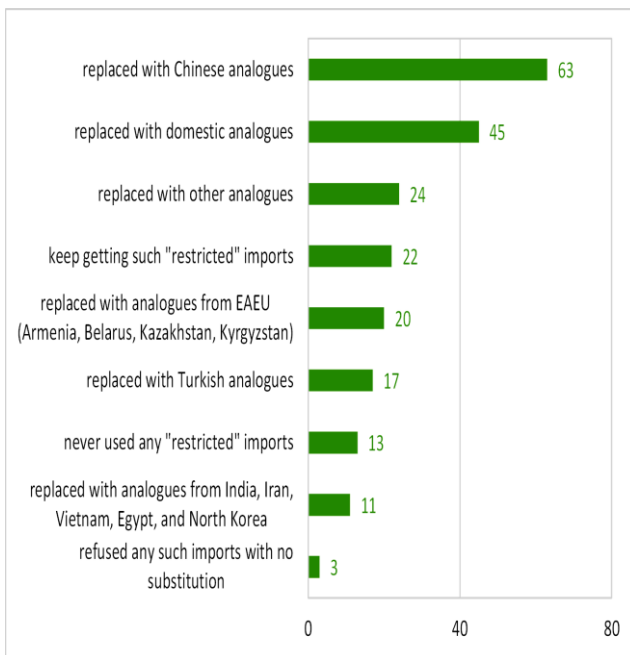
Figure 3.18 Assessment of the implications of import termination and the departure of western producers from Russia



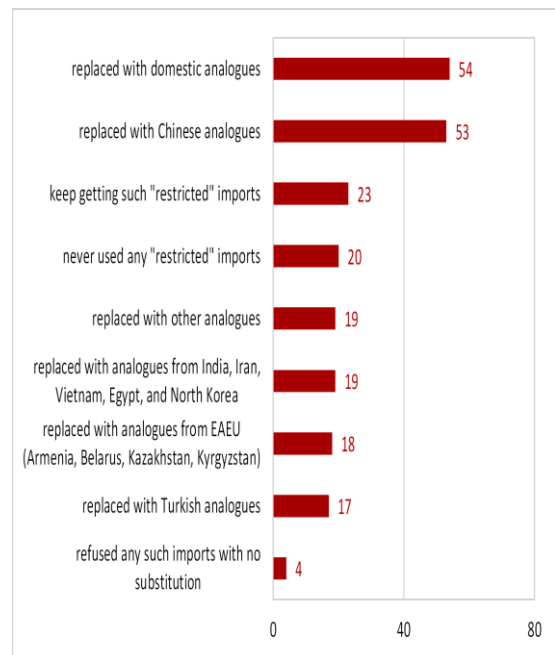
Russian industry estimates of the effects of western import cuts and western companies' leave



Substitution of restricted machinery imports



Substitution of restricted supply of spare parts



Substitution of restricted supply of components

Source: Tsukhlo S.V. Russian industry in March 2022 – February 2023. The results of 12 months' "sanctions war". Gaidar Institute for Economic Policy. March 28, 2023.

The recent 20 years in Russia were poisoned with the abundant inflow of petrodollars and so were lost for the diversification of the Russian economy and import substitution. The goal of attaining complete technical independence from the West was first set 90 years ago (Figure 3.19). Since 2014, the intention has been to put additional efforts to this end. However, they failed, and only one third of domestic industry was able to somehow "participate" in import substitution (Figure 3.18). In 2021, the deficit in machinery and equipment trade with the rest of the world was

US\$ 108 billion; in 2022, it was down to US\$ 88 billion – not because of import substitution, but driven by sanctions and the economic crisis.

Figure 3.19 Poster of the early 30's: "We shall achieve the complete technical independence of the USSR"



Source: Tsukhlo S.V. Russian industry in March 2022 – February 2023. The results of 12 months' "sanctions war". Gaidar Institute for Economic Policy. March 28, 2023.

Reliance on a variety of western countries is now being substituted by a more dangerous reliance on a single eastern country – China. China has become Russia's key partner responsible for more than 27% of total imports in 2022. This share is expected to grow, as Russia "goes further East".

In many respects, technically Russia is lagging behind China, and without supplies from the West this technological gap is likely to increase. China is unlikely to compensate Russia's loss of sophisticated equipment and components supply from the West (see Table 3.5). It will take a lot of time to bridge the gap, and meanwhile Russia will be facing lower capacity loads and lower investment activities in many industries. Other countries will hardly be able to geographically diversify Russia's technology imports. Trade balances with many of these countries are highly positive, because they have only few sophisticated products to offer to meet Russian demand for imported goods. Sometimes local currencies are used in foreign trade, but it may be difficult to spend the export revenues from such deals, as some participating countries do not produce goods Russia needs to import. India is one good example. In 2022, Russian exports to this country totaled US\$ 40 billion, while imports were only US\$ 3 billion. To sum up, the risks of the double-headed eagle (the Russian emblem) flying in a wrong direction with both heads turned to the East is extremely high.

4

Long-term effects of sanctions on Russian foreign trade

4.1 Ministry of economic development projection to 2026: rose-coloured spectacles for a bright future

No long-term projections have been recently published by the Ministry of economic development of the Russian Federation (MED RF), and so Russia has no long-term official vision of how the military operation and subsequent sanctions might affect its economic future. For the medium-term, as always, MED RF's projections are very optimistic. The latest projection to 2026 was published in April 2023. It implies, that GDP will be 1.2% up in 2023. Export of goods is expected to reach US\$505 billion by 2026, while the evolution of oil and gas export quantities and prices will be balanced at US\$228-233 billion (Table 4.1). Non-oil and gas exports are super-optimistically expected to be 11% up from the 2021 level. Physical imports of goods are expected to grow up dynamically (2-7%), well outpacing GDP, and no serious problems in meeting the import demand are expected, so the share of imports in GDP will partly rebound from its 2022 lows. Both trade balance and balance of current accounts are expected to be lower, than in 2022 and in 2021. MED RF expects ruble to stay strong across all years. However, early 2023 developments cast a deep shadow on this bright vision. Export earnings are much lower, than expected, and ruble/US\$ exchange rate in mid-April was 82, or 7% above the expected 2023 average.

Table 4.1 Medium-term foreign trade forecast for the Russian Federation

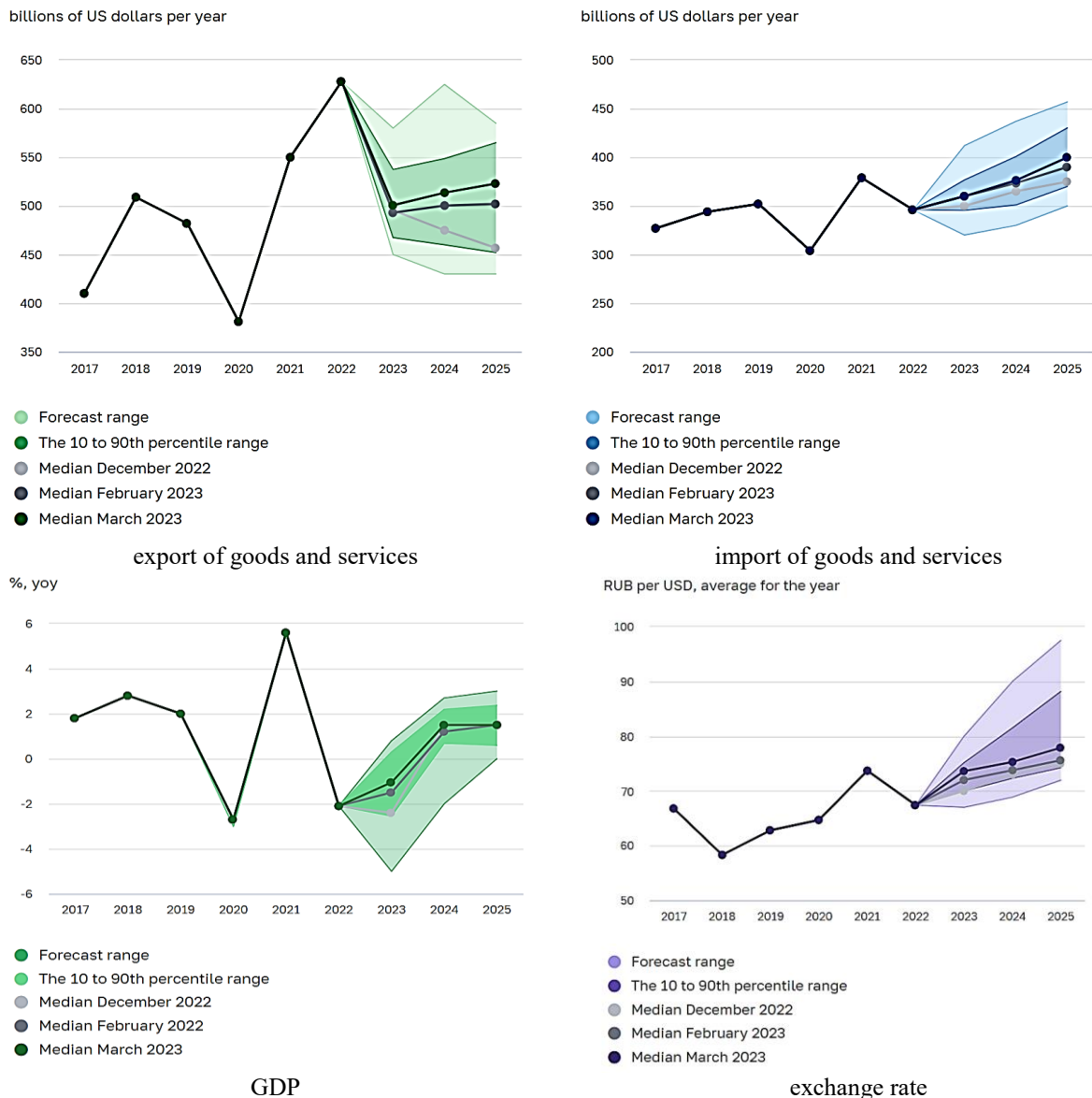
Indicator	Units	2021	2022	2023	2024	2025	2026
		fact	fact	estimate	base case projection		
GDP growth rate	%	104.7	97.1	101.2	102.0	102.6	102.8
Export of goods	US\$ billion	494.4	588.3	465.9	484.0	496.2	505.1
Annual nominal growth	%	148.3	119.0	79.2	103.9	102.5	101.8
Annual real growth	%	101.7	86.0	100.8	104.3	103.7	102.7
Share in GDP	%	27.8	25.9	22.6	22.2	21.6	20.9
Oil and gas export	US\$ billion	244.3	343.7	232.1	232.5	232.2	228.0
Annual real growth	%	98.9	92.2	93.3	102.7	104.2	101.9
Share in GDP	%	13.7	15.1	11.3	10.6	10.1	9.4
Non-oil and gas export	US\$ billion	250.1	244.6	233.8	251.6	264.0	277.1
Annual real growth	%	104.0	79.9	111.4	105.9	103.1	103.4
Share in GDP	%	14.1	10.8	11.3	11.5	11.5	11.5
Import of goods	US\$ billion	304.0	280.4	313.8	332.8	347.4	362.7
Annual nominal growth	%	126.9	92.2	111.9	106.1	104.4	104.4
Annual real growth	%	116.9	83.1	107.4	104.2	102.4	102.5
Share in GDP	%	17.1	12.3	15.2	15.2	15.1	15.0
Trade balance	US\$ billion	190.3	308.0	152.1	151.2	148.7	142.5
Share in GDP	%	10.7	13.5	7.4	6.9	6.5	5.9
Export of services	US\$ billion	55.7	48.5	49.3	52.7	56.9	61.0
Annual real growth	%	116.0	87.5	102.7	106.0	107.0	105.5
Share in GDP	%	3.1	2.1	2.4	2.4	2.5	2.5
Balance of current accounts	US\$ billion	122.3	233.0	86.8	81.0	73.6	63.6
Share in GDP	%	6.9	10.2	4.2	3.7	3.2	2.6
Exchange rate	rub./US\$	73.6	67.5	76.5	76.8	77.6	78.8

Source: [Social and economic development projections](#) | [Ministry of economic development of the Russian Federation \(economy.gov.ru\)](#)

4.2 “Never before – and once again”

Real long-term economic problems and risks faced by Russia are not being addressed by Russian banks and analytical centers, which cannot see beyond 2025-2026. The above citation from the Russian ex-Prime-Minister V. Chernomyrdyn is a good illustration of March 2023 consensus visions by Russian banks and a few analytical groups of Russia's foreign trade and overall near-term economic future. In general, 2023-2025 projections for a very untypical situation (“never before”) look like a simple extrapolation of the 2015-2022 trends (“and once again”) (Figure 4.1). However, this consensus projection is more pessimistic, than the one developed by MED RF. Exports of goods and services are projected at levels close to what MED RF expects for goods alone. For 2023, exports of goods and services are expected to stay below the 2021 level and US\$100-150 billion below the 2022 peak. These projections expect imports of goods and services to reach US\$400 billion, and so the balance of goods and services to go down to about US\$ 100 billion, and the ruble will weaken. In March 2023 projections, the ruble weakens faster than expected in December 2022 and February 2023.

Figure 4.1 Macroeconomic survey of the Bank of Russia



Source: [Macroeconomic survey of the Bank of Russia | Bank of Russia \(cbr.ru\)](https://www.cbr.ru).

This consensus forecast is more pessimistic about the GDP evolution compared to the one by MED RF: GDP decline in 2023 is expected at -1.1%, and from 2024 onwards it is anticipated to get back on the growth path and show 1.5% growth, which is 1.1% lower, than in the MED RF's projection. The only long-term projections – to 2060 – were made by CENEf-XXI, in which Russia will lose 10 or 11 years of economic growth. The 2021 GDP level will only be back in 2031-2032, and the most severe problems are awaiting the Russian economy beyond 2024-2025.⁴⁴

4.3 Channels of influence of Russia's foreign trade on the country's economic development: static assessment of the effects of sanctions

Sanctions can affect the economy through several channels. Export restrictions limit external markets, unless there are options to redirect export volumes to other locations. As a result, capacity loads are going down, and so do the incomes they generate. Import restrictions on intermediate goods, which cannot be replaced with analogues from other countries, destroy supply chains and stop production lines after stocks at warehouses are depleted. Restricted imports of spare parts to replace obsolete components hamper equipment load. Such equipment is partially dismantled for spare parts. All these sanctions have negative impacts, but may be partially mitigated via 'grey' imports. Import restrictions on investment goods have longer-term effects, as they restrict production and income flows in the future. Sanctions on consumer goods reduce wholesale and retail volumes. Sooner or later, all sanctions adversely affect incomes and so additionally reduce goods and services demand and supply. These impacts may be mitigated by additional government consumption and investment, or investment credits to private businesses, as long as the government has sufficient resources to finance them.

In March 2022, shortly after the first sanctions were imposed, preliminary estimates of related GDP losses were provided.⁴⁵ They captured three effects of the sanctions: export and import restrictions and related implications for the incomes. An analytical approach to assess the effects of sanctions was developed.⁴⁶ This analysis was updated in March 2023 based on the 2022 export and import data from the key trade partners (see Chapter 3) and takes account of not only sanctions-based export reductions, but also of the foreign trade geographical re-orientation.

The results are shown below (Table 4.2) against the Russian Central Bank's consensus forecasts, recent OECD projections, and the results obtained in March 2022 for a variety of combinations of assumptions. Such assessment only offers a static picture of potential GDP decline at the point of time with greatest sanctions coverage and depth. It was highlighted that "if any new markets for the Russian exports or new import suppliers are found, the GDP loss may be partially mitigated. Also, the impacts may be smaller, if the announced import restrictions are not fully implemented".⁴⁷ Both conditions were met. In 2022, slow sanctions process, substantial government spending and changes in foreign trade geography offset a significant part of the potential loss, and so new estimates of potential GDP losses are lower. **But after such adaptation possibilities are exhausted, actual GDP evolution may be closer to the estimated depth of GDP decline – 8.4%. In 2022, Russian GDP lost 2.1%, so there is a potential for another 6% GDP loss in the medium-term.** In 2023, OECD Economic Outlook expects Russian GDP 3% down in 2023-2024. In 2025, energy prices are expected much below the 2022-2023 levels, so GDP may continue to shrink.

⁴⁴ Bashmakov I. The angle of incidence is not equal to the angle of reflection. [CENEf-XXI](#).

⁴⁵ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichok, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENEf-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality-pathways-to-2060>.

⁴⁶ Bashmakov I. The angle of incidence is not equal to the angle of reflection. [CENEf-XXI](#).

⁴⁷ Ibid.

Table 4.2 Implications of sanctions for Russian GDP in constant prices

Assumptions	Parameter	Export restrictions	Import restrictions	Demand reduction effect	Total
March 2023 projections					
Export and import restrictions imposed by Western countries, yet mitigated by foreign trade turning to the East	GDP	-4.1%	-1.0%	-3.3%	-8.4%
	NOG GDP	-2.7%	-1.1%	-3.7%	-7.5%
Consensus projection by the Central Bank of Russia (March 2023)	GDP	2022	2023	2024	2025
		-2.1%	-1.1%	1.5%	1.5%
OECD March 2023	GDP	-2.1%	-2.5%	-0.5%	
March 2022 projections					
Export sanctions (EU-27, USA, Japan), 20% coverage of key export items to these countries; 40% for air transport; 20% for other items and services; 30% cut in intermediate imports	GDP	-5.4%	-1.8%	-4.5%	-11.7%
	NOG GDP	-3.6%	-2.0%	-5.1%	-10.7%
Export sanctions (EU-27, USA, Japan), 50% coverage of key export items to these countries; 40% for air transport; 20% for other items and services; 30% cut in intermediate imports	GDP	-8.3%	-1.8%	-6.2%	-16.2%
	NOG GDP	-5.4%	-2.0%	-7.0%	-14.3%
Export sanctions (EU-27, USA, Japan), 50% coverage of key export items to these countries; 40% for air transport; 20% for other items and services; 50% cut in intermediate imports	GDP	-8.3%	-4.5%	-7.6%	-20.3%
	NOG GDP	-5.4%	-5.0%	-8.5%	-18.9%
OECD*					-10%-15%
Consensus projection by Russian experts (Kommersant 11.03.2022; Kommersant 17.03.2022)	GDP	-2.3-2.8%			-8%
		2022	2023	2024	2022-2024
		-8%	1.5%	2%	-5%
Consensus projection by foreign experts (Focus economics; Kommersant 18.03.2022)	GDP	-5.7%	-1%		-6.2

* OECD Economic Outlook, Interim Report Economic and Social Impacts and Policy Implications of the War in Ukraine, MARCH 2022.

Source: CENef-XXI; [Macroeconomic survey of the Bank of Russia | Bank of Russia \(cbr.ru\)](#); [OECD Economic Outlook](#)

4.4 Oil and petroleum products

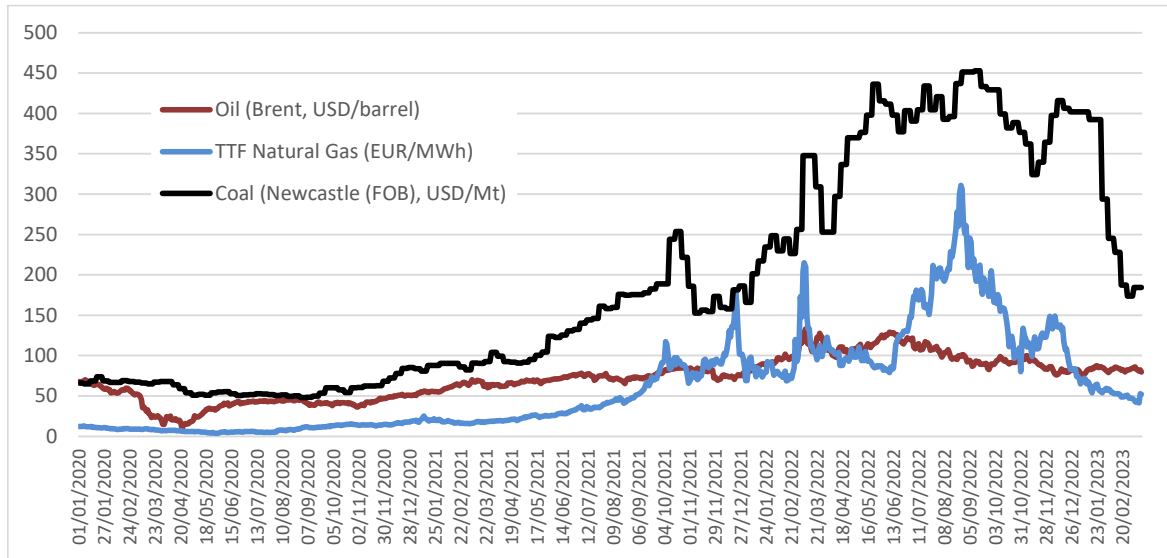
Russian petroleum products export is expected to decline. The depth of the decline depends on how severe the sanctions are in the short- and medium-term and on the progress towards global economy decarbonization in the longer term (see Chapter 5). In the years to come, sanctions on crude oil and petroleum products export will have limited effects on physical exports, as there is considerable flexibility in re-routing shipments to new markets, even if with substantial price discounts. The 2022-early 2023 experience supports this statement. It was decided to cut oil production by 25 Mt in 2023. If domestic use is maintained at the 2022 level, this will be reflected in 10% exports reduction from the 2022 level.

Oil and petroleum products price caps and the fact that oil prices are kept at moderate levels by maintaining demand and supply balance on the global oil markets allow it to keep oil prices medium or low and thereby aggravate the effects on Russian oil export revenues. After skyrocketing in 2022, fossil fuel prices dropped in 2023. If crude oil prices go down to, or below, 60 US\$/barrel in compliance with the IEA's Announced Pledges Scenario for 2030-2050,⁴⁸ price

⁴⁸ IEA. 2022. World Energy Outlook. 2022

discount for Russian oil may be smaller, as well as its attractiveness, compared with other suppliers. Shipment and oil cargo insurance costs have grown substantially since 2022, so Russian oil and petroleum products exporters are getting lower FOB prices.

Figure 4.2 Fossil fuels price evolution in 2020-2023



Source: [OECD Economic Outlook](#).

Import restrictions on the equipment required throughout the whole Russian oil supply chain may have stronger medium-term effects on oil production and export volumes, than sanctions on physical exports, but in the longer term. After 2014, the EU and US began to impose sanctions on the oil industry technology supply to Russia. The list included drilling platforms; underwater and offshore equipment for the Arctic; software for hydraulic fracturing operations; drilling, geophysical and geological services; and cartographic technologies. In 2022, this list was extended to include a lot of equipment and technologies for oil and LNG production and oil refineries. Practically all of the Western oilfield service companies left the Russian market.

Production at Russian old oil fields is expected to scale down to 380 Mt by 2030, 280 Mt by 2040, 205 Mt by 2050, and 150 Mt by 2060. New sophisticated technologies are required to offset this decline. Sanctions prevent timely access to these technologies and, unless lifted, will not allow for a full compensation of the oil production decline in the decades to come. The Energy Strategy of the Russian Federation adopted in 2020 highlighted the risk associated with “critical reliance of the fuel and energy sector organizations on imported technologies, equipment, materials, services and software for a variety of the most promising directions of energy development”. Even before additional sanctions were imposed in 2022, this Strategy mentioned just a chance for keeping oil production at 555-560 Mt to 2024. The production level for 2035 was expected between 495 and 555 Mt. This means that only in the super optimistic case, production decline in old fields was expected to be fully offset by new offshore, Arctic, and other hard-to-recover new oil fields with a subsequent decline in total production. Lack of imported technologies will bring the 2035 range closer to 380-450 Mt.

According to the Ministry of Energy, import reliance for oil and gas equipment in Russia in 2014 was 60%, and for certain positions no Russian analogues were available at all. In 2020, this reliance was down to 50% and in 2022 to 40%. The target for 2025 is 20%. The sanctions barred 68% of imported high-tech oil and gas equipment involved in the development of hard-to-recover reserves.

Import reliance in the refinery sector is much higher – nearly all of the technologies are imported. Sanctions are imposed on equipment imports for oil refining and catalysts. The sanctions made the Ministry of Energy propose extension of the state program to modernize refineries for two years until the end of 2028. Before 2022, the EU used to export €1.3 billion-worth equipment for oil refineries per year. Some Western equipment is still available for purchase to Russian oil companies, but with a 20-30% intermediary markup. China could supply much of the required equipment, but Russian oil businesses can see the risk of getting into a strong dependence on Chinese suppliers.

The long-term effects of the sanctions will depend on how the Russian manufacturing sector will be progressing towards reducing the imports reliance. It took 9 years to cut this reliance from 60 to 40%. As the import substitution targets become more ambitious, each additional percent of import reliance reduction takes longer to achieve, as more sophisticated technologies need to be substituted. The 20% reduction target for equipment imports by 2025 is unrealistic. It might take much longer (several decades) to substitute the last 20%.

4.5 Natural gas

All of the restrictions on gas supply to Europe were imposed by the Russian side. Natural gas export requires either pipeline or LNG infrastructure and the willingness of exporters and importers to use it. Before February 24th, six pipelines were used to supply Russian gas to Europe: through Finland, the Baltic states, Poland via Yamal-Europe, Nord Stream, Ukraine, and Turkey. After some countries had declined the Russian requirement to pay for gas in rubles, gas supply was terminated to Bulgaria, Poland, Finland, Denmark, and the Netherlands. Gas flow through Nord Stream-1 was reduced on the pretense of the restrictions on gas turbines maintenance.⁴⁹ In May 2022, the Russian government imposed sanctions on the Polish company EuRoPol Gaz S.A., which owns the Polish section of the Yamal-Europe natural gas pipeline.⁵⁰ The Nord Stream pipelines were damaged in September 2022 with vague restoration perspectives. Today, Russia is exporting the equivalent of 26 bcm per year of pipeline gas through Ukraine and TurkStream, and only LNG exports from Russia were not affected by the sanction war. In March 2023, the European Commission suggested that the EU countries extend the emergency measures to curb gas demand for the next 12 months to help Europe to live through the 2023/24 winter.

Chyong et al (2023) assessed 5 options to maintain or expand Russian natural gas exports (see Table 4.3 and Figure 4.3). CENEF-XXI added some additional dimensions to the assessment of the probability that local markets will succeed in absorbing more natural gas from Russia.

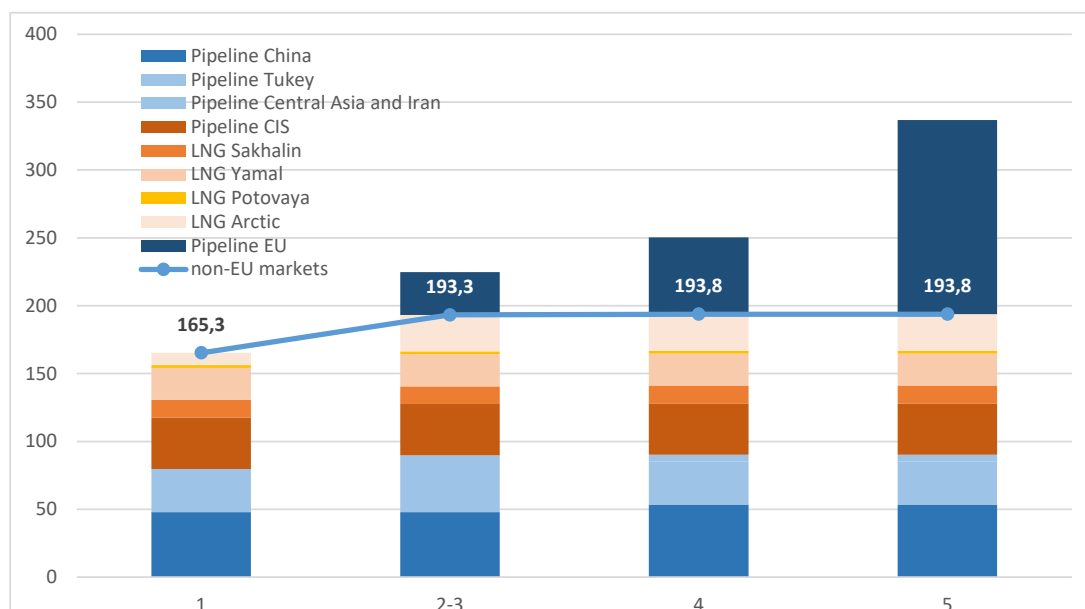
⁴⁹ Chyong C. K., A.-S. Corbeau, I. Joseph, and T. Mitrova. Future Options for Russian Gas Exports ENERGYPOLICY.COLUMBIA.EDU | JANUARY 2023 CENTER ON GLOBAL ENERGY POLICY [Russian-Gas CGEP Commentary 011823-5.pdf \(columbia.edu\)](https://www.columbia.edu/~ce2123/2023-01-05-Russian-Gas-CGEP-Commentary-011823-5.pdf).

⁵⁰ Annual capacity of 33 bcm. The Polish section spans 683 km.

Table 4.3 Assessment of five options to keep or expand Russian natural gas export

Options to keep or expand Russian natural gas export	Political conditions and sanctions	Security considerations	Markets and time limits	Probability to expand gas sales
Restart exports to Europe in reduced volume	Stop military operation and start successful peace negotiations	EU sets a target to refuse Russian gas use by 2027		Low
Increase pipeline sales to Asia		Asian consumers try to diversify gas supply	Pipeline construction takes a long time. Limited additional market for Russian gas with possible market reduction beyond 2035	Limited
Increase LNG exports	Sanctions on technologies and financing			Moderate
Increase domestic use and exports to Central Asia			Limited additional market	Limited
Use export routes through intermediaries, such as Turkey			Pipeline construction takes a long time, and the transition country has a large market power	Limited

Sources: CENef-XXI based on Chyong C. K., A.-S. Corbeau, I. Joseph, and T. Mitrova. Future Options for Russian Gas Exports ENERGYPOLICY.COLUMBIA.EDU | JANUARY 2023. CENTER ON GLOBAL ENERGY POLICY [Russian-Gas_CGEP_Commentary_011823-5.pdf \(columbia.edu\)](https://Russian-Gas_CGEP_Commentary_011823-5.pdf).

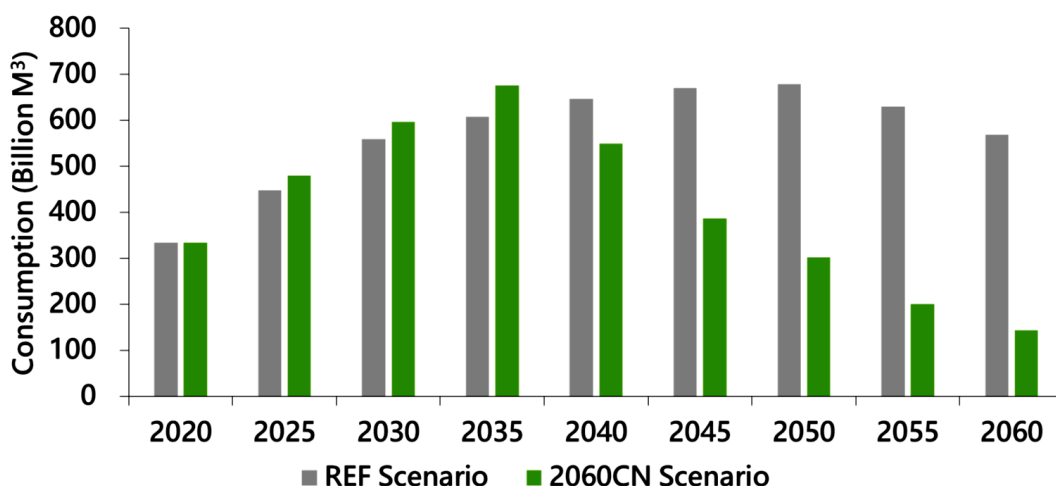
Figure 4.3 Technically feasible options for Russian natural gas exports in 2030 (bcm)

Sources: Based on Chyong C. K., A.-S. Corbeau, I. Joseph, and T. Mitrova. Future Options for Russian Gas Exports ENERGYPOLICY.COLUMBIA.EDU | JANUARY 2023. CENTER ON GLOBAL ENERGY POLICY [Russian-Gas_CGEP_Commentary_011823-5.pdf \(columbia.edu\)](https://Russian-Gas_CGEP_Commentary_011823-5.pdf). Export to the CIS countries (37.7 bcm) was added for all of the options.

Even if all longed-for projects of re-directing gas flows to the East are successful, Russia will still need to export at least 50-60 bcm to the EU market, if it wants to get back to the 2020-

2021 export volumes. If the country fails to return to the EU market, Russian gas export will, at the best, stay at the 2022 level till 2030. Potentially, gas export to non-EU markets might reach 165-194 bcm by 2030. This is close to the 2022 gas export (184 bcm). Re-directing pipeline gas to the East incurs the risks associated with the strong sole-buyer position (China) or strong market power of the transition country (Turkey). IEA expects Chinese gas market to go 75-100 bcm up by 2030-2050, then peak in 2030-2040 with a subsequent decline.⁵¹ BP's "New Momentum" scenario implies a more dynamic gas demand growth (additional 240 bcm) and a peak in 2045. OPEC and Institute of Energy, Environment and Economy, Tsinghua University (see Figure 4.4), project additional gas demand growth by 290-300 bcm by 2045 and a peak thereafter.⁵² Potential Russian gas pipelines may additionally supply 38 bcm. However, they will take 10-15 or more years to build, and so might reach design capacity at the time of, or even beyond, the peak demand. The more China progresses towards its 2060 carbon neutrality target, the higher the risks associated with the launch of Russian pipeline gas supply after the peak. If delayed, gas supply may be lower, and last for decades only, on China's terms and conditions. Therefore, it is questionable, if the huge investment will ever pay back.

Figure 4.4 China natural gas consumption projections



Source: Zhang Xiliang. China's Energy Security in the Context of Carbon Pricing. Institute of Energy, Environment and Economy. Tsinghua University. October 2022. The 22nd Annual IEA_IETA_EPRI Workshop on Greenhouse Gas Emission Trading.

Production at Russian old gas fields is expected to scale down to 490 bcm by 2030, 370 bcm by 2040, 275 bcm by 2050, and 200 bcm by 2060. In order to offset this decline and to meet domestic and export demand, new high-tech technologies are needed to explore new fields and transport gas to the consumers. Technological sanctions may impede meeting this demand. Energy Strategy of the Russian Federation adopted in 2020 sets extremely ambitious natural gas production targets: 795-820 bcm for 2024 and 860-1000 bcm for 2035. Now it is obvious, that neither range is attainable for two reasons: first, because domestic demand and exports are unlikely to exceed 600 bcm for the decades to come (see Chapter 5); and second, because of the serious reliance on imported technologies, particularly for LNG and gas pumping stations.

According to the Gas Industry Association of Equipment Manufacturers, in 2020, the share of domestic equipment for gas production was 55%. Back in 2014, it was 40%.⁵³ There is

⁵¹ IEA. World Energy Outlook. 2022.

⁵² BP Energy Outlook 2050: January 2023.

⁵³ [Speeding up local content – Kommersant St. Petersburg \(kommersant.ru\).](#)

some progress, but simple extrapolation means that it might take a quarter of a century (>45%/(55%-40%)*6 years) to reach full self-sufficiency and is quite unlikely. Additional restrictions on pipeline gas supply are imposed by the US sanctions on gas turbines. Both Siemens and Baker Hughes stopped their activities in Russia. This means problems not only in terms of equipment delivery for new pumping stations, but also in terms of maintenance of those in place, including TurkStream and the Power of Siberia. Russia's reliance on gas turbine imports exceeds 90%. There is no domestic production of high-capacity turbines. Over 75% of the imports were provided by countries that have imposed sanctions: the Czech Republic (33%), Canada (30%), USA (22%), and France (8%).⁵⁴

Increasing LNG exports becomes the most promising option; however, some of the announced projects have faced Western sanctions in terms of access to financing and liquefaction technologies. Therefore, the launch of these projects is likely to be delayed. Energy Strategy of the Russian Federation sets the following LNG production targets: 46-65 Mt (63-90 bcm) for 2024 and 80-140 Mt (110-193 bcm) for 2035. In 2022, production stood at 45.7 bcm, so by 2024 it was expected to double or triple. Six LNG projects were announced with 51 Mt (70 bcm) total capacity. Due to the sanctions, they will be either delayed or cancelled. LNG production volume scheduled for 2035 may be 15 or more years delayed. In its 2022 World Energy Outlook, IEA expects Russian LNG production down from the earlier projections by about 30 bcm in 2035.⁵⁵ Chyong et al. (2023) estimate possible medium-term LNG exports at 48-66 bcm,⁵⁶ or twice as low as the Russian Energy Strategy expected for 2024. BP estimates LNG supply from Russia at 65-107 bcm in 2030 and 63-171 bcm in 2050, or below the range set by the Energy Strategy for 2035. Declining natural gas prices along with growing fiscal pressure (Figure 4.2) limit the financing available to invest in expanding natural gas supply.

Imported technologies reliance for LNG production is estimated at 70%⁵⁷- 80%, in offshore operations 85%, in drilling equipment 80%.⁵⁸ Russia has no domestic technology for the production of large-tonnage LNG, and so all major projects critically rely on foreign technologies. After the first sanctions were imposed in 2014, the Russian government developed a roadmap in 2018 for the localization of LNG equipment production. In 2020, a long-term LNG production development program, which specified a list of equipment, was approved. In 2021, Russian Ministry of Industry approved a program to localize equipment for LNG projects in Russia until 2030 setting the following targets: to bring the share of Russian-made equipment in LNG projects to at least 40% by 2024 and up to 80% by 2030. Some progress was achieved towards the localization of equipment production for small-tonnage LNG – the share of Russian equipment is 90% (the Arctic Cascade). However, it is a long way to go for medium- and large-capacity production. Meanwhile, restricted technology access hampers the participation of foreign companies in Arctic LNG-2 project. Technip Energies, which is into the design and supply of equipment, materials and components, construction and the project commissioning; Siemens (a compressor supplier), Baker Hughes (turbines), Linde (heat exchangers), Royal Boskalis Westminster (the world's leading provider of dredging, marine power and land infrastructure services) – all terminated their participation in this and other projects.⁵⁹ Linde notified Gazprom of its withdrawal from the Baltic LNG gas terminal construction project in Ust-Luga, and withdrew

⁵⁴ <https://www.rbc.ru/business/01/08/2022/62e7793f9a7947a9cdbbab12>.

⁵⁵ IEA. World Energy Outlook. 2022.

⁵⁶ Chyong C. K., A.-S. Corbeau, I. Joseph, and T. Mitrova. Future Options for Russian Gas Exports ENERGYPOLICY.COLUMBIA.EDU | JANUARY 2023 CENTER ON GLOBAL ENERGY POLICY [Russian-Gas CGEP Commentary 011823-5.pdf \(columbia.edu\)](#).

⁵⁷ [Technological sovereignty: the basis for Russia's sustainable involvement in the global LNG market – Informational and analytical system Roscongress \(roscongress.org\)](#).

⁵⁸ [Russia's reliance on Western technologies for hydrocarbons processing is going through the roof \(expert-ural.com\)](#); [TEK Rossii | Focus on domestic equipment \(cdu.ru\)](#).

⁵⁹ Ibid.

from a joint venture with Severstal for the production of spiral-wound cryogenic heat exchangers for gas processing and LNG production. Baker Hughes announced service termination for all Russian LNG projects and halting shipments of equipment for Arctic LNG-2, primarily gas turbines. Because of the sanctions, Novatek-owned Sovcomflot failed to pay for the construction of three LNG tankers from South Korea.⁶⁰

4.6 Coal

Coal production in Russia will be affected by sanctions on coal import from Russia, on the one hand, and sanctions on coal mining and enriching equipment supply to Russia, on the other. In 2022, Russian coal exports were down by 17 Mt and the declining trend is expected to persist in the decades to come. Russian Ministry of Energy expects coal production to go 3-12.5% down in 2030 alongside 2-30% export decline.⁶¹ Following the EU ban on Russian coal imports and the decisions made by the UK, US, Japan, and South Korea to limit coal imports from Russia, Russian coal exports in 2022 were 7.5% down to 211 Mt.⁶² In 2021, Russia's coal export to Europe was about 50 Mt, or 22% of the total coal export. In other words, in 2023, this market lost the equivalent of one fifth of the whole year's export. This loss was only partially offset by re-orienting export flows to the East; in addition, transport bottlenecks make the situation more complicated. For many years, coal delivery by railroad transport had been supported by a system of cross-subsidies in railway tariffs, which was a big pressure on the rest of the economy. Russian Railways used to charge coal exporters 0.195 rubles/10t-km, whereas the tariff for ferrous metals was 0.687 rubles/10t-km, and for oil and petroleum products 0.805 rubles/10t-km.⁶³ As a result, coal contributed 43% to the Russian Railways freight turnover. These subsidies were recently removed. Coal export prices are sliding down (Figure 4.2); huge (45-60%) price discounts⁶⁴ offered in the Eastern markets, along with additional tax pressure, undermine the economics of coal export. As prices and discounts are declining, so is the attractiveness of Russian coal in Eastern markets.

Reliance of the Russian coal industry on imported equipment is even higher, than of the oil and gas industry, and was growing in 2014-2022. Reliance on imported equipment for coal mining was 64% in 2014 and reached 68% in 2017. It was 52% for mines and 83% for quarries, and reached 100% for bucket-wheel excavators and 31-110 t mining tracks.⁶⁵ Today, the share of foreign-made mining and transport equipment in the coal industry has reached 80-85%,⁶⁶ therefore, the primary challenge is to ensure the functioning of the U.S., Polish, Japanese and other imported equipment and the supply of spare parts. Russian-made "reverse engineering", parallel import and import from China are also available options. Import reliance on China may become just as severe, as on the Western countries.

All additional coal production since 2010 (115 Mt) was based on imported equipment. As its service life expires, coal production may be 20-25% down in 2035, due to the lack of appropriately functioning mining equipment and little progress towards import substitution. Local machinery production may grow in some niches, but there is a long way to go in terms of scaling down the import reliance even to the 2014 level and then beyond.

⁶⁰ Ibid.

⁶¹ [Russian coal industry development perspectives under the sanctions. Analysis by DELOVOY PROFILE Group \(delprof.ru\).](#)

⁶² [Russian energy sector-2022: challenges, results, and perspectives – Energy Policy.](#)

⁶³ [Sanctions plus tax: Russia's coal revenues turning into dust — Latest news from Russia and the world | New Izvestia \(newizv.ru\).](#)

⁶⁴ Ibid. [Turn to the East at the right coal. Western sanctions hit coal miners, Russian Railways, and millions of people living in Russia's resource regions \(vgudok.com\).](#)

⁶⁵ Plakitkina L.S., Yu.A. Plakitkin, K.I. Dyachenko. Estimating the reliance of Russian coal companies on the equipment imports. *Gornaya Promyshlennost [Mining Industry]*. No. 3 (139) 2018. (In Russian).

⁶⁶ [Sergey Kononenko: coal industry upgrades require consolidation of the market participants \(angi.ru\).](#)

4.7 Non-fossil fuels export and import perspectives

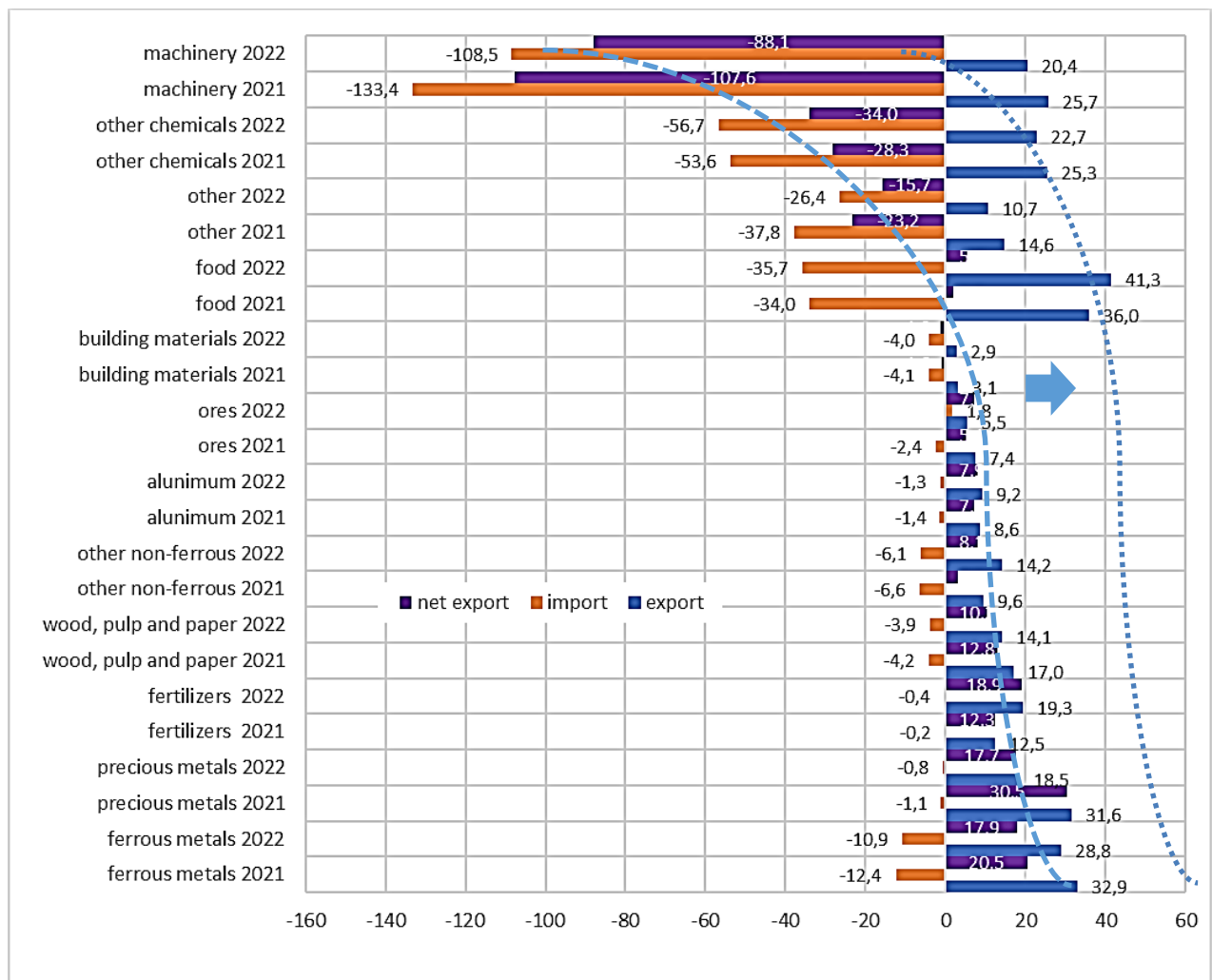
In 2022, sanctions led to substantial reductions in non-fossil fuels export revenues despite the higher prices compared to 2021. Long-term effects from the sanctions depend on how long they will be in place. Some of the sanctions date back to 2014, so some conclusions can be drawn up in terms of relatively soft, long-lasting sanctions. In 2022, EU and other countries imposed much more severe sanctions, which cover steel, steel products and iron, gold, jewelry, cement, asphalt, wood, paper, synthetic rubber and plastics, seafood and liquor (e.g. caviar and vodka), cigarettes and cosmetics.⁶⁷ Steel, steel products and iron, as well as precious metals and other chemicals (including plastics), used to be the largest contributors to Russian non-fuel export revenues. Therefore, changes in the logistics and export destinations cannot prevent sufficient decline in export volumes and value. This decline is expected to increase, as in 2023 prices are down from their high 2022 levels. As far as food exports are concerned, since the banned items are of minor importance and food prices skyrocketed in 2022, the value of food exports grew up in 2022. When logistical bottlenecks are handled and new markets are penetrated, the effects of the sanctions on non-fossil fuel exports may be partially mitigated, but the sanctions will obviously have long-lasting effects.

In 2021-2022, the gap between imports of goods and services and non-fuel exports of goods and services was US\$ 90-100 billion. Russian fuel export is expected to decline to US\$ 90-180 billion in the decades to come,⁶⁸ while the import of non-fuel goods and net import of services is expected to reach US\$ 300 billion in 2030 and scale up to US\$ 780-850 billion in 2050-2060. If this gap is to be bridged, the “lowered hand” shape curve bordering net export data in Figure 4.5 should substantially drift right. The largest Russia's foreign trade deficit is for machinery and equipment: US\$ 88-109 billion in 2021-2022. If weapons export is taken away (US\$ 8 billion in 2022⁶⁹), this deficit scales up correspondingly. The second largest deficit is for chemicals (mostly pharmaceuticals and plastics): Russia imports US\$ 54-57 billion-worth chemicals, while exports only the equivalent of US\$ 23-25 billion. The third largest component of the trade deficit is “other” – mostly durable and semi-durable consumer goods (except for appliances).

⁶⁷ [EU sanctions against Russia explained - Consilium \(europa.eu\).](https://www.consilium.europa.eu/en/press/press-releases/2022/03/22-eu-sanctions-against-russia-explained/)

⁶⁸ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichok, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENEf-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060>.

⁶⁹ [Russian arms exports to reach \\$8 billion in 2022 — Putin - Russian Politics & Diplomacy - TASS.](https://tass.com/economy/2022/03/22/russian-arms-exports-to-reach-8-billion-in-2022-putin)

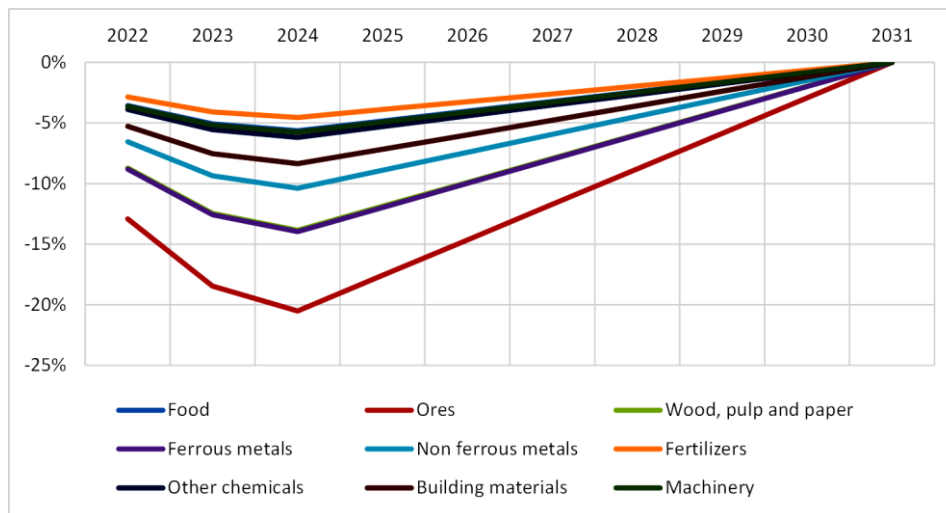
Figure 4.5 Russian non-fuel export and import in 2021-2022 (\$US billion)

Source: Federal Customs Service <https://customs.gov.ru/statistic/vneshn-torg/vneshn-torg-countries>.

The sanctions imposed on Russian imports have two major effects: a) reduced intermediate goods supply affects output, as inventories are depleted, and b) reduced investment goods supply, which works to reduce the ability to scale up production and hampers import substitution. The first component was assessed based on the methodology described in section 4.3.⁷⁰ It helps to establish the depth of the production decline. The assumption was, that the bottom will be reached in 2024, and by 2031 either the sanctions will be removed, or intermediate goods will be totally replaced either with domestically produced items or with those imported from other – friendly – countries. With the present set of sanctions and available alternative supply, export-oriented industries are facing 5-20% production decline, which will persist to 2031 (Figure 4.6).

⁷⁰ Bashmakov I. The angle of incidence is not equal to the angle of reflection. [CENef-XXI](#).

Figure 4.6 Production decline by industries resulting from sanctions on exports and imports



Source: The authors.

With the destroyed supply chains and very weak Russian competitive positions in many global machinery and equipment markets, hampered access to high-tech and financing, feasible import substitution and export expansion is unlikely. In 2021-2022, import covered about 40% of total machinery and equipment supply (by value). Much of the domestic machinery output was about assembling equipment from imported components. Therefore, real physical reliance on imports is even more substantial. Complete import substitution is equivalent to scaling up domestic machinery production by two thirds or even by 100% in value, ensuring comparable quality and competitive costs. In recent years (2015-2021), AAGR for Russian machinery industry were 1.5-2.7% for different equipment groups. If the time horizon is extended to 2015-2022, AAGRs were close to zero. In order to ensure full import substitution, say, in 10 years, Russia needs to scale up AAGRs for machinery and equipment manufacturing beyond 5% per year. Is this mission possible?

The sanctions brought machinery import down by US\$ 25 billion in 2022. In the coming years, this decline may be growing and undermining the growth and import substitution potential of the Russian economy. The list of import restrictions includes: cutting-edge technology (e.g. quantum computers and advanced semiconductors, electronic components and software); certain types of machinery and transportation equipment; specific goods and technology for oil refining; energy equipment, technology and services; aviation and space industry goods and technology (e.g. aircraft, aircraft engines, spare parts or all kinds of equipment for planes and helicopters, jet fuel); maritime navigation goods and radio communication technology; a number of dual-use goods (those that could be used for both civil and military purposes), such as drones and software for drones or encryption devices; luxury goods (e.g. luxury cars, watches, jewelry); civilian firearms and other army materiel.⁷¹

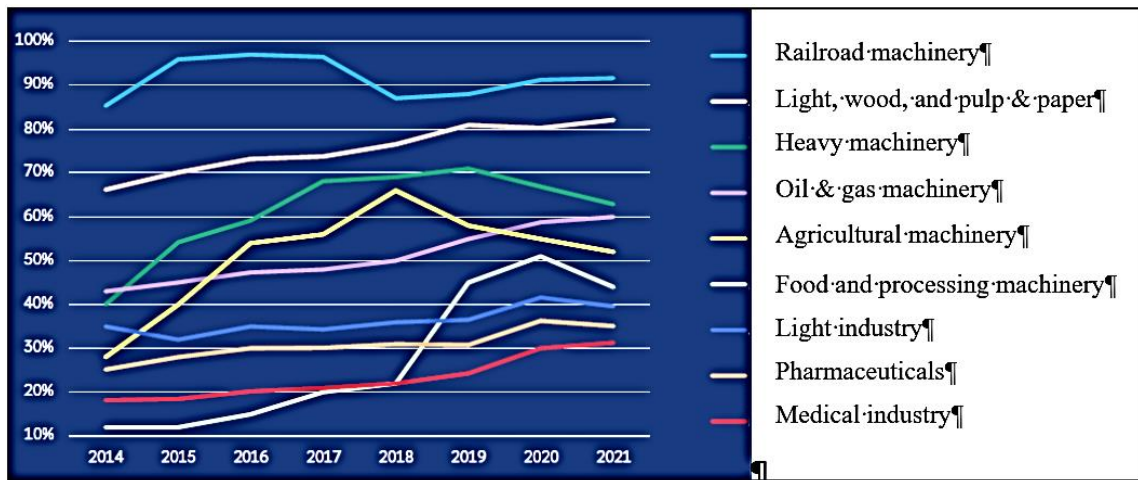
For many machinery manufacturing subindustries, the level of localization is below 70% and showing only slow progress (Figure 4.7). When the economy revives, like in 2021 after the COVID-19 pandemic, the localization progress stops. The critical import reliance (no Russian analogs and no (or limited) alternative foreign suppliers) in nearly all industries in 2018 were at the following levels: for parts and components 15-44%; for equipment 18-37%; for technologies 28-50%, and for engineering services, design, equipment service and repair 35-57%.⁷² Therefore, there

⁷¹ [EU sanctions against Russia explained - Consilium \(europa.eu\).](https://www.consilium.europa.eu/en/press/press-releases/2022/03/23/eu-sanctions-against-russia/)

⁷² HSE. Import substitution in Russia: yesterday and tomorrow. February 2023. [814560067.pdf \(hse.ru\).](https://hse.ru/data/2023/02/28/14560067.pdf)

is a long and thorny way to self-sufficiency – the goal which is presently attainable only by a primitive economy, which can do with technologies that are far from the technological frontiers.

Figure 4.7 Proportion of domestic products in 2014-2021 consumption



Source: HSE. Import substitution in Russia: yesterday and tomorrow. February 2023. [814560067.pdf \(hse.ru\)](https://hse.ru/publications/814560067.pdf)

In its recent analysis, the Higher School of Economics concluded:⁷³

- **The most successful import substitution may be expected in industries which are far from the technological frontiers** (agro-industrial complex, woodworking, pipes, furniture);
- In industries close to the technological frontier (aerospace, pharmaceuticals), opportunities for import substitution are limited, subcontracting networks are not sufficiently developed for localization and human capital is not sufficiently available;
- **The import substitution model with "rapid" use of foreign technologies (assembling) without producing "rooting" (localization) can increase the technological dependence.** One example is Russian automobile industry over the last two decades;
- Sustainable import substitution requires getting beyond the “threshold level” of change (own research, development and key components manufacturing). It takes time to approach and go beyond these thresholds, and there is no overnight import substitution success;
- The import substitution policy so far has focused on individual industries or products, ignoring the holistic approach. It is important to switch the focus to clusters of interconnected industries and services along the whole supply chain;
- The competitiveness of import-substituting products is a key. Export-oriented activities make import substitution sustainable and increase resilience to external shocks and interruptions in supply chains;
- Successful import substitution practices are based on entrepreneurial motivation and companies' preparedness to modernization and risks. It is important to create conditions for initiating bottom-up import substitution projects;
- For many products, import substitution is a long-term process, which for many directions requires global orientation.

⁷³ HSE. Import substitution in Russia: yesterday and tomorrow. February 2023. [814560067.pdf \(hse.ru\)](https://hse.ru/publications/814560067.pdf).

The theoretical results show, that if import substitution does not provide local products of comparable quality at comparable costs, potential GDP declines.⁷⁴ Even with effective import substitution, private consumption is declining because scarce skilled labor is diverted to import substitution and also because of the higher capital intensity of GDP. Where import substitution of investment goods is not so cost-effective, as of consumer goods, the import structure shifts towards investment goods. Import substitution in the consumer sector may be accompanied by growing consumer prices. If import substitution is ineffective in both sectors, then further decline of the economy is inevitable. Total factor productivity declines and production costs grow, as import substitution progresses.

The impact of sanctions on investment goods was already tangible in 2022. The share of machinery and equipment in the structure of gross fixed capital formation in 2022 was 3% down from its record 39.5% level in 2021. It is difficult to assess long-term effects of sanctions on investment goods, but it is clear that accumulation of fixed capital will slow down, the installed equipment will be less sophisticated and will have lower productivity. The critical shortage of skilled labor force will become even more critical. Slower and more primitive investments will slow down the economic growth to some 0.5-1.5% per year. Machinery supply from China (a) does not allow to address import reliance; (b) does not offer all required alternatives; (c) provides equipment of lower quality and productivity and potentially at higher costs. On this path, the risk of Russia's position as China's raw material colony reaches or even goes beyond the critical levels.

Russia can only reduce its import reliance through the re-integration into global supply chains and by pursuing thoughtful sustainable and efficient technology development policies based on competition and innovation and appropriate education and training. Such policies require that government officials be selected based on their professional expertise, rather than on their loyalty to the regime. So far government officials have demonstrated low capacity to address this problem.

⁷⁴ Lymar M.S., Reentovich A.A., Sinyakov A.A. A commodity exporting economy under “the new reality”: Aggregate and structural changes. *Voprosy Ekonomiki*. 2022;(12):44-71. (In Russ.) <https://doi.org/10.32609/0042-8736-2022-12-44-71>.

5

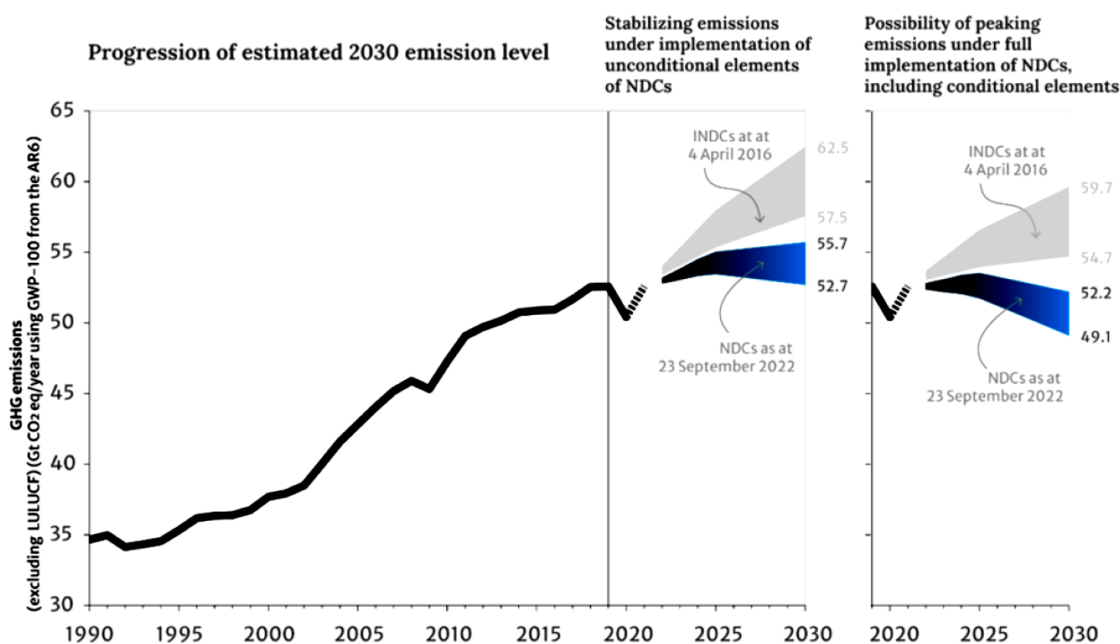
Global decarbonization and Russia's foreign trade: long term effects

5.1 Post-COP27 inventory of decarbonization targets and policies

5.1.1 NDCs: first baby steps on the long and thorny decarbonization pathways

If all the latest NDCs, including conditional elements, are to be implemented, global GHG emissions should peak before 2030 at 3.6% (0.7–6.6%) below the 2019 level. Net of conditional NDCs elements, GHG emissions are still on the rising trend and in 2030 will be 3.1% (0.2–6.0%) up from the 2019 level. UNFCCC 2022 update of the NDC synthesis report assessed 166 NDCs presented by the Parties to the Paris Agreement. This list includes all new or updated NDCs registered before 23 September 2022, covering 95% percent of total global 2019 GHG emissions (52.6 Gt CO₂eq without LULUCF). 26 parties communicated their new or updated NDCs after COP26.⁷⁵ Time horizon for NDCs commitments is to 2030. In updated NDCs, global emissions in 2025 and 2030 are about 2.4% (1.8–3.0%) and 4.7% (4.8–4.7%) down respectively from 2021 synthesis report and much below the emission levels shown in INDCs presented before April 2016 (Figure 5.1). If the emissions are to peak, conditional elements of NDCs have to be met. They include: access to financing, technology transfer and technical cooperation, capacity-building, Article 6 market-based mechanisms, and taking account of the absorption capacity of forests and other ecosystems.

Figure 5.1 Historical and projected total global emissions according to nationally determined contributions



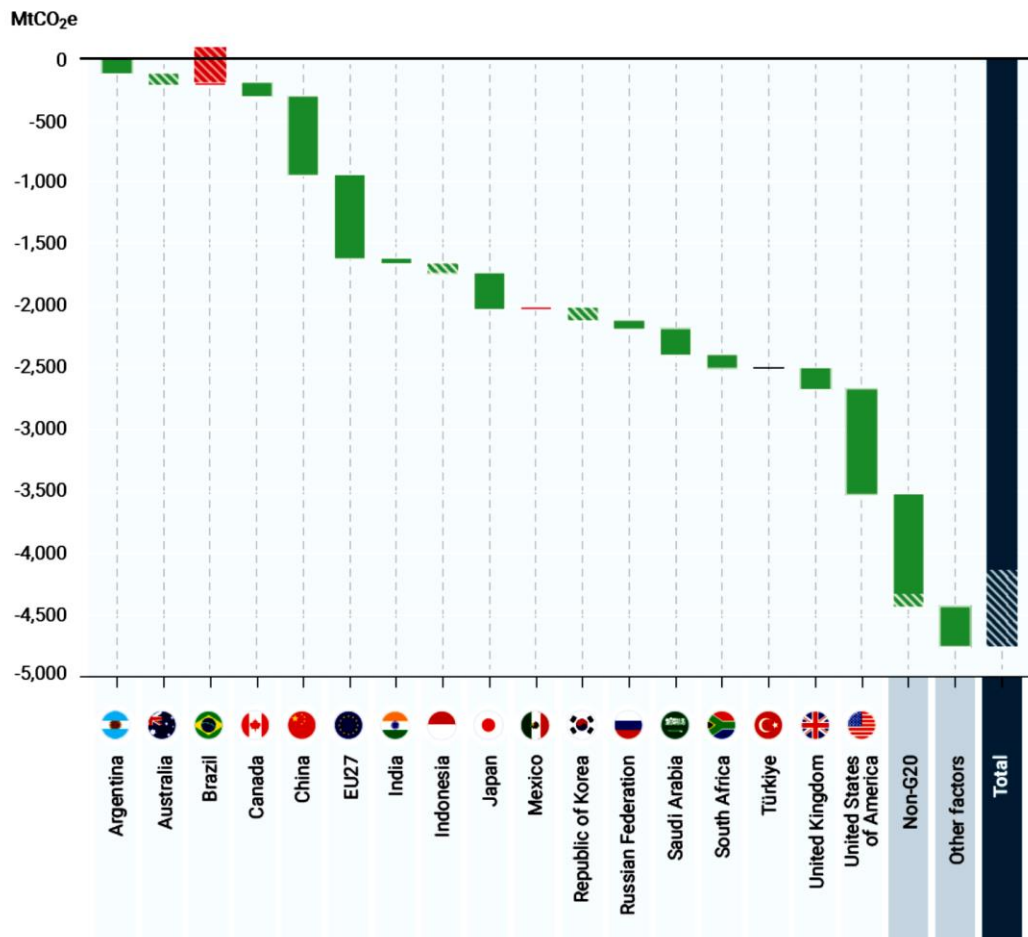
Note: For comparison, global emissions with LULUCF in 2030, when taking into account implementation of the new or updated NDCs (blue areas), are estimated to be 56.4 (54.9–57.9) Gt CO₂ eq considering unconditional elements and 52.8 (51.3–54.4) Gt CO₂ eq assuming full implementation.

Source: UNFCCC. 2022. Nationally determined contributions under the Paris Agreement. Synthesis report by the Secretariat. 26 October 2022.

⁷⁵ UNFCCC. 2022. Nationally determined contributions under the Paris Agreement. Synthesis report by the Secretariat. 26 October 2022.

Many of additional GHG emissions reduction commitments were made after the initial Paris Agreement pledges had been announced by Russia's major trade partners – China, Canada, the EU, US, and UK (Figure 5.2). Emissions Gap Report 2022 points out that the implementation of new and updated unconditional NDCs is projected to cut 2030 global GHG emission by 4.8 Gt CO₂e (1.7–7.9 GtCO₂e) annually, compared with initial pledges. For the NDCs updated in 2022 additional reduction is 0.7 Gt CO₂e.⁷⁶

Figure 5.2 Impact of new and updated unconditional NDCs on 2030 global emissions compared with initial NDCs



Source: United Nations Environment Programme (2022). *Emissions Gap Report 2022: The Closing Window — Climate crisis calls for rapid transformation of societies*. Nairobi. <https://www.unep.org/emissions-gap-report-2022>.

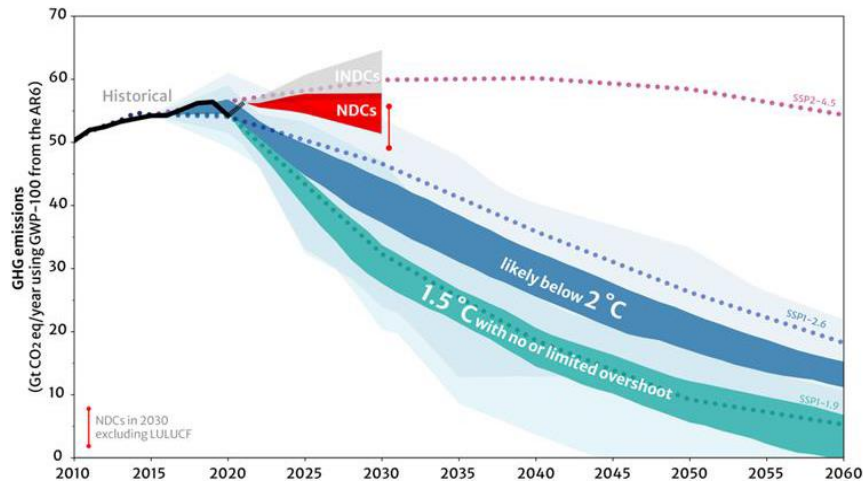
WG III IPCC 6AR concluded,⁷⁷ that global GHG emissions in 2030 associated with the implementation of NDCs announced prior to COP26 would make it likely that warming will exceed 1.5°C during the 21st century. Limiting warming to below 2°C would then rely on a rapid acceleration of mitigation efforts after 2030. After COP27, this statement is still valid. In 1.5°C warming scenarios (with over 50% likelihood) with no or limited overshoot, GHG emissions in 2030 are 43% (34–60%) below the 2019 level; and in below 2°C warming scenarios (with over

⁷⁶ United Nations Environment Programme (2022). *Emissions Gap Report 2022: The Closing Window — Climate crisis calls for rapid transformation of societies*. Nairobi. <https://www.unep.org/emissions-gap-report-2022>.

⁷⁷ IPCC, 2022: Summary for Policymakers. In: *Climate Change 2022: Mitigation of Climate Change*. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.001.

67% likelihood) 2030 emissions are 27% (13–45%) below the 2019 level (Figure 5.3). With full NDCs implementation global GHG emission will peak before 2030 at the best, with a limited potential for decline. The Emissions Gap Report 2022 estimates, that with full implementation of unconditional NDCs the gap with 1.5°C pathways is 23 Gt CO₂e (range: 20–24 Gt CO₂e) and the emissions gap with below 2°C pathways is about 15 Gt CO₂e (range: 12–16 Gt CO₂e).⁷⁸

Figure 5.3 Comparison of scenarios assessed in the IPCC 6AR with projected global emissions according to NDCs



Source: UNFCCC. 2022. Nationally determined contributions under the Paris Agreement. Synthesis report by the Secretariat. 26 October 2022.

5.1.2 Long-term commitments: roadmaps to final destinations

As of September 23, 2022, 88 UNFCCC parties had made long-term net-zero pledges covering 79% of global GHG emissions, including 21 parties by law; 47 parties via policy documents (NDCs or long-term strategies); and 20 parties by announcement made by high-level officials. 14 parties made such commitments after COP26. Net-zero pledges to 2050 cover 36% of global GHG emissions, 43% emission is covered by net-zero pledges beyond 2050.

19 of G20 members, including Russia, have already committed to net-zero emissions. This will work to decrease global fossil fuel demand in the decades to come and to create huge markets for low carbon products and technologies. Many G20 countries are already on the declining GHG emission trajectory (Figure 5.4). Others first need to peak (China has committed to emission peaking before 2030) before large reductions are expected. This type of dynamics will take more time to meet the net-zero commitments, which they set for 2060-2070.

In the last 30 years, global energy system failed to go through really transformational changes and to reduce GHG emissions. Current low carbon transition is expected to reshape the global economy and energy landscape. Projections for three decades published back in 1992 were quite close to reality, so the changes were mostly foreseeable and relatively marginal.⁷⁹ A net-zero transition would have substantially changed the demand for products and services, capital allocation, costs, and jobs.⁸⁰ As this transformation is in process, global fossil fuel demand is declining, whereas the demand for materials required for global decarbonization scales up, and so

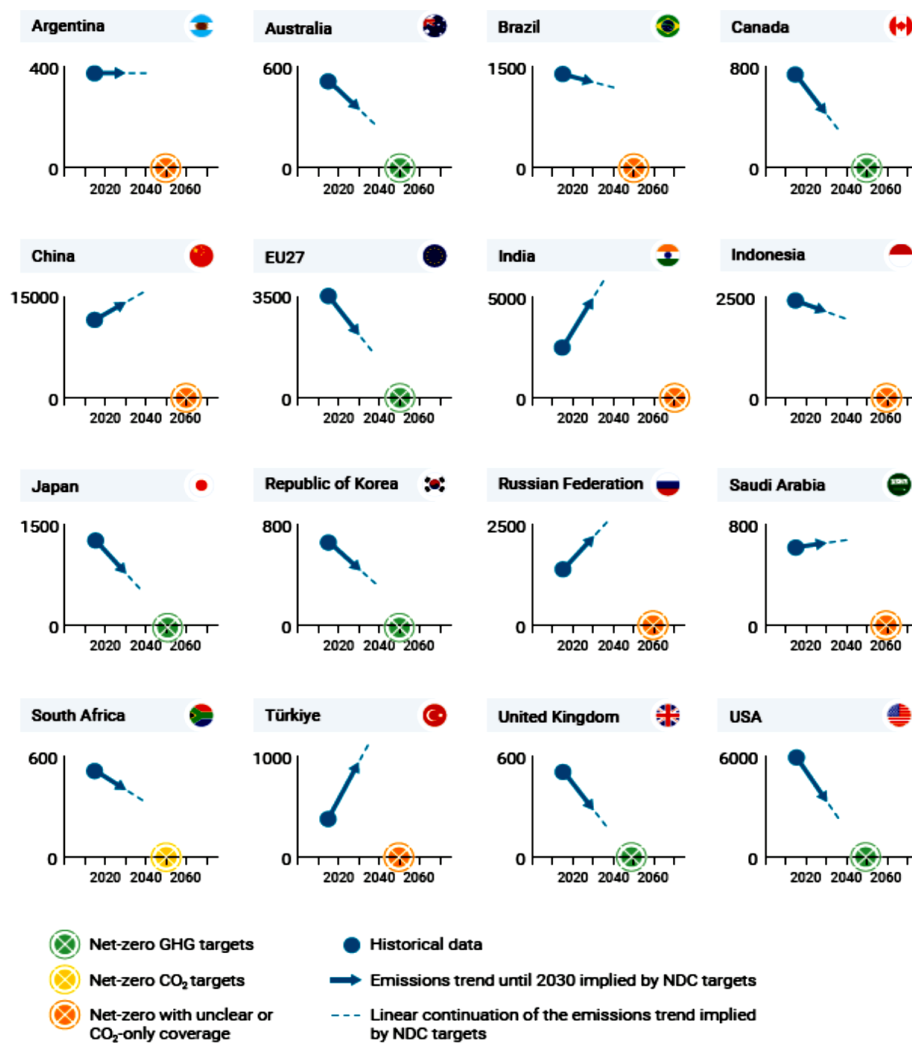
⁷⁸ United Nations Environment Programme (2022). *Emissions Gap Report 2022: The Closing Window — Climate crisis calls for rapid transformation of societies*. Nairobi. <https://www.unep.org/emissions-gap-report-2022>.

⁷⁹ Bashmakov I.A. Projections of the global energy system evolution 30 years later: Checking the lessons of the future by the past experience. *Voprosy Ekonomiki [Issues of Economy]*. 2022;(5):51-78. (In Russ.) <https://doi.org/10.32609/0042-8736-2022-5-51-78>.

⁸⁰ McKinsey Global Institute. 2022. The net-zero transition. What it would cost, what it could bring. January 2022.

do low carbon technology markets. Total investment is expected to grow, particularly investment in low carbon technologies, which will skyrocket. The costs of low carbon power and basic materials may rise at first and then decline; the growth in the investment and carbon price cost components will be offset by a decline in fuel and other operational costs. The potential cost growth is much below the volatility that huge fluctuations in fuel costs have been historically injecting into the global economy. The costs of vehicles ownership and life-cycle costs of building ownership will go down. Improved energy and material efficiency along with growing circularity will reduce resource extraction. The product structure of international trade will change, as fossil fuel markets are losing their dominance. Fossil fuel-based economies, if not timely adjusted, may lose their share in global GDP. So that they can mitigate these risks, technological, human, and physical capital should be timely mobilized.

Figure 5.4 Emissions trajectories implied by NDCs and net-zero targets of G20 members



Notes: The figure shows national net emissions in MtCO₂e/year over time. The timing of net-zero targets is approximate in this figure for G20 countries that have net-zero targets that only apply to CO₂. CO₂-only net-zero targets imply later (or no) achievement of net-zero GHG emissions (see table 3.4).

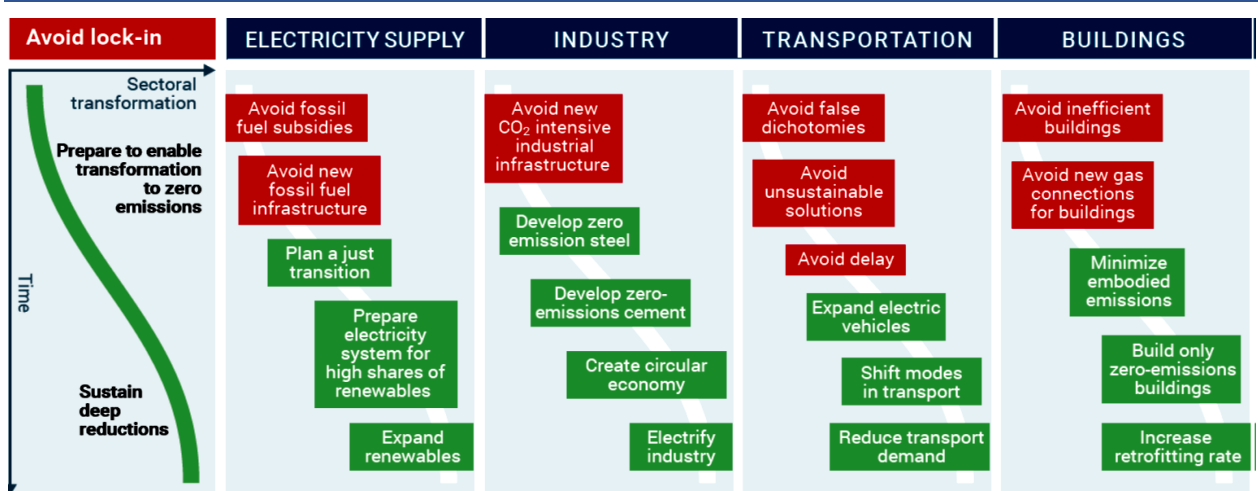
Source: United Nations Environment Programme (2022). *Emissions Gap Report 2022: The Closing Window — Climate crisis calls for rapid transformation of societies*. Nairobi. <https://www.unep.org/emissions-gap-report-2022>.

McKinsey Global Institute highlights six features which characterize the shifts in energy and land-use systems, economic sectors, and countries in the net-zero transitions:⁸¹

- **universal** – across all major GHG emitting sectors;
- **significant** – substantial change in technological basis, demand for products, capital allocation, costs, and jobs;
- **front-loaded** – requiring very intensive actions at initial stages;
- **uneven** – higher impacts on GHG intensive sectors and industries and on countries where such sectors dominate;
- **exposed to risks** – growth of climate change risks, asset-stranding risks, technological risks, rare materials supply risks, etc.;
- **rich in opportunities** – availability of natural capital, technologies, human, and physical capital, entrepreneurship, effective governance.

Net-zero targets for 53 parties cover all sectors. If these commitments are to be met, sectoral transformations have to build on deep technological change. These changes have been launched. The major technological shifts in the emitting sectors include acceleration of low carbon technological transformations (green colour in Figure 5.5.) and avoidance of carbon intensive technologies (red colour).

Figure 5.5 Selected important transformation interventions (green) and things to avoid (red) grouped by “avoiding lock-in” and different stages of the transformation S-curve



Source: United Nations Environment Programme (2022). *Emissions Gap Report 2022: The Closing Window — Climate crisis calls for rapid transformation of societies*. Nairobi. <https://www.unep.org/emissions-gap-report-2022>.

In **power and heat generation** low carbon transformation requires: dynamic growth of zero-carbon power proportion to 65-92% by 2030 and 90-100% by 2050; phasing out unabated coal- (in 2040-2050)⁸² and gas generation; large-scale application of grid storage and demand

⁸¹ McKinsey Global Institute. 2022. The net-zero transition. What it would cost, what it could bring. January 2022.

⁸² CAT, 2020: Paris Agreement Compatible Sectoral Benchmark. 67 pp.

https://climateactiontracker.org/documents/753/CAT_2020-07-10_ParisAgreementBenchmarks_FullReport.pdf.

management.⁸³ This would bring global carbon intensity down to 48-175 kg CO₂/kWh by 2030 and to (-)8-5 kg CO₂/kWh by 2050.⁸⁴

Transformation in the **industrial sector** should be based on reducing virgin basic materials demand; further development of circular economy; reduction in carbon intensity of cement, steel, non-ferrous metals and chemicals; scaling up the deployment of green hydrogen and biomass, improving material and energy efficiency. Such trends reduce global demand for materials and especially for those with high carbon footprint⁸⁵ to allow for carbon intensity reductions: for cement by 40% in 2030 and by 85-90% in 2050; for steel by 25-30% in 2030 and by 95-100% in 2050; for chemicals by 20-30% in 2030 and by 65-100% in 2050.⁸⁶

Climate mitigation requires transformation changes in the **transport sector**, including dynamic shift to low-emitting modes of transport (public transport, walking, cycling); deep electrification, including the move to zero-carbon cars (35-95% EV in stock by 2030⁸⁷ and 85-100% by 2050⁸⁸) and trucks; increasing the share of low emitting fuels (low carbon hydrogen, biomass) to 15% in 2030 and 70-95% in 2050 and transformation to zero-carbon aviation and shipping, where decarbonization options require additional R&D to reach 13-18% input to aviation fuels in 2030 and 78-100% in 2050.⁸⁹

In the **buildings sector**, key main mitigation options include: sufficiency – lower demand for excessive floor area; construction and retrofit of buildings to the level of zero energy/carbon buildings;⁹⁰ increase the renovation rate globally to 2.5-3.5% per year by 2030;⁹¹ electrification with low carbon power; fuel switch towards renewables and low emitting fuels; and reduction in embodied emissions in the construction process.

⁸³ Clarke, L., Y.-M. Wei, A. De La Vega Navarro, A. Garg, A.N. Hahmann, S. Khennas, I.M.L. Azevedo, A. Löschel, A.K. Singh, L. Steg, G. Strbac, K. Wada, 2022: Energy Systems. In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.008; IRENA (2022), World Energy Transitions Outlook 2022: 1.5°C Pathway, International Renewable Energy Agency, Abu Dhabi.

⁸⁴ CAT, 2020: Paris Agreement Compatible Sectoral Benchmark. 67 pp. https://climateactiontracker.org/documents/753/CAT_2020-07-10_ParisAgreementBenchmarks_FullReport.pdf.

⁸⁵ Bashmakov, I.A., L.J. Nilsson, A. Acquaye, C. Bataille, J.M. Cullen, S. de la Rue du Can, M. Fischedick, Y. Geng, K. Tanaka, 2022: Industry. In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.013.

⁸⁶ Ibid.

⁸⁷ United Nations Environment Programme (2022). *Emissions Gap Report 2022: The Closing Window — Climate crisis calls for rapid transformation of societies*. Nairobi. <https://www.unep.org/emissions-gap-report-2022>.

⁸⁸ CAT, 2020: Paris Agreement Compatible Sectoral Benchmark. 67 pp. https://climateactiontracker.org/documents/753/CAT_2020-07-10_ParisAgreementBenchmarks_FullReport.pdf.

⁸⁹ Ibid.

⁹⁰ Cabeza, L. F., Q. Bai, P. Bertoldi, J.M. Kihila, A.F.P. Lucena, É. Mata, S. Mirasgedis, A. Novikova, Y. Saheb, 2022: Buildings. In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.011.

⁹¹ CAT, 2020: Paris Agreement Compatible Sectoral Benchmark. 67 pp. https://climateactiontracker.org/documents/753/CAT_2020-07-10_ParisAgreementBenchmarks_FullReport.pdf.

5.2 Long-term effects of decarbonization targets and policies on the demand for Russian traditional goods

5.2.1 Fossil fuels: scaling down in the historical order

IPCC WGIII Sixth Assessment Report concludes, that pathways limiting the global warming to 2°C involve deep reductions in fossil fuel consumption and nearly total elimination of the use of coal without CCS.⁹² Only on the Current policy and Moderate illustrative mitigation pathways (IMPs) the ensemble of models projects growing use of fossil fuels. In order to maintain the warming below 3°C, fossil fuel use may stay constant to 2050 and even to 2100, but restricting the warming to any lower level requires profound reductions in fossil fuel use. Historically, coal was the first fuel in the global energy balance followed by oil and natural gas. Decarbonization is taking them away from the global energy balance in the historical order: coal was first in and should be first out.

The Russian military operation has given momentum to the global decarbonization process. In addition to closing up foreign markets for Russian fuels in the coming years, it has undermined global long-term prospects for fuel consumption and international trade. For the first time, in all IEA WEO 2022 scenarios, each fossil fuel peaks or plateaus before 2050.⁹³ Shell and BP in their 2023 scenario sets arrive at the same conclusion.⁹⁴ Total global fossil fuel demand is expected to go down after the mid-2020s.⁹⁵

Energy security and affordability policies coupled with decarbonization policies forced the proportion of fossil fuels in global energy mix to decline faster, than expected in 2021. The share of all fuels imports in primary energy supply in all major importing regions (EU, China, India) will reach the maximum before 2035 at levels much below the values expected just a year ago, and then will decline.⁹⁶ 2022-2023 fossil fuel prices had never been seen before and paved the way for the alternatives – energy efficiency, renewables, and nuclear.

The conclusion made by CENef-XXI in April 2022 – that Russian fossil fuel exports and production will never return to the 2021 levels⁹⁷ – was half a year later echoed by IEA: “Russian fossil fuel exports never return – in any of our scenarios – to the levels seen in 2021, and its share of internationally traded oil and gas falls by half by 2030 in the STEPS”. The new trends formed after February 24th are expected to be permanent with little chance for Russian fuel export to rebound.

⁹² Riahi, K., R. Schaeffer, J. Arango, K. Calvin, C. Guivarch, T. Hasegawa, K. Jiang, E. Kriegler, R. Matthews, G.P. Peters, A. Rao, S. Robertson, A.M. Sebbit, J. Steinberger, M. Tavoni, D.P. van Vuuren, 2022: Mitigation pathways compatible with long-term goals. In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.005.

⁹³ IEA. World Energy Outlook. 2022.

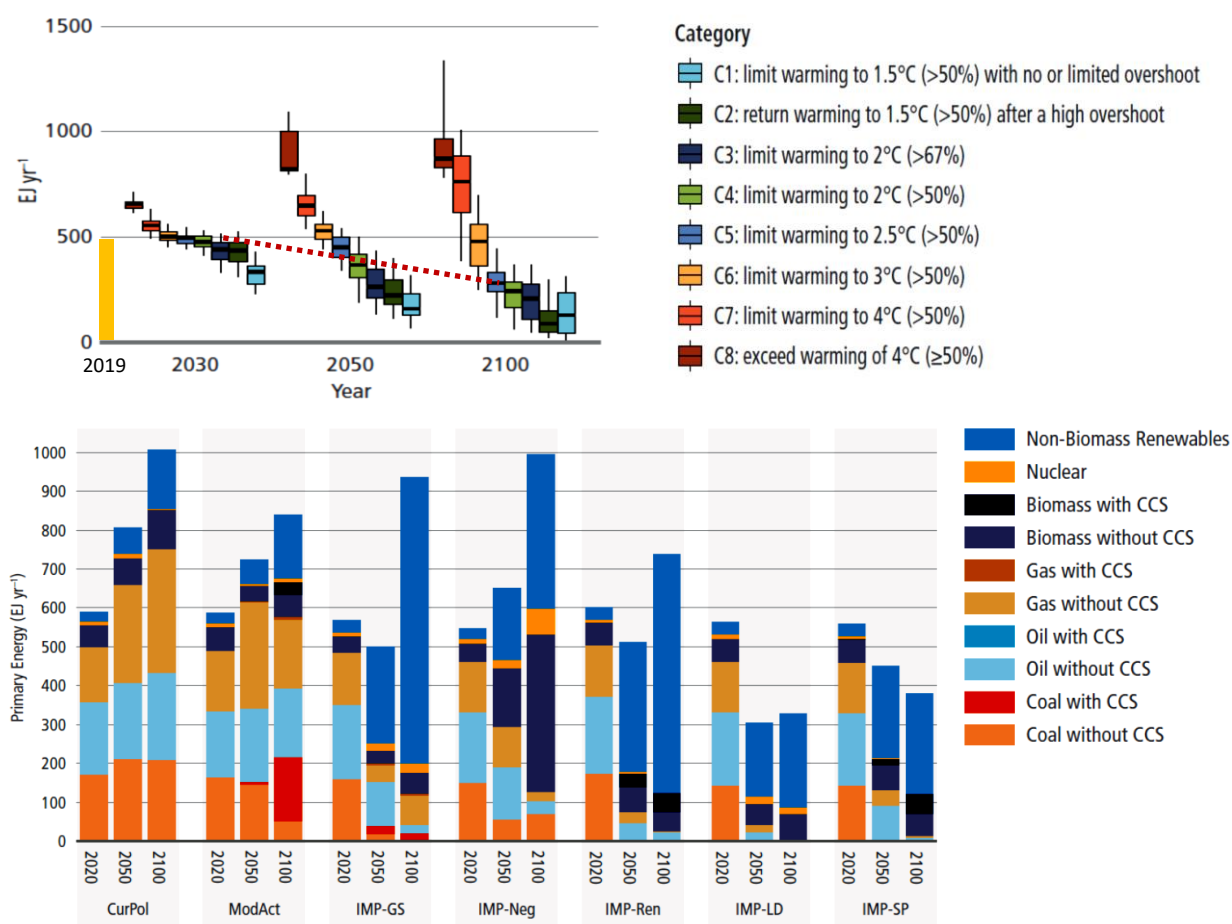
⁹⁴ bp Energy Outlook, 2023 Edition. January 2023; Shell International Limited. 2023. The Energy Security Scenarios. Full report. [The Energy Security Scenarios | Shell Global](#).

⁹⁵ IEA. World Energy Outlook. 2022.

⁹⁶ bp Energy Outlook, 2023 Edition. January 2023.

⁹⁷ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia-s-carbon-neutrality-pathways-to-2060>.

Figure 5.6 Fossil fuels consumption across scenarios and primary energy use and net emissions at net zero year for the different illustrative mitigation pathways (IMPS)*



* The CurPol pathway explores the consequences of continuing along the path of implemented climate policies in 2020 and only a gradual strengthening thereafter. The ModAct pathway explores the impact of implementing the NDCs as formulated in 2020 and some further strengthening thereafter. IMP-GS – implications of a slower and gradual strengthening of near-term mitigation actions, IMP-Neg – extensive use of carbon dioxide removal (CDR) in the energy and industrial sectors to achieve net negative emissions, IMP-Ren emphasises a heavy reliance on renewables, IMP-LD – strong emphasis on energy demand reductions, IMP-SP – mitigation in the context of broader sustainable development.

Source: Riahi, K., R. Schaeffer, J. Arango, K. Calvin, C. Guivarch, T. Hasegawa, K. Jiang, E. Kriegler, R. Matthews, G.P. Peters, A. Rao, S. Robertson, A.M. Sebbit, J. Steinberger, M. Tavoni, D.P. van Vuuren, 2022: Mitigation pathways compatible with long-term goals. In IPCC, 2022: Climate Change 2022: Mitigation of Climate Change. Contribution of Working Group III to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change [P.R. Shukla, J. Skea, R. Slade, A. Al Khourdajie, R. van Diemen, D. McCollum, M. Pathak, S. Some, P. Vyas, R. Fradera, M. Belkacemi, A. Hasija, G. Lisboa, S. Luz, J. Malley, (eds.)]. Cambridge University Press, Cambridge, UK and New York, NY, USA. doi: 10.1017/9781009157926.005.

5.2.2 Crude oil and petroleum products: decarbonization and energy security are turning off the oil valve and blunting the oil needle

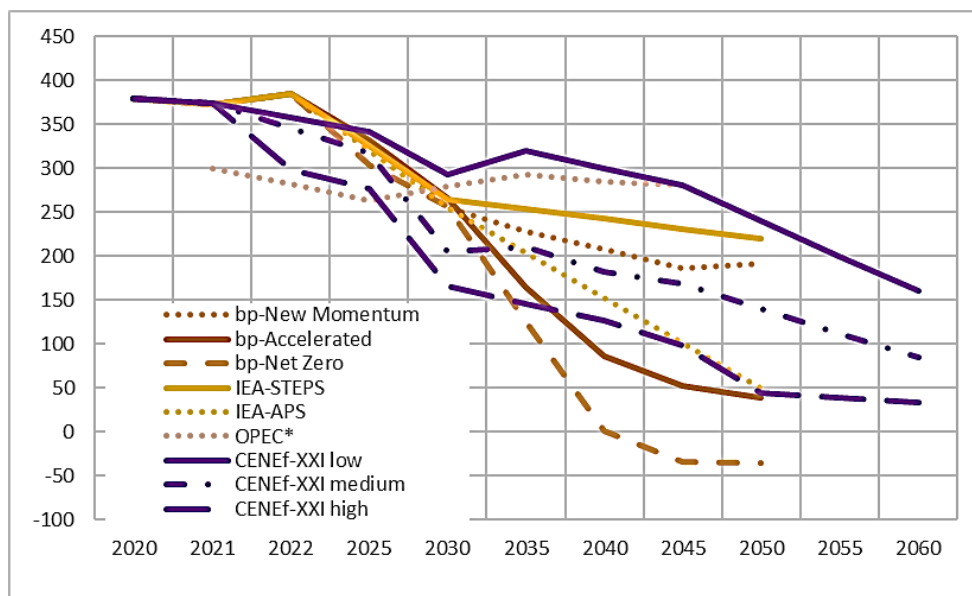
In all of the recent long-term projections, decarbonization activities and energy security considerations force global crude oil consumption to peak or plateau before 2040 with a subsequent decline. In the most recent (2022-2023) global projections, in all scenarios, BP and Shell see oil peak before 2030, IEA projects oil to plateau in 2030-2050 in STEPS scenario and oil use decline in all other scenarios after 2030. Even OPEC expects oil plateau after 2035.

Energy security concerns and increased preference for locally produced energy reduce the role of oil and natural gas imports in global energy supply. Over just one year – 2022 – estimated global primary energy use was 10% down. BP believes, that the EU has already passed the peak of oil and gas import share; this peak will be reached before 2035 in China and before 2040 in India.

Anticipated growing reliance on OPEC oil supply may give an additional push to energy security considerations. The share of OPEC in global petroleum products supply will be growing, while the shares of non-OPEC suppliers will be declining. IEA projects OPEC's share to stay at 36% in 2030 and at 43-53% in 2050, Shell sees this share at 43-52% in 2050. OPEC provides a more modest value – 38% in 2045, whereas the highest estimate is that of BP: 48-63% in 2050.⁹⁸

In none of the available (developed after 2022) global long-term projections to 2050-2060 does Russia's petroleum products export exceed half of its 2021 level; some projections expect order of magnitude decline by 2060. In April 2022, right after the Russian military operation in Ukraine started, CENef-XXI projected Russia's oil and petroleum products export decline by 2050 to 44-240 Mtoe with a subsequent decline to 33-160 Mtoe by 2060.⁹⁹ This was one of the very first assessments of the long-term effects of sanctions coupled with the effects of global decarbonization. One year after, more long-term projections of Russian petroleum products export are available from IEA, BP and OPEC. They are mostly within the range outlined by CENef-XXI in April 2022 (Figure 5.7).

Figure 5.7 Projections of Russian oil and petroleum products export with an account of sanctions and decarbonization effects (Mtoe)



OPEC* – crude oil only, including Caspian.

Sources: Bashmakov I. 2022. The angle of incidence is not equal to the angle of reflection. April 2022. [CENef-XXI](#); Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichok, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060>; IEA. 2022. World Energy Outlook. 2022; BP Energy Outlook, 2023 Edition. January 2023; OPEC. 2022 World Oil Outlook. 2045

⁹⁸ IEA. World Energy Outlook. 2022; BP Energy Outlook, 2023 Edition. January 2023; OPEC. 2022 World Oil Outlook. 2045; Shell International Limited. 2023. The Energy Security Scenarios. Full report. [The Energy Security Scenarios | Shell Global](#).

⁹⁹ Bashmakov I. 2022. The angle of incidence is not equal to the angle of reflection. April 2022. [CENef-XXI](#); Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichok, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060>.

BP in its Accelerated and Net-Zero scenarios expect a deeper drop of Russian petroleum products export for 2035 and even Russia's transformation into a net petroleum products importer beyond 2040. Russian oil industry resilience to sanctions in 2022 explains the squeeze of the projections range for 2025 to 320-332 Mtoe. CENef's new projections were adjusted accordingly, yet the initially outlined ranges beyond 2030 were sustained. There are two main reasons for the long-term oil export decline: (a) up to 2030 it is lack of technologies and investment to prevent natural production decline at existing fields, and (b) from 2040 onwards it is tangible results of global decarbonization with liquid fuel use peaking before 2040¹⁰⁰ driven by the electrification of road vehicles and other factors. Only OPEC 2022 scenario expects a rebound of crude oil exports from Russia and Caspian back to the 2020-2021 levels before 2035 (this projection doesn't single out Russia). Even in the OPEC scenario, global crude oil and petroleum products export plateau after 2025.

There is no potential to compensate the declining petroleum products export from Russia with higher domestic petroleum products use, therefore, Russian oil production peak has passed, and only a decline can be expected in the coming decades. Even additional use of oil as feedstock in petrochemical production is unlikely to stop oil production decline.¹⁰¹ This will cut the petrodollar inflow, but will also save investment that would otherwise go to maintain oil production at a high level. Not all of the most recent (2022-2023) global projections single out Russia as a producing region; however, Russia dominates in regions, such as Europe East other (Shell) and Russia and Caspian (OPEC). IEA expects Russian oil production to drop to 385 Mt in 2050 in STEPS scenario and to 195 Mt in APS scenario. OPEC believes that Russia can keep its production above 500 Mt to 2045, while BP expects production at 450 Mt to 2030 with a subsequent drop to 50-350 Mt by 2050. Shell sees the ranges for Europe East other as 202-464 Mt by 2050 and 58-351 Mt by 2060.¹⁰² Therefore, the Russian oil valve will be gradually turning off.

5.2.3 Natural gas: Russian pillar of the “methane bridge” to the low carbon future destroyed

The hopes for the “gas golden age” or “methane era”¹⁰³ are now bygone. Global natural gas consumption will peak or plateau before 2030. This milestone is now 10 years closer and the peak or plateau level is much below the range projected by the earlier studies. The 2022 crisis destroyed trust in the Russian pipeline gas supply reliability. Current global policy scenarios were adjusted in 2022-2023 to capture energy security concerns (EU) and stronger decarbonization policies (US Inflation Reduction Act and others) and the reaction to the unprecedented gas prices. All this shifted global gas use peak 10 years ahead, set it about 10-15% lower and with much lower reliance on pipeline gas supply. Gas demand growth in emerging economies is slowing down. High prices made gas less attractive compared to coal or oil, on the one hand, and to renewables, on the other. If decarbonization process speeds up, gas demand will decline after the peak making the economics of large and capital-intensive gas supply infrastructure projects questionable. IEA projects natural gas to plateau in 2030-2050 at a level below 4,400 bcm in its STEPS scenario and

¹⁰⁰ IEA. World Energy Outlook. 2022; BP Energy Outlook 2050: January 2023; OPEC 2022. World Oil Outlook.

¹⁰¹ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060>; Bashmakov I. Russia on the trajectories to carbon neutrality: three fours and one two. Neftegasovaya Vertical. No. 11, 2022; Bashmakov I. Scenarios of Russia's progress towards carbon neutrality. Energoberezhenie. No. 1, 2023.

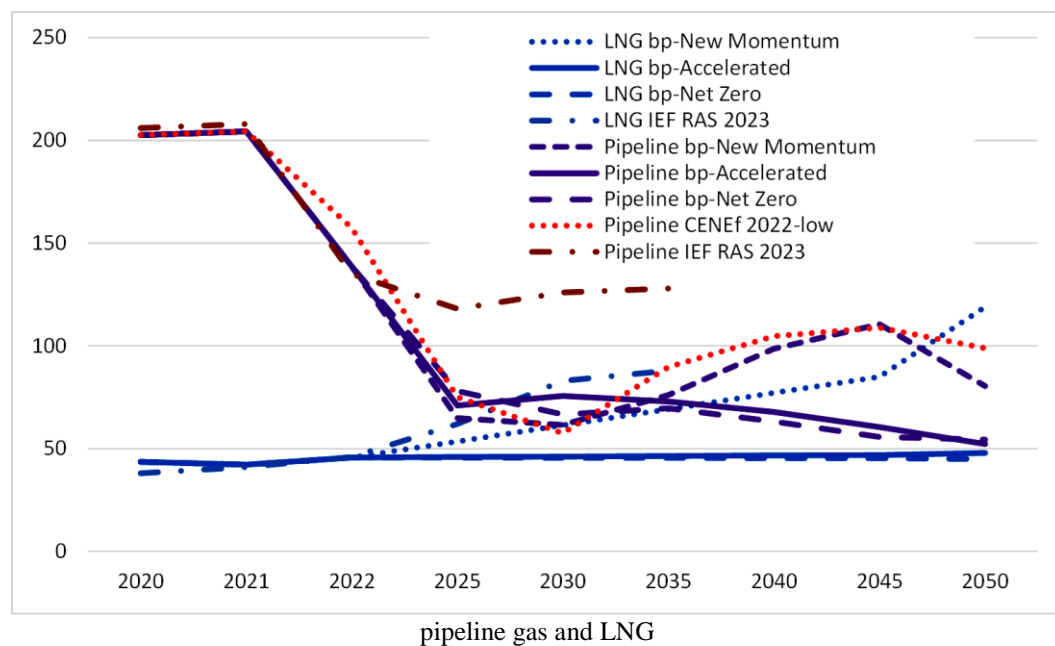
¹⁰² IEA. World Energy Outlook. 2022; BP Energy Outlook, 2023 Edition. January 2023; OPEC. 2022 World Oil Outlook. 2045; Shell International Limited. 2023. The Energy Security Scenarios. Full report. [The Energy Security Scenarios | Shell Global](#).

¹⁰³ Bashmakov I.A. et al. World Energy: Lessons of the Future / I.A. Bashmakov Ed. – Moscow: MTEA, ERI RAS, 1992; Bashmakov I. World energy development and CO2 emission // Perspectives in Energy. – 1992. – Vol. 2. – P. 1-12; IEA, 2011. Are we entering a golden age of gas? <https://www.iea.org/news/iea-specialreport-explores-potential-for-golden-age-of-natural-gas>; Wolfram, P. et al. (2022). Using ammonia as a shipping fuel.

to decline in 2050 to 2,661 and 1,159 bcm respectively in its APS and NZE scenarios.¹⁰⁴ In BP's New Momentum scenario, the peak is reached in 2045 at 4,635 bcm, while in Accelerated and Net Zero scenarios in 2030 at 4,072 and 3,579 bcm respectively.¹⁰⁵ Shell projects the peak at 4,050 bcm in 2030 in its Archipelagos scenario and at 3,795 bcm in 2025 in Sky 2050 scenario. Global natural gas production will decline in 2060 to 3,000 and 1,250 bcm respectively.¹⁰⁶ Only in OPEC Reference case and Laissez-Faire scenarios gas production continues to grow up to 2045, whereas in Advanced Technology scenario it peaks in 2021 and is expected approximately 15% down before 2030 to be nearly frozen at this lower level till 2045.¹⁰⁷

For at least 20 years (2025-2045) Russian pipeline gas export is not expected to exceed 100 bcm, which is half of the 2017-2021 levels. In April 2022, it was hard to anticipate how gas supply from Russia would be evolving. CENef-XXI came up with three trajectories.¹⁰⁸ Projections of Russian pipeline gas export made later by IEA and BP nearly reproduced CENef-XXI's lowest trajectory, which goes steeply down in volume to 65-78 bcm in 2025, stays nearly frozen there until 2035, and possibly varies between 50 and 100 bcm thereafter. In other words, the volumes are much below the potentially acceptable pipeline range: 117-159 bcm (see Figure 5.8). The fading enthusiasm for Russian LNG export makes future production volumes nearly constant. Only BP's "New Momentum" scenario projects LNG export up to 119 bcm in 2050. In this scenario, total gas export may rebound to 200 bcm in 2050. The Institute for Economic Forecasting of the Russian Academy of Science (ecfor.ru) is even more optimistic anticipating a rebound to 219 bcm in 2035.¹⁰⁹

Figure 5.8 Russian gas export projections (bcm)



¹⁰⁴ IEA. World Energy Outlook. 2022.

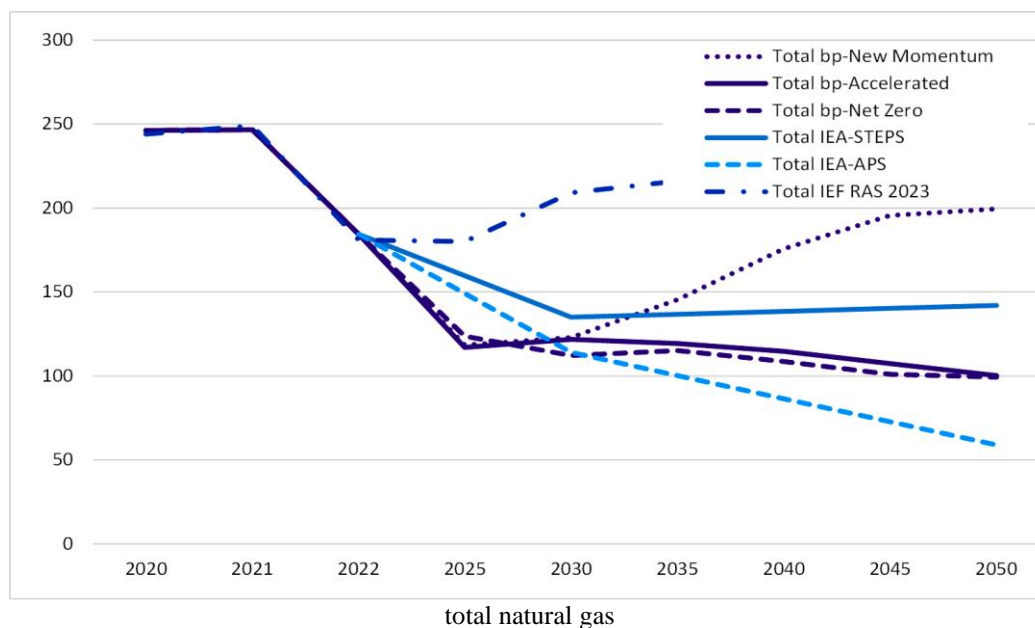
¹⁰⁵ BP Energy Outlook, 2023 Edition. January 2023.

¹⁰⁶ Shell International Limited. 2023. The Energy Security Scenarios. Full report. [The Energy Security Scenarios | Shell Global](#).

¹⁰⁷ OPEC. 2022 World Oil Outlook. 2045.

¹⁰⁸ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060>.

¹⁰⁹ Semikashov V.V. and M.S. Gaivoronskaya. Analysis of the state and development prospects of gas industry of Russia in the new conditions. Institute of Economic Forecasting RAS. Presentation at the Seminar on Economics of Energy and the Environment. Moscow School of economics. March 30, 2023.



Sources: Bashmakov I. 2022. The angle of incidence is not equal to the angle of reflection. April 2022. [CENef-XXI](#); Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060>; IEA, 2022. World Energy Outlook. 2022; BP Energy Outlook 2050: January 2023; Semikashev V.V. and M.S. Gaivoronskaya. Analysis of the state and development prospects gas industry of Russia in the new conditions. Institute of Economic Forecasting RAS. Presentation at the Seminar on Economics of Energy and the Environment. Moscow School of Economics. March 30, 2023.

The conclusion drawn up in April 2022 that gas exports and production in Russia will never exceed the 2021 level¹¹⁰ has got larger support. The most recent long-term gas export projections fall in the following ranges: 112-135 bcm in 2030; 109-176 bcm in 2040, and 99-199 bcm in 2050. None exceeds the nearly 250 bcm recorded in 2021. Only the upper boundary of the range for 2050 exceeds the potential export to non-EU markets estimated for 2030 (Figure 4.3). Russia's share in international gas trade comes down from 30% in 2021 to below 5% in 2030, and IEA expects net gas export revenues down from US\$ 75 billion in 2021 to US\$ 25 billion in 2030.¹¹¹

No return: Russia's natural gas production will never again get back to the formerly high levels. Since domestic gas use is not expected to grow above the 2021 level, Russian gas production will not return to 700 bcm in the decades to come; it will highly likely stay below 620 bcm, which is nearly 143 bcm down from the record 2021 level and 260-380 bcm down from the 2035 targets as specified by the Russian Energy Strategy. For the decades to come Russian gas production will stay below the 2021 level, even with an account of potential additional natural gas use for hydrogen and ammonia production.¹¹² Up to 2030, all Russian natural gas production projections fall in the range estimated by CENef-XXI back in April 2022.¹¹³ Beyond 2030, the uncertainty range shifts downwards. IEA expects Russian natural gas production to fall in 2030 to 633 bcm in STEPS scenario and to 584 bcm in APS scenario and further in 2050 to 612 bcm and 483 bcm respectively. These estimates assume that pipeline export to China will grow to 50 bcm in 2030, but will still be 155 bcm and 210 bcm below IEA's 2021 projections. BP provides the widest range for its three

¹¹⁰ Bashmakov I. 2022. The angle of incidence is not equal to the angle of reflection. April 2022. [CENef-XXI](#).

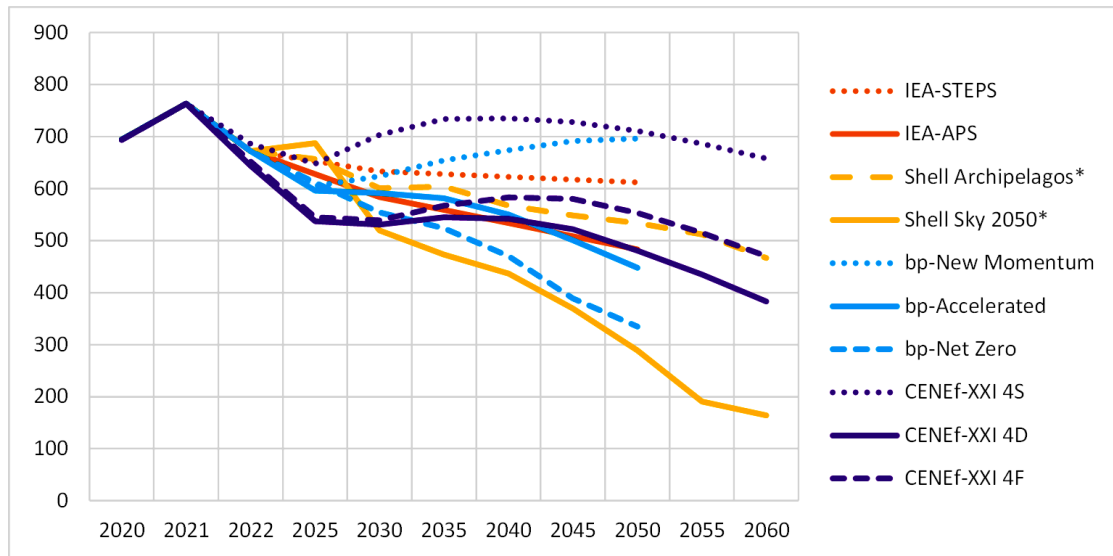
¹¹¹ IEA. World Energy Outlook. 2022.

¹¹² Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060>; Bashmakov I. Russia on the trajectories to carbon neutrality: three fours and one two. Neftegasovaya Vertikal. No. 11, 2022; Bashmakov I. Scenarios of Russia's progress towards carbon neutrality. Energoberezhenie. No. 1, 2023; IEA. World Energy Outlook. 2022.

¹¹³ Bashmakov I. 2022. The angle of incidence is not equal to the angle of reflection. April 2022. [CENef-XXI](#).

scenarios: 554-624 bcm in 2030 and 335-696 bcm in 2050. Shell's vision is the most pessimistic: 520-601 bcm in 2030, 289-534 bcm in 2050, and 164-466 bcm in 2060.

Figure 5.9 Russian gas production projections made in 2022-2023 (bcm)



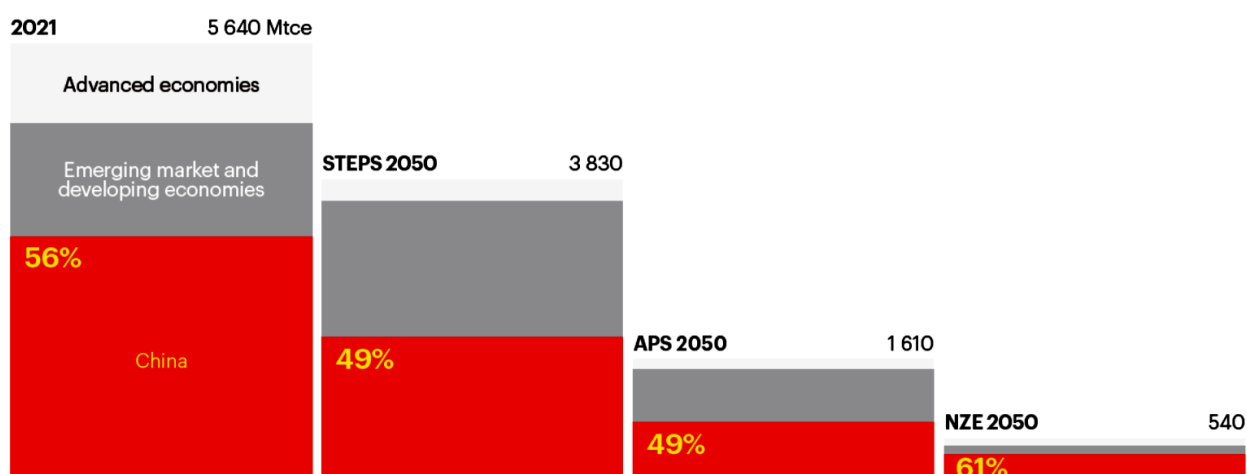
Sources: Bashmakov I. 2022. The angle of incidence is not equal to the angle of reflection. April 2022. [CENef-XXI](#); Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality-pathways-to-2060>; IEA. World Energy Outlook. 2022; BP Energy Outlook 2050: January 2023; Shell International Limited. 2023. The Energy Security Scenarios. Full report. [The Energy Security Scenarios | Shell Global](#).

5.2.4 Coal to peak before 2025 and never return

The Russian military operation and global economic revival after the COVID-19 pandemic temporarily created additional coal demand; but as decarbonization progresses, global coal use is expected to peak before 2025 and then steeply go down. In all IEA and OPEC 2022 scenarios, as well as in BP and Shell 2023 scenarios, global coal consumption peaks before 2025 and then declines at a rate determined by global decarbonization progress (Figure 5.10). Coal use peaks in China before 2030 and in India in 2030-2040.¹¹⁴ Global coal production reached 5,826 Mtce in 2021. By 2030, IEA expects it to scale down to 4,539-5,139 Mtce; BP to 2,698-4,986 Mtce, and Shell to 4,591-5,635 Mtce. IEA further projects it down to 540-3,830 Mtce in 2050; BP to 580-3,278 Mtce, and Shell to 1,510-3,969 Mtce.

¹¹⁴ IEA. World Energy Outlook. 2022; BP Energy Outlook, 2023 Edition. January 2023; OPEC. 2022 World Oil Outlook. 2045; Shell International Limited. 2023. The Energy Security Scenarios. Full report. [The Energy Security Scenarios | Shell Global](#); Zhang Xiliang. China's Energy Security in the Context of Carbon Pricing. Institute of Energy, Environment and Economy. Tsinghua University. October 2022. The 22nd Annual IEA_IETA_EPRI Workshop on Greenhouse Gas Emission Trading.

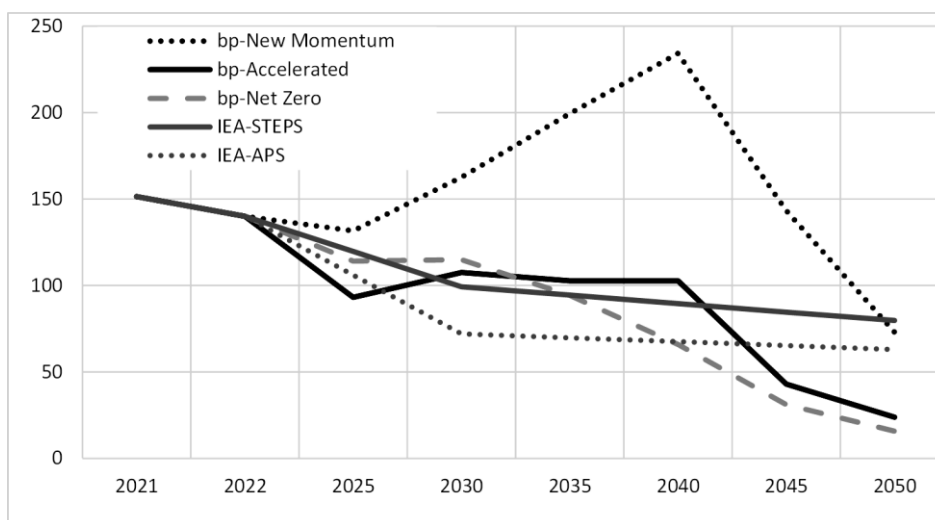
Figure 5.10 Future coal use depends heavily on climate mitigation efforts



Sources: IEA. World Energy Outlook. 2022.

International coal trade will be declining even faster – 60-90% down in 2050 – leaving few possibilities for large-scale Russian coal export. Only in BP's New Momentum scenario Russian coal export is growing in 2025-2040 and then drops. In all other scenarios coal export from Russia drops 47-90% down from the 2021 level (Figure 5.11). This decline is not compensated by higher domestic coal demand,¹¹⁵ and so forces Russian coal production down to 245-362 Mtce in 2030 and to 41-184 Mtce in 2050, according to BP. In its scenario, Shell expects 379-432 Mtce in 2030 and 137-372 Mtce in 2050 for 'Europe East other' (includes Russia) (used to be 420 Mtce in 2019 for this region). For Eurasia, IEA projects 292-323 Mtce in 2030 and 216-274 Mtce in 2050 (versus 444 Mtce in 2021).¹¹⁶

Figure 5.11 Russian coal export projections (Mtce)



Sources: IEA. World Energy Outlook. 2022; bp Energy Outlook 2050: January 2023.

¹¹⁵ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichok, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality-pathways-to-2060>.

¹¹⁶ IEA. World Energy Outlook. 2022; BP Energy Outlook 2050: January 2023; Shell International Limited. 2023. The Energy Security Scenarios. Full report. [The Energy Security Scenarios | Shell Global](https://www.shell.com/global/energy-security-scenarios).

5.2.5 Basic materials: not much growth for the global markets ahead

For traditional exports, such as iron and steel, aluminum, cement, fertilizers, wood, wood products, and food, global markets are unlikely to expand much,¹¹⁷ and Russia is unlikely to get an additional share in these markets. Exports of basic materials, precious stones, precious metals, and relevant products contributed 30% to the Russian exports of goods, or \$US 148 billion, in 2021, and 23%, or \$US 135 billion, in 2022. Detailed analysis of what awaits these markets was made by CENef-XXI in 2022.¹¹⁸

Sanctions-driven revenue loss for the Russian exports of CBAM goods to the EU can be estimated at US\$ 4.1-5.4 billion. This loss is more than half of pre-2022 CBAM goods export revenues from Russia to the EU and goes far beyond any loss that had been expected from CBAM. In late 2022, EU adopted CBAM regulations, and effects for the Russian industry were assessed with the following main takeaways.¹¹⁹ The Russian military operation and the subsequent sanctions closed EU markets for some CBAM goods (mostly iron and steel products) for the years to come. With the most likely combination of various conditions, CBAM-associated losses of Russian companies will not exceed US\$ 1-1.5 billion to 2050. If Russia is much behind the EU in decarbonizing CBAM industries, because it takes no action and conserves the current carbon intensity levels for the decades to come, then by 2050 CBAM export revenue loss may amount to US\$ 5 billion and will become equal to the effect of the sanctions. On the contrary, Russia's leap to carbon neutrality coupled with the EU's passivity may deliver more than US\$ 8 billion in additional export revenues by 2050. If Russia and the EU race in parallel, apply effective industrial GHG mitigation policies and technologies, Russia's export revenue loss may peak at US\$1 billion in the mid-2030s and halve towards 2050. Only proactive reduction in carbon intensity of Russian CBAM-products and (or) the introduction of fiscal-neutral carbon payments will help reduce the losses or even end up with additional export revenues. Deployment of CBAM-like mechanisms in other jurisdictions may lead to additional losses of basic materials export earnings.

5.2.6 Emerging markets for critical materials and new fuels

A glittering future is awaiting materials that are critical for global decarbonization, including nickel and copper. In 2021, Russian copper and nickel exports together were US\$ 8 billion, in 2022 US\$ 14 billion. IEA expects global markets for these 2 metals to reach US\$ 150-210 billion in 2030 and US\$ 210-230 billion in 2050 (Figure 5.12). The OECD vision is even brighter than that. It expects global primary copper production to grow up to 39 Mt in 2050 and to 46 Mt in 2060, and with account of secondary copper, up to 62 Mt in 2050 and to 76 Mt in 2060.¹²⁰ BP expects 30-70 Mt copper use in 2040 and 6-10 Mt nickel use.¹²¹ IRENA expects copper production up from 30 Mt in 2021 to 50-70 Mt in 2050 and nickel production from 3 Mt in 2021 to 5-8 Mt in 2050.¹²² Shell gives a similar range for copper in 2050 (52-73 Mt), but higher for nickel (8-15 Mt). Therefore, there is room for expansion, while presently IEA projects that Russia will have a limited role to play in copper supply chains for clean technologies, but a growing role for nickel and

¹¹⁷ IEA. Energy technology perspectives. 2023.

¹¹⁸ Bashmakov I. 2022. The angle of incidence is not equal to the angle of reflection. April 2022. [CENef-XXI](#); Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality-pathways-to-2060>.

¹¹⁹ Bashmakov I., M. Dzedzichuk A. Myshak, and V. Bashmakov. Sanctions and CBAM: Implications for the Russian industry. CENef-XXI. December 2022. [CENef-XXI](#).

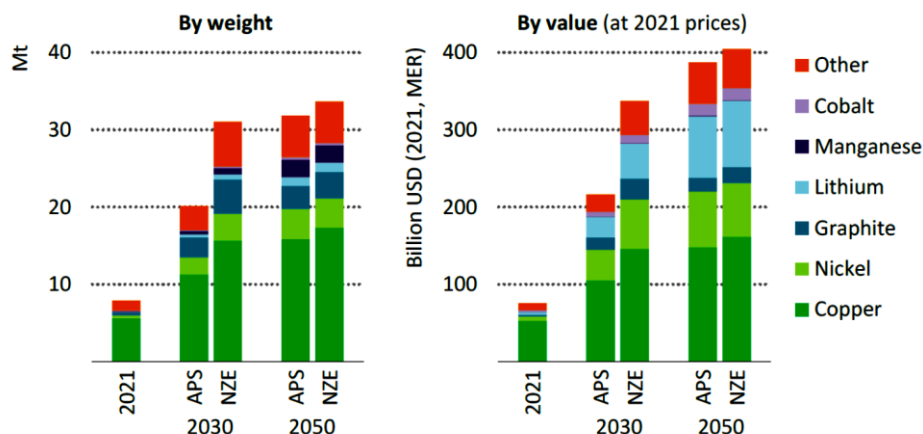
¹²⁰ OECD, 2019: Global Material Resources Outlook to 2060. OECD, 210 pp.; Fitch Solutions, ResearchAndMarkets.com (<https://www.mining.com/global-copper-output-to-grow-over-the-next-decade-report/>).

¹²¹ BP Energy Outlook 2050: January 2023.

¹²² IRENA (2022), World Energy Transitions Outlook 2022: 1.5°C Pathway, International Renewable Energy Agency, Abu Dhabi.

lithium.¹²³ Aluminum demand may go 35% up in 2050,¹²⁴ but as the role of secondary aluminum grows, additional primary aluminum demand is limited.

Figure 5.12 Critical mineral demand by weight and value for clean energy technologies by scenario



Source: IEA. World Energy Outlook. 2022.

Another potential market for Russia is chemicals and petrochemicals, including pharmaceuticals. In 2021 and 2022, Russia exported US\$ 25 and 23 billion-worth of chemicals (excluding fertilizers), yet imported more than twice as much. The advances of the chemical and petrochemical industry will scale up the export of relatively simple chemicals and substitute the imports of more complex ones (pharmaceuticals and plastics).

According to the available projections, global plastics production could more than double to 985 Mt on the 2050 horizon. In low-carbon scenarios, it rises to 600-659 Mt (Figure 5.13). In 2021, global plastics trade was 369 Mt (US\$ 1.184 trillion-worth).¹²⁵ The growth will depend on the progress in plastics circularity. IEA expects limited additional oil use in the chemical sector and has not come up with any gas use projections for this sector.¹²⁶ OPEC projects substantial growth in oil use for petrochemicals production.¹²⁷ Shell expects oil and gas use for chemicals production 20-60% up.¹²⁸ Market growth prospects for fertilizers are limited. In 2021, global market for pharmaceuticals reached US\$ 1-1.5 trillion (up from US\$ 300 billion in 2001¹²⁹) and is expected to further grow up to US\$ 1.4-2.1 trillion by 2026-2027.¹³⁰ If these growth rates persist, this market may scale up to US\$ 5-7.5 trillion by in 2050-2060. In 2021 and 2022, Russia's export of pharmaceuticals was only US\$ 2.7 and 1.3 billion respectively.

¹²³ IEA. World Energy Outlook. 2022; IEA. Energy technology perspectives. 2023.

¹²⁴ IEA. Energy technology perspectives. 2023.

¹²⁵ [Beyond 20/20 WDS - Table view - Global plastics trade, annual \(unctad.org\)](#).

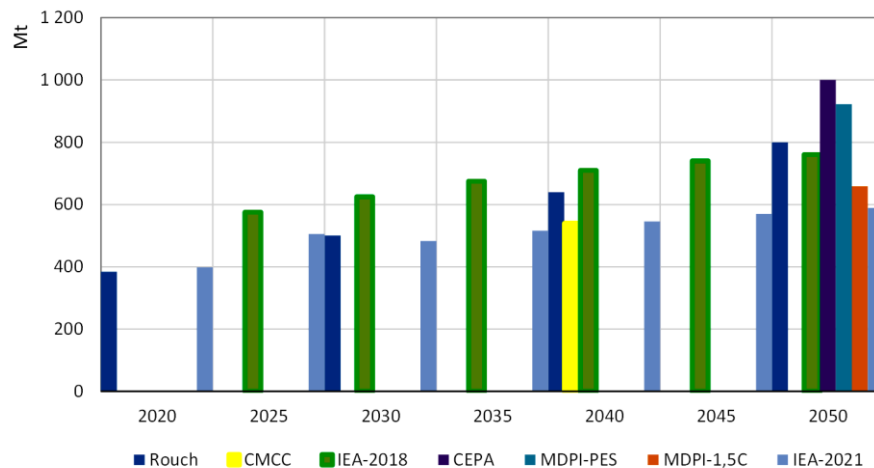
¹²⁶ IEA. World Energy Outlook. 2022.

¹²⁷ OPEC. 2022 World Oil Outlook.

¹²⁸ Shell International Limited. 2023. The Energy Security Scenarios. Full report. [The Energy Security Scenarios | Shell Global](#).

¹²⁹ [Pharmaceuticals Market, Consumption Trends and Disease Incidence Are Not Driving the Pharmaceutical Research on Water and Wastewater - PMC \(nih.gov\)](#).

¹³⁰ [Pharmaceuticals - Worldwide | Statista Market Forecast; Pharmaceuticals Global Market Report 2022 \(reportlinker.com\)](#).

Figure 5.13 Global plastics production projections

Sources: Plastics future: How to reduce the increasing environmental footprint of plastic packaging. January 2021. <https://www.climateforesight.eu/global-policy/the-future-of-plastics-is-uncertain/>; The Future of Petrochemicals, IEA, Technological report, 2018; Estimation of carbon dioxide reduction by utilization biomass bioplastic in Malaysia using carbon emission pinch analysis (CEPA), Research Paper, 2020; MDPI, Zero-Emissions Pathway for the Global Chemical and Petrochemical Sector, Saygin, D., and D. Gielen, 2021; Zero-emission pathway for the global chemical and petrochemical sector. *Energies*, 14(13), 3772, doi:10.3390/en14133772; <https://www.iea.org/termsandconditions/>.

A broader view on potential global chemicals market highlights a large potential for the production of ammonia for fueling shipping and power generation from current 185 Mt to 968-996 Mt in 2050 (Figure 5.14). In 2021, Russia exported 4.4 million tons of ammonia (US\$ 1.7 billion-worth). Russian ammonia export may expand, but if it is to be green, it will need either green hydrogen, or large-scale CCUS deployment for methane-based production.

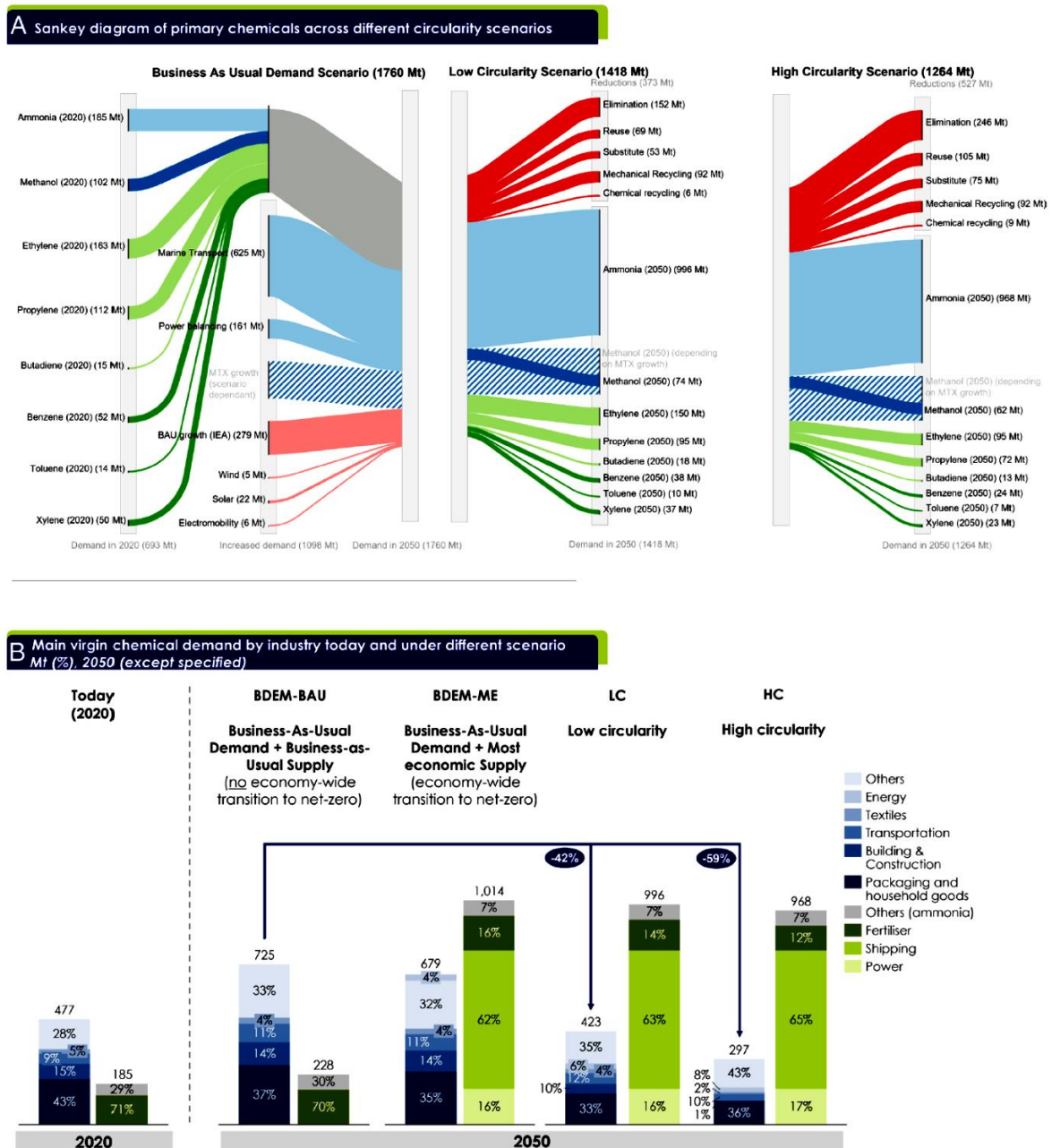
Hydrogen is another large emerging market: BP expects hydrogen production up from 66 Mt in 2019 to 165-460 Mt in 2050. IEA expects global low-emission hydrogen production at 30 Mt in 2030; however, this would require US\$ 170 billion in investment in electrolyzers and CCUS equipment, three times that amount for new renewable capacity, and also infrastructure and plants for the conversion to hydrogen-based fuels. Installed electrolyser capacity is anticipated to reach 260 GW fed by over 1,000 TWh of low emission renewables.¹³¹ In the 1.5°C scenario, IRENA projects global clean hydrogen and derivative fuels production at 154 Mt in 2030 and at 614 Mt in 2050.¹³² Shell estimates hydrogen use at 45-227 Mt in 2050 and at 200-440 Mt in 2070.¹³³ IEA expects natural gas with CCS to meet 20% of global hydrogen demand in 2030 and 25% in 2050.¹³⁴

¹³¹ IEA. World Energy Outlook. 2022.

¹³² IRENA. World Energy Transitions Outlook 2022: 1.5°C Pathway, International Renewable Energy Agency, Abu Dhabi.

¹³³ Shell International Limited. 2023. The Energy Security Scenarios. Full report. [The Energy Security Scenarios | Shell Global](https://www.shell.com/global/energy-security-scenarios/).

¹³⁴ IEA. Energy technology perspectives. 2023.

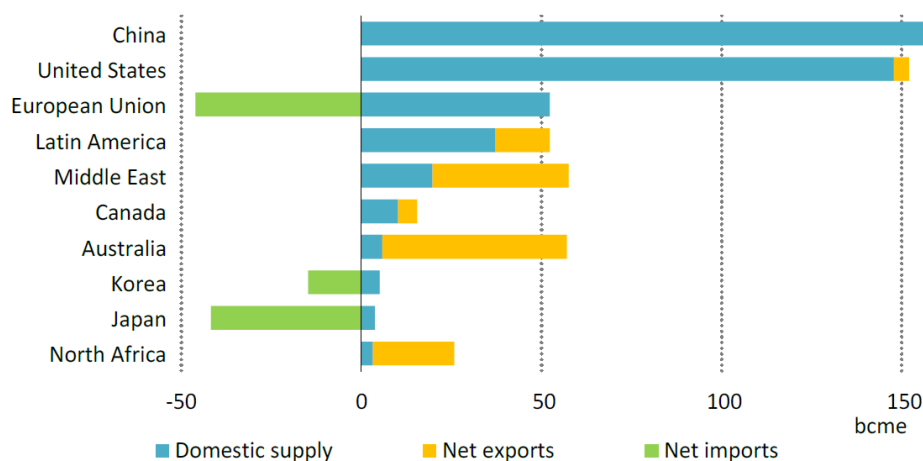
Figure 5.14 Scenarios for primary chemicals demand (Mt)

(A) Material demand changes (in Mt) of eight primary chemicals (ammonium nitrate and urea shown as part of ammonia) between 2020 and 2050 under LC, HC and Business as Usual Demand (BDEM) scenarios, respectively. MTX growth is dependent on supply scenario and illustrated for the low circularity demand scenario coupled with the most economic (ME) supply scenario. Flow width indicates the masses of chemicals; flow color is used to distinguish different types of chemicals; grey indicates the Business-as-usual (BAU) demand in 2020; red shows demand reduction through resource efficiency and circularity strategies, with improvements in agricultural practices included in the elimination wedge. Chemical recycling represents depolymerization and degradation. (B) Key industries for virgin chemical demand under different scenarios. The major difference between BDEM-BAU and BDEM-ME is that under the former, it is assumed that the economy does not transition to net-zero. Hence, it is assumed in BDEM-BAU that there is no transition of the shipping industry from heavy fuel oil to ammonia, no rollout of renewable energy production, electric vehicles, or any improvement in mechanical recycling rates. The figure includes ammonia (& derivatives ammonium nitrate, urea) ethylene, propylene, methanol (but excludes MTX), benzene, toluene, xylene, and butadiene.

Source: Meng F., A. Wagner, A.B. Kremer, D. Kanazawa, J.J. Leung, P. Goult, M. Guan, S. Herrmann, E. Speelman, P. Sauter, S. Lingeswaran, M.M. Stuchtey, K. Hansene, E. Masanet, A.C. Serrenho, N. Ishii, Y. Kikuchi, and J. M. Cullen. Planet-compatible pathways for transitioning the chemical industry. PNAS 2023 Vol. 120 No. 8 e2218294120 <https://doi.org/10.1073/pnas.2218294120>.

Strong competition is expected in global hydrogen markets, because many countries have export plans, while only the EU, Japan and Korea are expected to be large hydrogen importers (Figure 5.15). **The competition will be based on hydrogen carbon footprint and costs.** There is a potential for CBAM application to hydrogen trade, and CBAM could hamper access to affordable hydrogen in sufficient quantities during the transition.¹³⁵ Russia was initially planning to attain hydrogen export volumes of up to 0.2 Mt in 2024, 2-12 Mt in 2035, and 15-50 Mt in 2050.¹³⁶ However, it was argued, that reaching even the lower boundary of the range is challenging.¹³⁷ With the price of 3-4 \$US/kg hydrogen, the exports of 15 Mt of hydrogen will yield \$US 45-60 billion in revenues by 2060.

Figure 5.15 Domestic supply and trade of low-emissions hydrogen for key regions in the APS by 2050



Source: IEA. World Energy Outlook. 2022.

5.2.7 Machinery and equipment for low carbon technologies: can Russia hope to get a share in trillions dollars-worth markets?

In 2021, global export of machinery and transport equipment (US\$ 7,653 billion) was 3 times larger, than fossil fuel export (US\$ 2,558 billion). As decarbonization progresses, this ratio will be further growing. For Russia, access to global machinery and equipment market is a challenge, as this product group generated only US\$ 25.7 billion in its export revenues in 2021 and US\$ 20.4 billion in 2022, or just 0.33% of global total machinery and equipment exports.¹³⁸ The Russian share in global low carbon technologies trade (nuclear excluded) is negligible. Machinery and equipment are large perspective markets for both import substitution and export, especially for low carbon technologies, but sanctions prevent Russia from participating in supply chains and restrict its potential market niches. In 2022, global trade in goods hit a record of US\$ 32 trillion. “Green goods” trade amounted to US\$1.9 trillion (6%). In 2022, it added more than US\$ 100 billion, led by electric and hybrid vehicles (+25%), non-plastic packaging (+20%), and wind turbines (+10%).

¹³⁵ Marcu A., M. Mehling, A. Cosbey, O. Imbault, A. Fernandez. The inclusion of hydrogen in the EU CBAM. ERCST. 2023.

¹³⁶ In its Operation plan for the implementation of the Low Carbon Development Strategy of the Russian Federation Russia sets the target of contributing 20% to the global hydrogen trade in 2030.

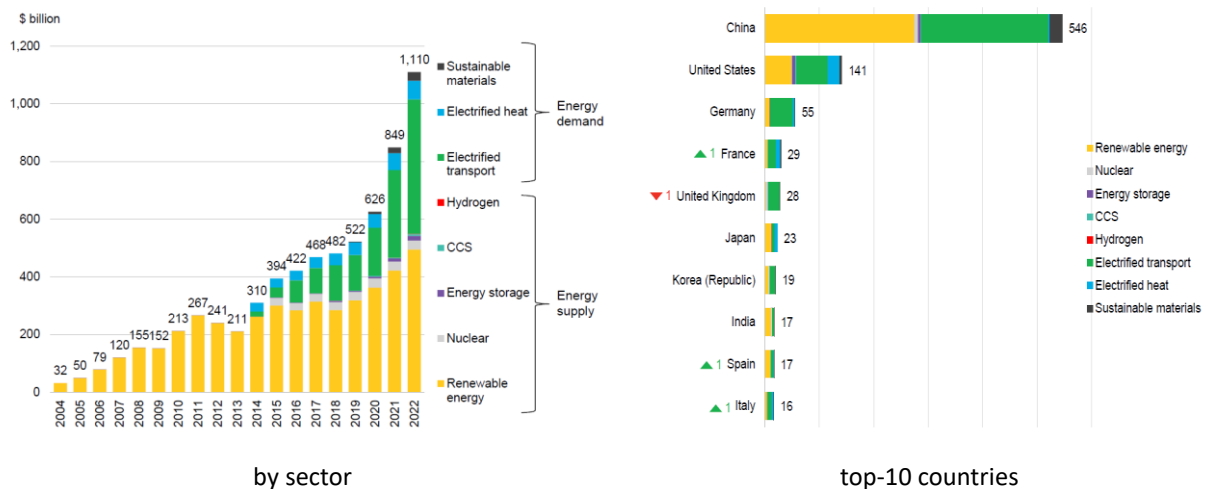
¹³⁷ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichok, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060>.

¹³⁸ [Beyond 20/20 WDS - Table view - Merchandise trade matrix in thousands United States dollars, annual, 2016-2021 \(unctad.org\)](https://unctad.org/Beyond_20/20_WDS_-_Table_view_-_Merchandise_trade_matrix_in_thousands_United_States_dollars,_annual,_2016-2021).

In 2022, US\$ 1.1 trillion investment in energy transition (US\$ 1.6 trillion, if power grid, supply chain, and corporate R&D are included¹³⁹) for the first time in history matched fossil fuels investments despite the fossil investment growth triggered by that year's energy crisis. According to IRENA, global investment in energy transition technologies went up 5-fold from about US\$ 210 billion in 2010 to US\$ 998 billion in 2021.¹⁴⁰ BNEF reports that in 2022, global investment in the low-carbon energy transition totaled \$US 1.1 trillion – a new record.¹⁴¹ This BNEF estimate doesn't include energy efficiency which, according to IEA, was additional US\$ 330 billion.¹⁴² If energy efficiency is included, overall investment in energy transition technologies reaches US\$ 1.9 trillion. Investment in renewable energy attracted US\$ 495 billion, followed by electrified transport (electric vehicles and infrastructure) – US\$ 466 billion (Figure 5.16). Hydrogen is the sector that in 2022 received the least financial commitment – US\$ 1.1 billion, but is the fastest-growing sector with tripled investment over 2021. China alone invested half of that amount – US\$ 546 billion, followed by the US (US\$ 141 billion) and the EU (US\$ 180 billion).

In 2030-2050, annual investment in energy transition is expected to be twice the present fossil fuel international trade. Annual market for energy transition products is expected to scale up to US\$ 3-5 trillion on average in 2023-2030; to US\$ 4-7 trillion in the 2030s; and to US\$ 6-16 trillion in the 1940s. Just 1% market niche yields US\$ 30-160 billion-worth high-tech import reduction or export expansion. BNEP projects annual energy transition investment at US\$ 4.6 trillion on average in 2023-2030; US\$ 6.9 trillion in the 2030s, and US\$ 7.9 trillion in the 2040s (Figure 5.16). These amounts do not include energy efficiency investments.¹⁴³

Figure 5.16 Global investment in energy transition by sector and by country



Source: BNEF. 2023. Energy Transition Investment Trends 2023. Tracking global investments in the low-carbon energy transition. January 2023.

¹³⁹ US\$ 1.4 trillion, according to IEA (IEA. World Energy Investment 2022).

¹⁴⁰ IRENA. World Energy Transitions Outlook 2022: 1.5°C Pathway, International Renewable Energy Agency, Abu Dhabi.

¹⁴¹ <https://about.bnef.com/blog/global-low-carbon-energy-technology-investment-surges-past-1-trillion-for-the-first-time/>.

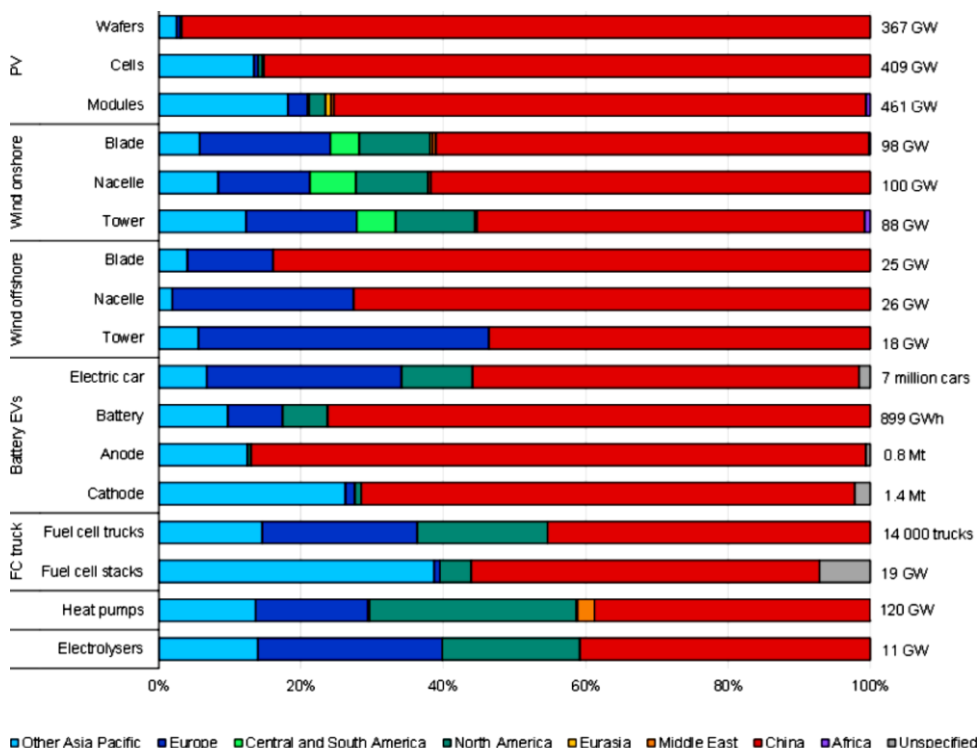
¹⁴² This amount does not include investment in transportation, as it is already captured in spendings on electrified transport. If transport is included, IEA assesses 2022 investment in energy efficiency at US\$ 560 billion (IEA. World Energy Investment 2022).

¹⁴³ BNEF. 2023. Energy Transition Investment Trends 2023. Tracking global investments in the low-carbon energy transition. January 2023.

IRENA assessed 2021-2030 average annual investment demand at US\$ 3.5 trillion in its PES scenario, and at US\$ 5.7 trillion in 1.5°C scenario.¹⁴⁴ IEA estimates clean energy and energy efficiency investment at US\$ 6 trillion in 2030.¹⁴⁵ McKinsey estimated, that eleven high-potential value pools could be worth more than US\$ 12 trillion in annual revenues by 2030, as net-zero transition advances.¹⁴⁶ In 2050, low carbon transition investment may reach US\$ 5-16 trillion.¹⁴⁷ Shell expects such investment to stay between US\$ 4 and 5 trillion in 2030-2050.¹⁴⁸

China is the major Russia's competitor in low carbon technologies markets, followed by the EU and US, which recently adopted regulations to support low carbon technologies localization. China accounts for 90% of global investments in net-zero manufacturing facilities and dominates in major low carbon manufacturing (Figure 5.17). In this Figure, Russia is hardly visible – only for solar PV (Eurasia). Presently, EU imports more than 90% of solar photovoltaic (PV) wafers and other PV components from China, as well as over 25% of electric cars and batteries.

Figure 5.17 Low carbon tech in red – China's dominance in manufacturing capacity for selected mass-manufactured clean energy technologies and components



Source: IEA. Energy Technology Perspectives 2023.

¹⁴⁴ IRENA. World Energy Transitions Outlook 2022: 1.5°C Pathway, International Renewable Energy Agency, Abu Dhabi.

¹⁴⁵ IEA. World Energy Outlook. 2022.

¹⁴⁶ McKinsey & Company. 2022. Playing offense to create value in the net-zero transition. McKinsey Quarterly. April 2022.

¹⁴⁷ IEA. World Energy Outlook. 2022; Bashmakov I.A., Bashmakov V.I., Borisov K.B., Carvalho P., Drummond P., Dzedzich M.G., Lunin A.A., Lebedev O.V. (2020). Monitoring of low carbon technologies deployment in Russia. *Ekologicheskiy Vestnik Rossii*, No. 4, pp. 6–11. (In Russian).

¹⁴⁸ Shell International Limited. 2023. The Energy Security Scenarios. Full report. [The Energy Security Scenarios | Shell Global](#).

Russia is facing the risk of devastating reliance on China for low carbon technologies. It is better sooner, rather than later, to launch support for low carbon technologies localization. Provisions of the 2022 US Inflation Reduction Act and 2023 EU Net-Zero Industry Act¹⁴⁹ were largely developed to reduce the reliance on China. The Inflation Reduction Act improves the competitiveness of the US manufacturers by allocating US\$ 128 billion for renewable energy and grid energy storage; US\$ 37 billion for advanced manufacturing; US\$ 30 billion for nuclear power; US\$ 22 billion for home energy supply improvements; US\$ 14 billion for home energy efficiency upgrades; US\$ 13 billion for electric vehicle incentives; US\$ 9 billion for home energy rebate programs that focus on improving the access to energy efficient technologies and 10 years of consumer tax credits for the use of heat pumps, rooftop solar, and high-efficiency electric heating, ventilation, air conditioning and water heating; US\$ 3 billion in tax incentives for installing carbon capture and storage at existing power plants, and US\$ 3 billion for the electrification of the USPS fleet.¹⁵⁰ The EU set the goal of ramping up manufacturing of clean technologies to make them fit for the clean energy transition. The goal is to increase EU's net-zero manufacturing at least to 40% of its net-zero application by 2030. The Net-Zero Industry Act supports: solar PV and solar thermal, onshore wind and offshore renewable energy, batteries and storage, heat pumps and geothermal energy, electrolysers and fuel cells, biogas/biomethane, carbon capture, utilization and storage, and grid technologies.

5.2.8 Bridging the perspective gap in the balance of trade

The gap in Russia's foreign trade balance of goods and services anticipated for the coming decades is based on expected fossil fuels export revenues loss and sanctions; it can be bridged by expanding non-fossil fuel export, higher level of localization and import substitution, which all may only be possible upon return to the global supply chains. One from many possible combinations of Russia's products export and import is presented in Table 5.1. If fossil fuel revenues go 70% down in 2050 driven by lower prices and export volumes reductions, and the sanctions hamper non-fuel exports, the foreign trade balance in goods may still be positive (providing imports stay at the 2022 level). But when net export of services and foreign trade revenues balance get negative, the balance of current accounts will go negative too.

Revolutionary shifts are required in technological, foreign trade, business climate and decarbonization priorities, so that evolutionary changes maintain the balance of foreign trade structure. If this structure is to be improved, promotion of the non-fuel export and import substitution policies for different product groups need to become effective. In the presented scratch of the trade balance, growth in non-fossil exports and lower reliance on imported products allow for the positive trade balance despite the declining fossil fuels export. This change is not revolutionary, if structural aspects are in the focus: the share of fuels and basic materials shows moderate decline – from 92% in 2021 to 83% in 2050, and the share of chemicals (except fertilizers) and machinery in import goes down from 64% in 2021 to 56% in 2050.

¹⁴⁹ COM (2023) 161 – Proposal for a regulation of the European Parliament and of the Council on establishing a framework of measures for strengthening Europe's net-zero technology products manufacturing ecosystem (Net Zero Industry Act). [Net Zero Industry Act \(europa.eu\)](https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32023P0161).

¹⁵⁰ https://en.wikipedia.org/wiki/Inflation_Reduction_Act_of_2022#Provisions.

Table 5.1 Possible change in Russian non-fossil export and import to compensate fossil fuels export loss (bln US\$)

Product groups	Export			Import		2050 multipliers	
	2022	2022*	2050	2021	2050	Export	Import
fossil fuels	268.8	115.9	115.9	-2.4	-2.4	0.3	1
precious metals	31.6	14.8	18.5	-1.1	-1.1	1.2	1
iron and steel	32.9	23.1	34.6	-12.4	-8.3	1.2	0.67
fertilizers	12.5	19.3	23.2	-0.2	-0.1	1.2	0.67
wood, pulp and paper	17.0	12.7	17.0	-4.2	-2.8	1.2	0.67
other non-ferrous	9.6	14.2	28.4	-6.6	-6.6	2	1
aluminum	8.6	8.3	13.8	-1.4	-1.0	1.2	0.67
ores	7.4	5.0	8.3	-2.4	-1.6	1.2	0.67
building materials	3.1	2.6	3.5	-4.1	-2.7	1	0.67
food	36.0	41.3	61.9	-34.0	-22.8	1.2	0.67
other	14.6	10.7	16.1	-37.8	-25.3	1.5	0.67
other chemicals	25.3	15.9	45.4	-53.6	-26.8	2	0.5
machinery	25.7	18.4	40.9	-133.4	-66.7	2	0.5
Total	493.1	302.1	427.3	-293.5	-168.2	87%	57%

*Change driven by sanctions, decarbonization and CBAM-like mechanisms.

Source: the authors.

Export promotion and import substitution can only happen on condition of laxer or lifted high-tech import sanctions; competition-based incentives to invest in new technologies; and re-gained access to international financing. Production of low carbon products/services can be based on accelerated phasing out obsolete plants and boosting the modernization of the remaining capacities with low carbon technology uptake. Demand for new low carbon products in the domestic and international markets will significantly scale up capacity additions and demand for high-tech options to improve the competitiveness to the BATs standards. Potentially wide geographical and products-wise spread of CBAM-like mechanisms will foster demand for low carbon products and services and provide incentives to reduce Scope 1 emissions via improved energy and material efficiency, circular economy, and electrification, CCUS and hydrogen deployment; and Scope 2 emissions via low carbon energy penetration, including renewables, both in grid and off-grid systems; hydrogen-based technologies; CCUS; electric vehicles; and other low carbon technologies, as they reach the commercialization stage.

6

**Effects
of decarbonization
targets and policies
(including sanctions)
on Russia's economic
development
and attainability
of the 2060 carbon
neutrality target**

6.1 Long-term visions of Russia's economic growth: lost decade and bleak future

Russia needs realistic long-term visions of the effects of sanctions and decarbonization policies on its future economic development and attainability of the 2060 carbon neutrality target. Russian Ministry of economic development is providing official optimistic visions only to 2026. Russian think tanks and banks also have a planning horizon only to 2025 (see Chapter 4) with just a few exceptions (see below).

Russia is losing its economic future – that's the overall takeaway from the first assessments of the long-term sanctions and decarbonization effects. The first long-term vision of the effects of sanctions and decarbonization policies was provided by CENef-XXI.¹⁵¹ The main conclusions were as follows: Russia will lose a decade of growth; by 2050, Russia will have lost 46-51% of the previously expected potential GDP, and its share in the global economy would be steadily declining from 3.1% to 1.3-1.7%, if estimated in PPP, and to 0.7-0.9%, if estimated in exchange rates.

Problems are expected to aggravate by 2025 and beyond. Another study was conducted half year later by the Higher School of Economics (HSE) with a time horizon to 2030. Even in the most favorable “New Engagement” scenario with eased sanctions, restoration of the pre-crisis personal incomes is not expected until 2030.¹⁵² The worst scenario with stronger sanctions (“Turbulent lost decade”) assumes many social risks and the negative dynamics of key employment and income indicators with no hope for recovery. Experts of the Higher School of Economics anticipate substantial negative distributional effects: further concentration of wealth; reduction in inequality between lower income groups, as the middle class (or what used to be middle class) is converging with the poor; and aggravating objective and subjective poverty. This will affect consumers' behavior by shifting the structure of consumption from high-tech items towards food and so slow down human capital development.

From bad to worth. After the bottom of the crisis is reached in 2023-2025, Russian economy will be very slowly reviving; average annual GDP growth from 2023 to 2050-2060 will be limited to 1-1.5%. Even before the military operation began, many analytical groups, including OECD, IEA, US DOE, and BP, expected Russian annual GDP growth rates (AAGRs) to stay below 1% till mid-21st century. Long-term projections updated in 2022-2023 are even more pessimistic. According to Statista, in 2027, Russian GDP will be below the 2021 level.¹⁵³ IEA projects Russian GDP AAGR at -1.1% for 2021-2030 and at 0.8% in 2030-2050.¹⁵⁴ Therefore, 2050 GDP level is expected only at 5% above the 2021 level. This matches CENef's projection with low contribution from total factors productivity.¹⁵⁵ Knoema projects that until 2050 annual GDP growth rates will stay in the range 0-0.86%, and only after 2050 they may steadily grow up to 1.6% in 2060.¹⁵⁶ These results are close to the ones provided by OECD.¹⁵⁷ OPEC is more optimistic and projects Russian AAGR at 0.2% in 2021-2027, 1.6% in 2027-2035, and 1.3% in 2035-2045.¹⁵⁸ Goldman Sachs

¹⁵¹ Bashmakov I. 2022. The angle of incidence is not equal to the angle of reflection. April 2022. [CENef-XXI](#); Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060>; Bashmakov I. Russia on the trajectories to carbon neutrality: three fours and one two. Neftegasovaya Vertikal. No. 11, 2022; Bashmakov I. Scenarios of Russia's progress towards carbon neutrality. Energoberezhenie. No. 1, 2023.

¹⁵² [796094249.pdf \(hse.ru\)](#); [The future under sanctions – Novosti – Science and education portal IQ – National research university Higher School of Economics \(hse.ru\)](#).

¹⁵³ [Russia - Gross domestic product \(GDP\) growth rate 2027 | Statista](#).

¹⁵⁴ IEA. World Energy Outlook. 2022.

¹⁵⁵ Bashmakov I. 2022. The angle of incidence is not equal to the angle of reflection. April 2022. [CENef-XXI](#).

¹⁵⁶ [Russia GDP Growth Forecast 2019-2024 and up to 2060, Data and Charts - knoema.com](#).

¹⁵⁷ OECD (2018), GDP long-term forecast (indicator). doi: 10.1787/d927bc18-en (Accessed on 29 March, 2023) [Domestic product - GDP long-term forecast - OECD Data](#).

¹⁵⁸ OPEC. 2022 World Oil Outlook. 2045.

(December 2022) projects 2029 Russian GDP at the 2020 level, and 1.2% growth rate in 2024-2029; 1.6% in 2030-2039; 1.2% in 2040-2049; 1.2% in 2050-2059; 1.3% in 2060-2069; and 1.1% in 2070-2079.¹⁵⁹ These are only half of the expected global GDP growth rates over the same periods. In none of the long-term projections provided since 2022 do AAGRs exceed 1.5% between 2023 and 2050-2060.

No one can buy time, especially if the pocket is half-empty. Shirov (2023) concludes, that in the conservative scenario, GDP growth rates may be 1.5-1.6% per year in 2026-2036, and in the base scenario even exceed 3% per year.¹⁶⁰ He points out that such growth rates can be attained at the cost of lower dynamics of production efficiency or “exchange of quality for quantity” (for example, switch from manufacturing to construction).¹⁶¹ In other words, total factor productivity (TFP) is expected to go further down from its negative 2008-2021 values, and with declining or even constant labor force it is difficult to understand how Russia, with its low export revenues, can accelerate the formation of accumulated fixed capital to see GDP growth above 3% per year. Gusev (2023) highlights, that in 2024-2035, Russian GDP AAGRs may stay close to 1%, and the recent impact of the geopolitical developments is not the key reason for such low rates, as the factors driving the economic growth had been exhausted well before 2022.¹⁶² He questions Shirov's findings about investment growth and points out that investment may only be growing at 1.5% per year. Gusev concludes, that monetary and fiscal instruments can provide only limited stimulating potential, while import substitution might add 1-1.5% per year to the GDP growth rate.¹⁶³ It should be added, that lack of technologies to produce equal quality import substitutes for western products will rather lead to geographical re-orientation of imports, which is happening right now, while effective import substitution may take decades.

6.2 CENEf-XXI's model set

CENEf-XXI's last year projections have been updated using an upgraded set of interconnected models. The models are grouped around ENERGYBAL-GEM-2060, the core multisector model. Many of its parameters are identified using a ‘cloud’ of models. Their interplay is shown in Figure 6.1.¹⁶⁴ The ‘cloud’ of CENEf-XXI's models includes: macroeconomic model RUS-DVA (2 sectors – Oil and Gas and Non-Oil and Gas, 5 products, and 6 blocks); model for the power and heat sector – P&HMOD (10 types of power and heat generation); model for industry – INDEE-MOD (about 60 types of industrial products, technologies, and production processes); model for transport – TRANS-GHG (9 transport modes plus 1-2 vehicle groups in each mode broken down by the power train); models for buildings – RESBUILD (two types of residential buildings – multifamily and single-family – with 9 processes and equipment groups); WASTE – a model for GHG emissions from the waste sector. All of these models have a one-year calculation step and a projection horizon to 2060.

¹⁵⁹ Goldman Sachs. Daly K and T. Gedminas. Global Economics Paper. The Path to 2075 — Slower Global Growth, But Convergence Remains Intact. 6 December 2022 |

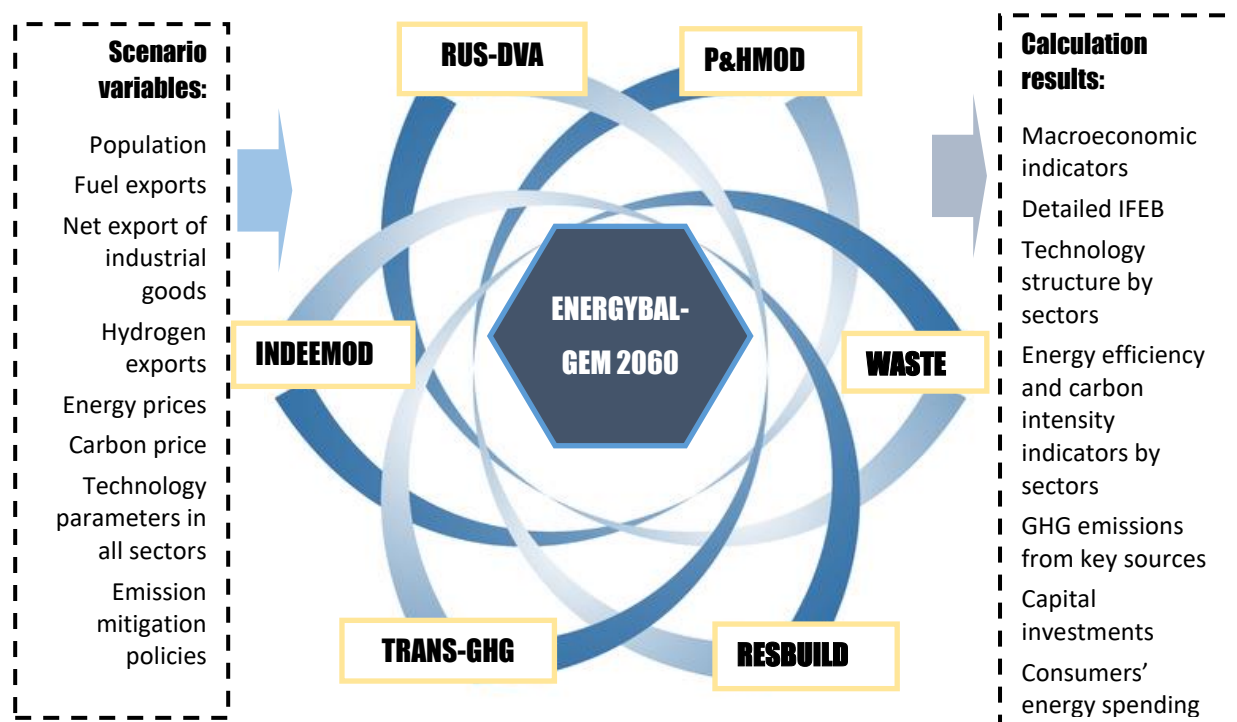
¹⁶⁰ Shirov A.A. Development of the Russian Economy in the Medium Term: Risks and Opportunities // Studies on Russian Economic Development. 2023. Vol. 34. No. 2. Pp. 159-166. DOI: 10.1134/S1075700723020120.

¹⁶¹ A switch towards construction is possible only when the investment activity is high, which is not going to be the case for Russia in the decades to come.

¹⁶² M.S. Gusev. Russian Economic Development Strategy – 2035: Ways to Overcome Long-Term Stagnation // Studies on Russian Economic Development. 2023. Vol. 34. No. 2. Pp. 167-175. DOI: 10.1134/S107570072302003X.

¹⁶³ Ibid.

¹⁶⁴ For more detail about the models description see: Bashmakov I. 2022. The angle of incidence is not equal to the angle of reflection. April 2022. [CENEf-XXI](https://cenef-xxi.ru/articles/russia-s-carbon-neutrality-pathways-to-2060); Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENEf-XXI. <https://cenef-xxi.ru/articles/russia-s-carbon-neutrality-pathways-to-2060>.

Figure 6.1 The 'cloud' of models

Source: CENef-XXI. The angle of incidence is not equal to the angle of reflection. Macroeconomic perspectives.

The models were updated to integrate 2021 and 2022 data in the datasets used to calibrate the parameters. The most significant changes are related to the assumptions, whereas the major storylines for 4S, 4D and 4F scenarios remained basically unchanged. The assumptions were adjusted to better capture the effects of sanctions and decarbonization processes and the new developments in labor force availability, as well as to better understand potential multifactor productivity change limits and the new developments in the parameters of foreign trade.

6.3 Assumptions

6.3.1 Demographic projections

On the 2060 horizon, Russia is expected to lose one fifth to one third (17-26 million) of the working age (25-64) population. In 2022, demographic projections for Russia were updated by the UN,¹⁶⁵ Rosstat,¹⁶⁶ and HSE.¹⁶⁷ The new UN's 2022 population medium projection shows, that:

- In 2030, it will be 1.5 million below the 2019 projection, and 5 million lower in 2060;
- Russia's population will be declining to 128 million in 2060;
- The working-age population is going down with a substantial reduction in 2030, subsequent stabilization until 2045, followed by another decline to 60 million in 2060.

Rosstat's medium scenario is close to the UN's high projection, while its low scenario very well matches the UN's low scenario. Experts from HSE considered 30 scenarios and concluded that by the mid-2070s, Russian population could shrink to 131 million with a potential subsequent growth to 137.5 million people by the end of the century. This projection is more optimistic, than the UN's

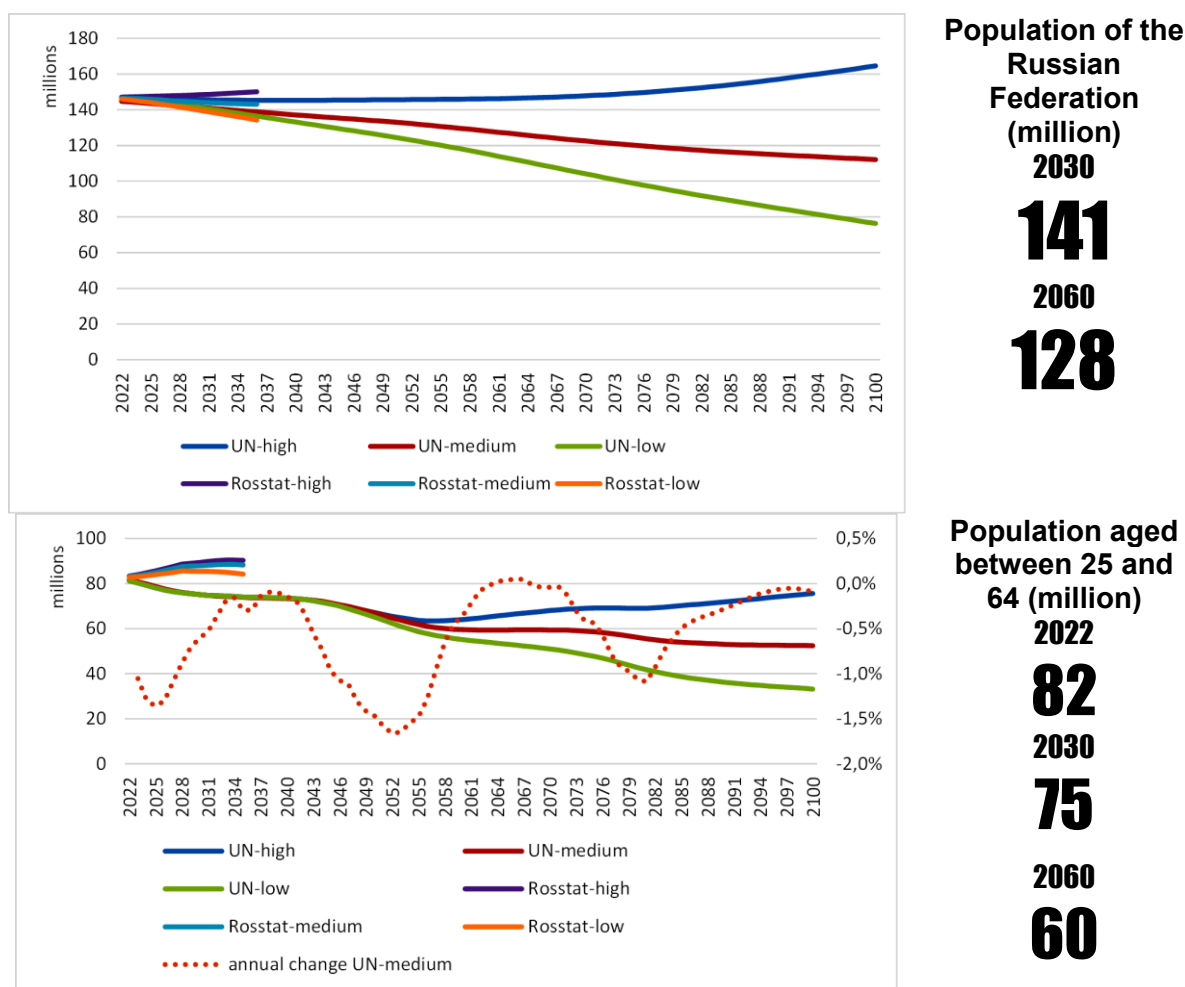
¹⁶⁵ United Nations, Department of Economic and Social Affairs, Population Division (2022). World Population Prospects 2022, Online Edition.

¹⁶⁶ Rosstat. [progn1.xls \(live.com\)](https://rosstat.gov.ru/progn1.xls).

¹⁶⁷ Yumaguzin V.V. and M.V. Vinnik. 2022. Forecast of Population Size and Demographic Burden in Russia up to 2100 // Studies on Russian Economic Development. 2022. Vol. 33. No. 4. Pp. 422-431. DOI: 10.1134/S1075700722040141.

medium one. Rosstat projects growth in the working age population driven by the pension reform and extended working age span. This projection was not used, because the participation rate at 60+ is relatively low, and the extension of working age will not add much to full-time employment, because even before the pension reform many people used to work after they hit the retirement age. This statement is supported by the sharp deficit of workforce in Russia.¹⁶⁸ The interplay between working age population ratios and workforce participation ratios is not simple. It was assumed that workforce follows population in the given age span (15-64), rather than in the span with a moving upper pension age boundary.¹⁶⁹

Figure 6.2 Demographic projections for Russia



Source: United Nations, Department of Economic and Social Affairs, Population Division (2022). World Population Prospects 2022, Online Edition; Rosstat. progn1.xls (live.com).

None of the new demographic projections takes into account the mobilization and emigration from Russia. After the military operation was launched, emigration (assessed at 0.4-0.8 million in 2022 with a large proportion of the working age population)¹⁷⁰ and mobilization (the official

¹⁶⁸ 33% of enterprises named lack of qualified personnel as a major barrier. Tsukhlo S.V. Russian industry in March 2022 – February 2023. The results of the 12 months’ “sanctions war”. Gaidar Institute for Economic Policy. March 28, 2023.

¹⁶⁹ Goldman Sachs. 2022. Daly K and T. Gedminas. Global Economics Paper. The Path to 2075 — Slower Global Growth, But Convergence Remains Intact. 6 December 2022 |

¹⁷⁰ [Emigration from Russia after the launch of Russia's special operation in Ukraine \(wikipedia.org\)](https://en.wikipedia.org/wiki/Emigration_from_Russia_after_the_launch_of_Russia's_special_operation_in_Ukraine).

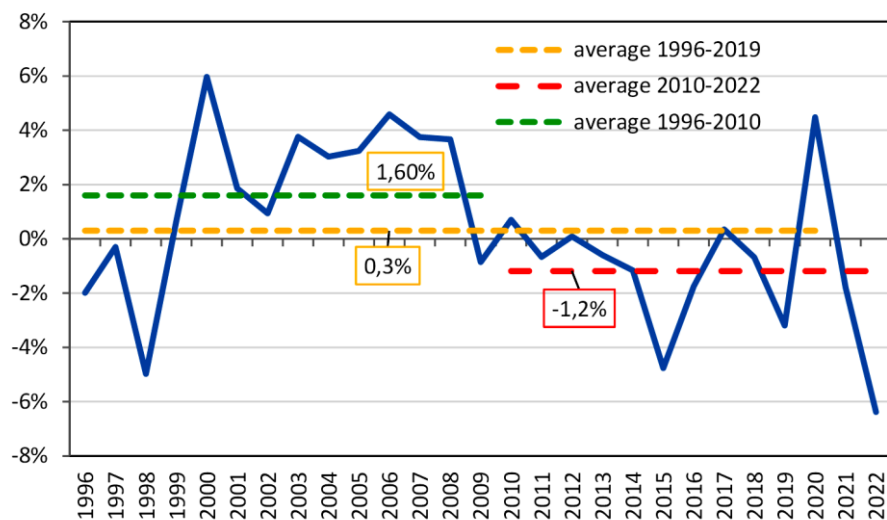
number is 0.318 million, all of whom are working age population¹⁷¹) cut labor force by 0.5-0.8 million, or close to 1%.

Negative demographic developments make it difficult to sustain the economic growth. When the working age population is 0.5-1% down per year, even 2% per year improvement in labor productivity limits GDP growth to only 1-1.5% per year. Therefore, a tough demographic situation in the 2030s and 2040s will severely restrict potential GDP growth rates.

6.3.2 Total factor productivity

Contribution from the total factor productivity is revised down. Average 1995-2022 TFP for Russian NOG GDP was 0.3% (Figure 6.3). Market reforms of the 1990s – with some delay – brought it up to 1.6% in 1996-2010; however, gradual going back on these reforms – also with some delay – took TFP to -1.2% in 2010-2022. In other words, after 2007 the economic growth has been fully extensive.¹⁷² Another study also shows no progress in TFP since 2008.¹⁷³

Figure 6.3 TFP for Russian NOG GDP



Source: CENef-XXI.

The World Bank looked into potential economic growth to 2030. The potential growth represents potential output as a function of the fully utilized capital stock, fully employed labor force, and technology contribution (Solow residual) as measured by TFP. The latter is a negative function of the gap in per capita income with the advanced-economy average (to proxy convergence-related productivity catchup), and positive function of trade openness, institutional quality, macro stability, infrastructure quality, education, demographic indicators and trend investment. In this WB book,

¹⁷¹ [Putin gave the number of the mobilized people in Russia \(rbc.ru\)](https://rbc.ru).

¹⁷² Russia KLEMS. National Research University Higher School of Economics. December 2019. <https://www.hse.ru/russiaklems/dataklems/>; Voskoboynikov I.B. Recovery experiences of the Russian economy. Implications for the Indian Economy. State Bank Institute of Leadership, Kolkata, 18 September. 2020. 34 p. <https://www.hse.ru/mirror/pubs/share/403285320.pdf>; Voskoboynikov I. Accounting for growth in the USSR and Russia, 1950–2012. J Econ Surv. 2021;35:870–894. DOI: 10.1111/joes.12426.

¹⁷³ University of Groningen and University of California, Davis. Total Factor Productivity at Constant National Prices for Russian Federation [RTFPNARUA632NRUG], retrieved from FRED, Federal Reserve Bank of St. Louis; <https://fred.stlouisfed.org/series/RTFPNARUA632NRUG>, March 29, 2023.

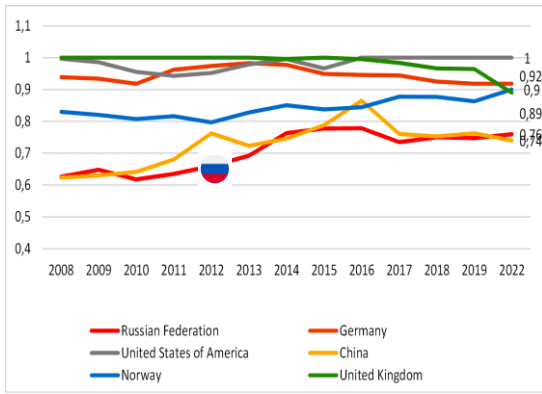
Russia is part of the ECA region (Europe and Central Asia). 2022-2030 TFP for this region was estimated at 0.8%.¹⁷⁴

In the model runs presented below three options were used for TFP:

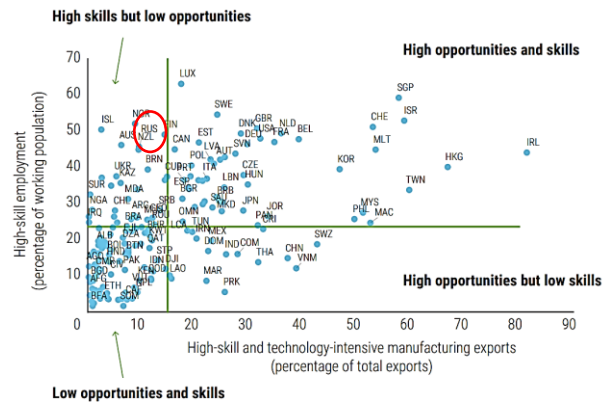
- Quite optimistic, compared with the recent past zero level, for the case of improving business climate in Russia to promote economic activity. Such activities were already launched by the government to inject some adrenalin in the sluggish Russian economy, including grants, preferential loans, business mortgage, and other incentives, along with a moratorium on business inspections;
- 0.4 – for the case of “going both West and East”, with laxer sanctions, promoting domestic and international competition, real progress in import substitution, maintaining the quality and costs of substituted products close to the pre-sanctions level;
- 0.8 – maximum expected by the WB level of TFP for Russia with applying frontier technologies based on lifting the sanctions (along with the underlying reasons), effective competition in domestic and international markets, including those for cutting edge low carbon products and technologies.

The “going East” strategy will not allow it to move closer to the technology frontier, while the former orientation to the West used to provide access to more advanced technologies and so ensured higher TFP. UNCTAD provides frontier technology readiness index, which is composed of the index to assess the level of ICT (information and communication technologies) infrastructure for using, adopting and adapting frontier technologies; index to assess the level of relevant skills for using, adopting and adapting frontier technologies; index to assess the level of R&D capacity for using, adopting and adapting frontier technologies; and index to assess the level of relevant industrial capacity for using, adopting and adapting frontier technologies. The USA 2019 level is taken as a unity. Russia's index is 0.76 – just as high as China (Figure 6.4).

Figure 6.4 UNCTAD frontier technology readiness index and readiness to benefit from Industry 4.0 diffusion



frontier technology readiness index. Russia close to China and much below Western countries



readiness to benefit from Industry 4.0 diffusion. Russia: high skills yet low opportunities

Sources: UNCTAD (2022). Industry 4.0 for Inclusive Development (United Nations publication, Sales No. E.22.II.D.8, New York and Geneva; UNCTADSTAT. [us_ftri_62754370428803.xlsx](https://unctadstat.unctad.org/Download.do?lang=en&table=US_FTRI_62754370428803.xlsx) (live.com); [Beyond 20/20 WDS - Table view - Frontier technology readiness index, annual \(unctad.org\)](https://unctad.org/fr/publications-and-reports/beyond-2020-wds-table-view-frontier-technology-readiness-index-annual).

When productivity growth and cost optimization are no longer taken into account by decision-makers, poverty takes over. The assumption made for the 4D scenario that TFP in

¹⁷⁴ Falling Long-Term. Growth Prospects. Trends, Expectations, and Policies. Edited by M.A. Kose and F. Ohnsorge 2023 International Bank for Reconstruction and Development / The World Bank.

Russia may scale up to 1.5% was too optimistic.¹⁷⁵ Many recent decisions made by the Russian authorities were driven by political reasons at the expense of productivity growth and cost reduction. This brought TFP down to below zero in 2008-2021. After 2022, unwise political decisions coupled with sanctions led to what Shirov calls production efficiency decline as “quality in exchange for quantity”.¹⁷⁶ In reality, both quality and quantity are sacrificed. TFP growth may be based on the economy of scale (access to large domestic and foreign markets is required); uptake of new, and modernization of old, technologies; economy openness; introduction of more efficient management practices – all driven by the exposure to international and domestic competition.¹⁷⁷ Economy openness allows it to capture TFP improvement originating in upstream industries in suppling countries.¹⁷⁸ Trade liberalization is more beneficial for countries like Russia, which are far from the technological frontier, because they may benefit from technologies transfer from advanced economies. Business liberalization is advantageous for countries which are close to the frontier, because it removes regulatory barriers, improves chances for market penetration and reinforces the incentives for innovation.¹⁷⁹ Russia is facing reduction in foreign market trade, lack of international and domestic competition, shrinking economy openness, loss of TFP improvement effects originating in upstream industries in the West, loss of skilled workforce (emigration), and poor access to foreign investment (long-term financing at favorable conditions for large-scale projects) and to the advanced Western technologies.

It is very likely that TFP for the Russian non-oil and gas sector will be staying below, or close to, zero in the decades to come, and there are no grounds to believe that Russia's TFP will be above 0.8%. Potential TFP values as used in this study range between zero and 0.8. Average TFP for 24 OECD countries was 0.57% in 1995-2021 and 0.56% in 2010-2021.¹⁸⁰ Only for 5 countries average TFP was above 0.8% over 27 years (1995-2021): South Korea (2.55%), Ireland (1.65%); Finland (1.01%); Israel (0.94%), and the U.S. (0.9%) (Figure 6.5). All of them are close to the technological frontier, have open market economies, are deeply involved in the international division of labour, make large R&D allocations, benefit from successful technologies commercialization and very skilled workforce.

¹⁷⁵ Bashmakov I. 2022. The angle of incidence is not equal to the angle of reflection. April 2022. [CENef-XXI](#); Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality-pathways-to-2060>.

¹⁷⁶ A switch towards construction is only possible when the investment activity is high, which is not going to be the case for Russia in the decades to come.

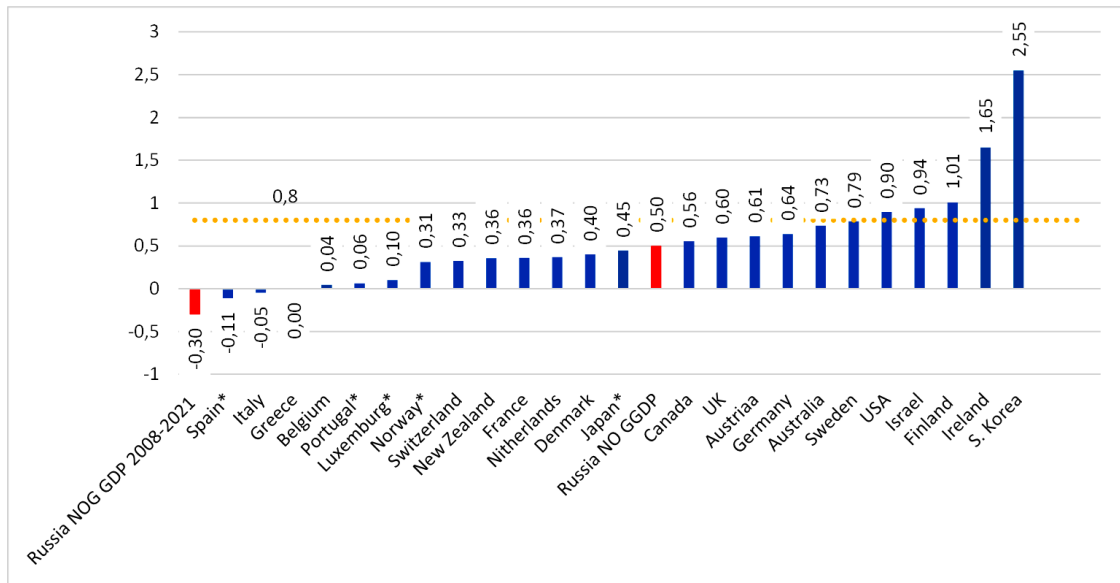
¹⁷⁷ Potential Growth: Outlook and Options for the Russian Federation. Yoki Okawa and Apurva Sanghi. World Bank Policy Research Working Paper 8663 Development Prospects Group & Macroeconomics, Trade and Investment Global Practice December 2018 [World Bank Document](#).

¹⁷⁸ Gu W. and B. Yan. 2017. Productivity growth and international competitiveness. Economic Analysis Division, Statistics, Canada. Review of Income and Wealth Series 63, Supplement 1, February 2017 DOI: 10.1111/roiw.12254.

¹⁷⁹ Competition and Economic Growth: An Empirical Analysis for a Panel of 20 OECD Countries. Scopelliti, Alessandro Diego University of Warwick, Department of Economics. December 2009. Online at: <https://mpr.ub.uni-muenchen.de/20127/> MPRA Paper No. 20127.

¹⁸⁰ [Productivity – Multifactordev productivity – OECD Data](#).

Figure 6.5 Average 1995-2021 total factor productivity for different countries (percent)



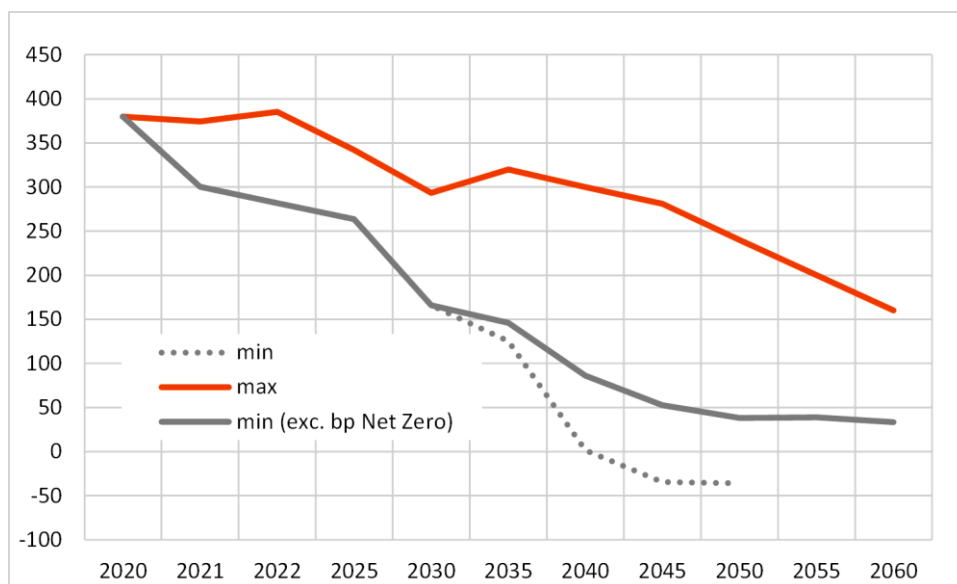
*1995-2020.

Sources: CENef-XXI for Russia historical; OECD countries – [Productivity – Multifactordev productivity – OECD Data](#).

6.3.3 Oil and gas export

Crude oil and petroleum products export from Russia is assumed down to 33-160 Mt in 2060. This parameter is an exogenous variable in RUS-DVA and ENERGYBAL-GEM-2060 models. To cover the whole uncertainty range presented in Chapter 5, the trajectories outlining this range were selected to serve as model inputs (Figure 6.6). The only correction made for the lower boundary is the elimination of bp Net Zero scenario close to, or below, zero estimates.

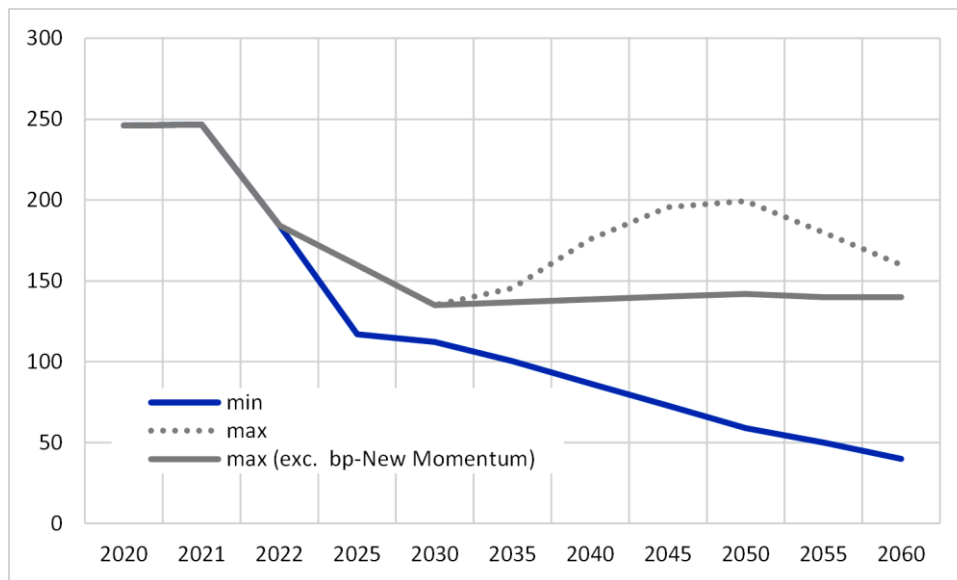
Figure 6.6 Crude oil and petroleum products export from Russia (Mt)



Source: CENef-XXI based on data from Figure 5.7.

Gas export was assumed to collapse before 2025 with a further smaller decline to 40 bcm in 2060 or freezing at 140 bcm in 2030-2060. Combined pipeline and LNG gas export assumptions were selected as outline trajectories covering the full range of recent long-term projections presented in Chapter 5. BP New Momentum scenario (see Chapter 5) with a projection for Russian gas export to rebound to 200 bcm before 2050 and the IEF RAS' scenario with Russian gas export restoration to 216 bcm in 2035¹⁸¹ were excluded from the range, as they look unrealistic, especially with an account of the late-March 2023 information leakage about N. Shulginov, Russian Minister of Energy, writing in his letter of December 2022 and stating in his March 28, 2023, presentation at the collegium of the Ministry, that by 2040 gas production at the largest West Siberia gas fields may drop from 468 bcm in 2023 to 184 bcm in 2030 and to 73 bcm in 2040.¹⁸² Therefore, natural gas production decline at the existing fields may amount to 395 bcm and much exceed both historical and projected export volumes. If not compensated by new hard-to-recover fields (which are currently much harder-to-recover because of the limited access to the required technologies), and if domestic gas use stays close to the current levels, Russian gas export potential will be undermined, if not fully destroyed. In this case the upper dotted line trajectory in Figure 6.7 looks unrealistically optimistic.

Figure 6.7 Natural gas export from Russia (bcm)



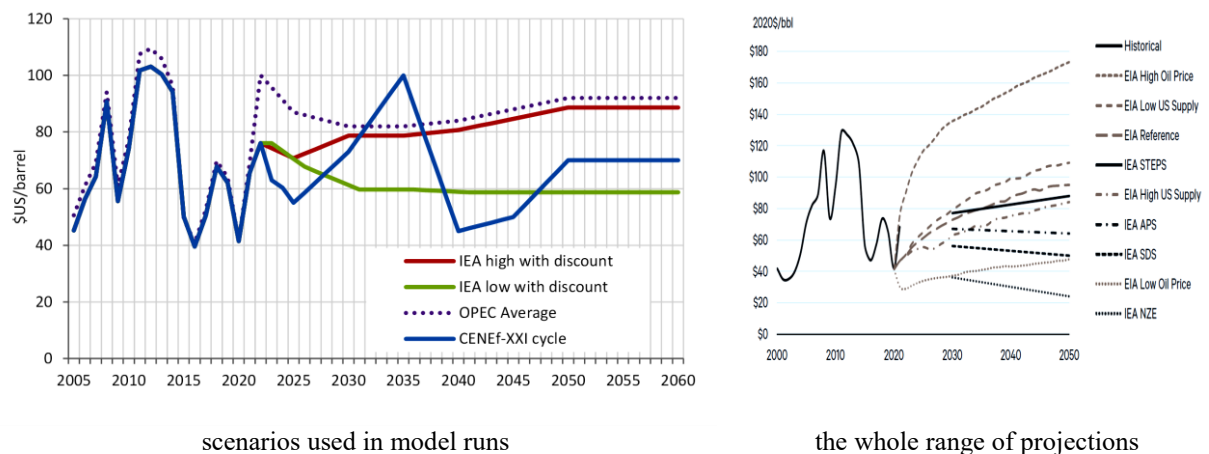
Source: CENef-XXI based on data from Figure 5.7.

6.3.4 Oil and gas prices

On the 2050 horizon, crude oil export prices are expected to fluctuate within the ranges observed in 2005-2022 with the price discount smoothly shrinking, but practically no chance of staying any close to the 2022 highs for any long timespan. In 2022, average OPEC crude oil export price was 100.8 US\$/barrel, while average price for Russian exported crude oil was reported at 76.1 US\$/barrel. In 2005-2021, Russian export price was on average 3.3 US\$/barrel below the OPEC average price, so in 2022 average price discount was 21.4 US\$/barrel (Figure 6.8). It is assumed that by 2030 this discount will smoothly disappear and the difference in oil quality alone will keep Russian oil export price at 3.3 US\$/barrel below the OPEC average.

¹⁸¹ Semikashev V.V. and M.S. Gaivoronskaya. Analysis of the state and development prospects of gas industry of Russia in the new conditions. Institute of Economic Forecasting RAS. Presentation at the Seminar on Economics of Energy and the Environment. Moscow School of Economics. March 30, 2023.

¹⁸² ["Izvestia": Minenergo saw the risks of one third gas production decline in Russia by 2040 because of reserves depletion - Novosti - Business - Kommersant \(kommersant.ru\).](https://www.kommersant.ru/doc/5811111)

Figure 6.8 Price assumptions for Russian crude oil exports

Sources: CENef-XXI; IEA. World Energy Outlook. 2022; Raimi D., E. Campbell, R. Newell, B. Prest, S. Villanueva, and J. Wingenroth. Global Energy Outlook 2022: Turning Points and Tension in the Energy Transition. Resources for the Future (RFF). Report 22-04 April 2022.

For the Russian economy, oil and gas price levels are more important, than physical export volumes. Oil price projections are risky, but they are required as inputs to the model set. In order to outline the oil price evolution range, IEA 2022 World Energy Outlook projection fork for STEPS and APS was used. IEA suggests even lower price values for the NZE scenario, but the logic that the unprecedentedly high rates of energy efficiency improvements and low-carbon technologies penetration can be coupled with low oil prices seems questionable, as assumed CO₂ prices in the NZE scenario are not much different from those for APS. These two IEA price trajectories were adjusted for the price discount to provide Russian export price. Oil prices never go smoothly in the same direction. The logic under the third trajectory of oil price evolution in Figure 6.5 is based on the historically observed cyclical (25-30-year cycles) evolution of energy prices (and the shares of energy costs in the income).¹⁸³

Prices of exported petroleum products are set as a function of the crude oil export price. In 2022, gas prices substantially deviated from the traditional link with oil prices. Nevertheless, analysis made based on IEA 2022 oil and gas price projections to 2050 shows, that gas prices are assumed to follow crude oil price. Based on this analysis, export gas prices are set as distributed Koyck lag functions of crude oil prices.

6.3.5 Non-oil and gas exports and imports

‘Slowbalisation’¹⁸⁴ will limit the Russian export potential. Firstly, we are moving to a future with slower growing working age population and declining labor-force participation. Secondly, security considerations and projectionism have led to a recent reversal of globalisation (global trade in goods as share of global GDP) after peaking in 2010-2014. It means global trade will be lagging behind and slowing down global GDP, and since trade-openness is important for total factor productivity, it will slow down global productivity growth.¹⁸⁵ This will add to the slowing effects

¹⁸³ Bashmakov I. “Economics of the constants” and long cycles of energy prices dynamics. *Voprosy Ekonomiki*. 2016;(7):36-63. (In Russ.) <https://doi.org/10.32609/0042-8736-2016-7-36-63>; The first law of energy transitions and carbon pricing. *International Journal of Energy, Environment, and Economics*, Vol. 25, No. 1, pp. 1-42; Bashmakov I., Myshak A. 2018. ‘Minus 1’ and energy costs constants: Sectorial implications. *Journal of Energy*, Vol. 2018, Article ID 8962437. <https://doi.org/10.1155/2018/8962437>.

¹⁸⁴ Goldman Sachs. Daly K and T. Gedminas. Global Economics Paper. The Path to 2075 — Slower Global Growth, But Convergence Remains Intact. 6 December 2022.

¹⁸⁵ Falling Long-Term. Growth Prospects. Trends, Expectations, and Policies. Edited by M.A. Kose and F. Ohnsorge. 2023 International Bank for Reconstruction and Development / The World Bank; Goldman Sachs. Daly K and T.

from demographic factors. All available long-term projections show that global economy will slow down from 3.8% after 2000 to slightly above 2% by and beyond the mid-century, and global trade will be growing even slower.

Russia has failed to scale up physical volumes of non-oil and gas exports since 2000. In the foreign trade block of RUS-DVA model, both non-oil and gas exports and total imports of goods are set as econometric functions, which include NOG GDP variable as an explanatory factor. For non-fuel export, another variable is unit value index of exports. It was used as proxy for unit value index of non-fuel exports from Russia. When nominal non-oil and gas export is corrected for the unit value index, it appears that there has been no progress in physical volumes since 2000. MED RF expects physical NOG GDP export in 2026 back to the 2021 level; so no progress is expected in 2000-2026. As shown in Chapter 5, current accounts can be balanced by promoting non-oil and gas export or through import substitution. Correction multipliers are used for NOG GDP variable to capture the assumed effectiveness of foreign trade policies. These multipliers are based on the analysis conducted in Chapters 3-5.

6.4 Scenarios

6.4.1 Combinations of economic drivers

In 2022, three scenarios were considered to assess low carbon transformation perspectives of the Russian economy:

- 4S – Stagnation, Sanctions, Self-Sufficiency (which might be alternatively titled Forward-to-the-Past, as the opposite of Back-to-the-Future);
- 4D – Development Driven by Decarbonization and Democratization, which opens the door for Russia to return to the global economy;
- 4F – Fossil Fuels for Feedstock, which builds upon 4D and non-energy use of Russia's fossil fuel resources.¹⁸⁶

Below we are looking in more detail into how sanctions and decarbonization process may affect Russian economic developments and GHG emissions in the decades to come. The options considered for economic drivers are listed in Table 6.1. In order to limit the scope of options only three combinations were considered below in detail, with some comments on possible deviations within each scenario group. In Table 6.1, the combination of drivers in the left column yields the lowest economic growth, and the right-hand combination ensures the highest growth, thus covering much of the uncertainty range.

Gedminas. Global Economics Paper. The Path to 2075 — Slower Global Growth, But Convergence Remains Intact. 6 December 2022.

¹⁸⁶ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichok, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060>; Bashmakov I. Russia on the trajectories to carbon neutrality: three fours and one two. Neftegasovaya Vertikal. No. 11, 2022; Bashmakov I. Scenarios of Russia's progress towards carbon neutrality. Energoberezhenie. No. 1, 2023.

Table 6.1 Options for economic drivers

	Combination 1	Combination 2	Combination 3
Sanctions	strong	medium	relaxed
TFP	0	0.4	0.8
Employment	low	medium	high
Fiscal policy*	relaxed	relaxed	relaxed
Foreign trade policy	weak import substitution	stronger import substitution	non-fuel export promotion and stronger import substitution
Oil and gas export	low	medium	high
Oil and gas prices	low	medium	high
Carbon price	low	low	high

* options considered for separate model runs include: relaxed (no strong control over deficit); zero deficit (control for expenditure to fully fit revenues); real 2% (2% annual growth in real expenditures).

Source: CENef-XXI.

Combination 1 provides conditions which are worth comparing with the ones used in the 4S scenario, while Combination 3 is close to the storylines underlying the 4D scenario. The combinations of economic drivers are wider, than in the 2022 assessments, when low oil and gas exports were thought to be a strong motivation for TFP improvement. Now a combination of low oil and gas export revenues with low TFP is one considered scenario.

6.4.2 The “magic skin economy”

If the current sanctions persist into the future and are added up with Russia's poor integration in the dynamic global decarbonization, they will lead, first, to stagnation and then to a drop in economic activities in the decades to come, because non-oil and gas sector will be unable to offset the shrinking oil and gas “magic skin”. Unluckily for Russia, Combination 1 of economic drivers (Table 6.1) leads to GDP stagnation till 2040 with a subsequent decline resulting from workforce shortage and oil and gas revenues loss (Table 6.2). It is a shrinking economy scenario, because 2060 GDP will be 23% below the 2021 level and even below the 2007 level. GDP will be stagnating until 2040 – this is not much different from 2008-2022 and 2016-2020, when average annual GDP growth was only 0.3-0.4%. But beyond 2040, global decarbonization will be steadily driving OG GDP down, and non-oil and gas GDP will be declining too. After a small growth to 2040, private consumption in real terms will get back down to the 2021 level in 2060.

Russia's share in global GDP will shrink to 0.9% expressed in PPP and to 0.5%, if estimated in exchange rates. Back in 2011, the answer to the question – will Russia have economic growth in the mid-XXI century? – was conditionally negative.¹⁸⁷ Now it has become only conditionally positive. Not only the declining oil and gas GDP, but also shrinking workforce, zero TFP and scaling down investment (with a relatively stable rate of accumulation following the GDP drop) leave no hope for non-oil and gas GDP growth.

Oil and gas export will shrink significantly, the “magic skin” will be getting smaller and smaller and finally will become just too small to prevent budget deficit, given the escalating military spending and large social obligations. Budget deficit to GDP ratio will be growing to above 10% beyond 2055, thus bringing the government debt to incredible 114% of GDP in 2060. A decade

¹⁸⁷ Bashmakov I. Will Russia Have Economic Growth in the Mid-XXI Century? *Voprosy Ekonomiki*. 2011;(3):20-39. (In Russ.) <https://doi.org/10.32609/0042-8736-2011-3-20-39>.

after 2050 ruble will have lost on average 60% of its mean 2016-2020 value making the import of technologies and products less affordable and limiting the TFP improvement potential.

Table 6.2 Major economic parameters with Combination 1 of economic growth drivers

	Units	2016-2020	2021-2030	2031-2040	2041-2050	2051-2060	2021-2060
GDP AAGR	%	0.4%	-0.1%	0.0%	-0.8%	-1.1%	-0.7%
Oil and gas GDP AAGR	%	0.2%	-3.0%	-2.7%	-3.4%	-2.1%	-3.1%
Non-oil and gas GDP AAGR	%	1.2%	0.4%	0.3%	-0.5%	-1.1%	-0.4%
Oil and gas GDP share	%	17.4%	14.8%	9.1%	5.6%	4.4%	8.5%
Gross fixed capital formation/GDP	%	21.4%	22.1%	22.3%	22.0%	21.3%	21.7%
Oil and gas investments share in gross fixed capital formation	%	19.3%	14.4%	13.1%	11.3%	10.3%	12.3%
Number of employees	million	71.2	69.7	66.7	62.9	52.9	63.0
GDP deflator AAGR	%	4.5%	6.9%	3.0%	2.3%	2.5%	3.3%
Non-oil and gas GDP deflator AAGR	%	7.1%	6.7%	3.2%	2.4%	2.5%	3.4%
Consolidated budget expenditures/GDP	%	35.7%	39.1%	41.9%	43.6%	44.1%	42.2%
Consolidated budget deficit/GDP	%	-0.9%	-4.1%	-7.2%	-9.1%	-9.6%	-7.5%
Average current accounts balance	US\$ billion	57.9	42.7	-45.8	-7.8	126.8	29.0
Exchange rate	rub./US\$	63.6	100.3	148.1	155.6	157.5	140.4
Annual average oil export	Mt	255.0	145.3	43.5	26.7	23.5	59.7
Annual average petroleum products export	Mt	147.3	138.8	88.4	28.3	13.5	67.3
Annual average gas export	bcm	230.5	141.5	125.2	118.2	112.6	63.3
Oil and gas investment	US\$ billion	323.9	558.9	489.3	487.2	499.1	464.8
Private consumption AAGR	%	0.7%	0.1%	0.4%	-0.4%	-1.0%	0.0%

Source: CENef-XXI.

Policies aimed to increase the fiscal pressure beyond the thresholds in order to keep the budget deficit manageable may become an additional barrier to economic growth by discouraging investment and private consumption. Policies aimed to control government expenditures by keeping consolidated budget strictly balanced would lead to a drop in economic activities (in 2060, GDP will be 31% below the 2021 level), while policies aimed to keep budget spending growing by 2% per year in constant prices would allow it to scale down the 2060 GDP reduction to 13% of the 2021 level; however, the price would be a fantastic deficit of consolidated budget – 23% of GDP – and the government debt skyrocketing to 171% of GDP in 2060. Both of these two developments are hardly possible though.

In an attempt to turn away from global integration to global isolation and by deploying a corresponding combination of economic drivers, Russia will lose out the race for the future. The results presented in Table 6.2 show that things might be much worse, than expected in 2022 in the 4S scenario.

Feasibility of any scenario can be estimated by using effective analytical tools¹⁸⁸ to allow for a comparison between scenario storylines, assumptions, and expected outcomes of the assessed macroeconomic development pathways. The expected effects of the Russian economic

¹⁸⁸ Bashmakov I.A. (1987). On the implementation and analysis of the results of macroeconomic forecasts (method of seven matrices). In: *The system of macroeconomic information processing*. M.: Nauka. P. 117–132. (In Russian).

development based on Combination 1 drivers very well fits the 4S scenario storylines developed in 2022.¹⁸⁹

- strong sanctions persist for Russia's dominating traditional exports, which are considered toxic in the global, and especially G7, markets; the same goes for the ban on high-tech imports to Russia;
- after switching to new regional markets, oil and gas exports shrink, as the global economy is steadily switching to low carbon pathways;
- O&G sector declines, and so does its contribution to GDP, foreign trade, and consolidated budget;
- strong government control over the economy along with aging production facilities, slow phasing out and low modernization rates does not allow for the improvement in overall efficiency in the sectors under control and keeps TFP low;
- Russia is cut off many global supply chains and forced to rely on self-sufficiency for domestic needs. Poor quality or costly high-tech imports substitution limits the potential to improve TFP, which have already suffered from a deeper government control;
- slow/no economic growth in the NOG sector:
 - is a result of low TFP, declining labor force, intensive brain drain, low investment, and limited inflow of international capital;
 - limits the potential to expand non-fuel and non-basic materials exports to the global markets, which are dynamically switching to the low carbon pathways;
- poor access to international financing for companies and the public sector will restrict the ability of the consolidated budget to keep real expenditures growing, as beyond 2025 oil and gas revenues will be brought down by low exports and low energy prices, and the NOG sector will be unable to fill the gap.

6.4.3 Struggle for stagnation

It is not a trivial task to have 2060 Russian GDP at the 2021 level; to this end, TFP is to be improved to at least 0.4% per year. It is only attainable through the trade openness, better quality of institutions, macrostability, improved quality of infrastructure, higher skills and better opportunities to use them, and better business climate. The storylines underlying Combination 2 of economic drivers are roughly between the ones outlined above and those developed in 2022 for the 4D scenario. The assumptions are as follows:

- progress towards termination of Russia's military operation in Ukraine would allow for relaxed sanctions and enable Russia to regain some of its lost positions in the global value chains;
- relaxed or lifted high-tech import sanctions, competition-based incentives to invest in new technologies, and re-gained access to international financing will improve TFP to 0.4% per year;
- democratization and competition will develop, as the role of the oil and gas sector and the government sector will be shrinking, and reliance on a wider political and social spectrum will become key for sustaining social stability and inspiring business activity. This would reduce the emigration of qualified workforce and attract skilled professionals from abroad. It will reduce corruption and provide incentives for investment and rewarding based on skills, rather than on loyalty;

¹⁸⁹ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichok, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia-s-carbon-neutrality:-pathways-to-2060>

- proactive decarbonization policies in Russia will help to get a market niche in some global regions for a variety of low-carbon products and get access to the hardware and software essential to produce them;
- growing potential to increase low carbon products/services production will accelerate phasing out obsolete capacities and boost modernization of the remaining assets.

Such developments would allow it to keep Russian 2060 GDP and NOG GDP close to the 2021 levels (Table 6.3). As the proportion of OG GDP in GDP declines from 17.4% in 2016-2020 to 5% in 2051-2060, NOG GDP will be increasingly setting the pattern for overall GDP evolution. Sensitivity analysis shows that (as already observed in 2008-2022) fluctuations in oil and gas prices and oil and gas export volumes provide only limited effects on GDP. Therefore, the ability and willingness to invest in non-oil and gas sector and availability of skilled labor to run high-tech equipment are becoming the key drivers of economic growth. In 2060, NOG GDP will be 9% up from the 2021 level to allow for only 2.7% decline in total GDP, despite 57% decline in OG GDP. Consolidated budget deficit is still high reaching 10% by 2060, but the government debt to GDP ratio is 86% versus 114% in the above scenario. More effective import substitution enables improvement in the current accounts balance and more moderate devaluation of ruble, making imported technologies more affordable.

Table 6.3 Major economic parameters with Combination 2 of economic drivers

	Units	2016-2020	2021-2030	2031-2040	2041-2050	2051-2060	2021-2060
GDP AAGR	%	0.4%	0.2%	0.5%	-0.1%	-0.4%	-0.1%
Oil and gas GDP AAGR	%	0.2%	-1.5%	-1.1%	-2.4%	-2.7%	-2.2%
Non-oil and gas GDP AAGR	%	1.2%	0.6%	0.8%	0.1%	-0.2%	0.2%
Oil and gas GDP share	%	17.4%	14.8%	11.2%	5.9%	5.1%	9.3%
Gross fixed capital formation/GDP	%	21.4%	22.0%	22.1%	21.9%	21.3%	21.6%
Oil and gas investments share in gross fixed capital formation	%	19.3%	15.3%	15.3%	14.5%	12.4%	14.4%
Number of employees	million	71.2	70.0	66.5	63.6	55.8	64.0
GDP deflator AAGR	%	4.5%	6.9%	3.0%	1.9%	1.7%	3.0%
Non-oil and gas GDP deflator AAGR	%	7.1%	6.6%	3.6%	1.7%	1.7%	3.1%
Consolidated budget expenditures/GDP	%	35.7%	39.0%	41.2%	43.3%	44.0%	41.9%
Consolidated budget deficit/GDP	%	-0.9%	-4.0%	-6.4%	-8.8%	-9.4%	-7.2%
Average current accounts balance	US\$ billion	57.9	52.7	30.7	28.2	157.5	67.3
Exchange rate	rub./US\$	63.6	98.5	121.6	148.4	137.0	126.4
Annual average oil export	Mt	255.0	172.3	65.9	48.7	37.4	81.1
Annual average petroleum products export	Mt	147.3	145.8	154.4	115.0	79.1	123.6
Annual average gas export	bcm	230.5	162.4	152.8	143.1	130.5	86.1
Oil and gas investments	US\$ billion	323.9	593.1	749.6	715.8	763.1	595.6
Private consumption AAGR	%	0.7%	0.2%	0.8%	0.4%	-0.1%	0.8%

Source: CENef-XXI.

This scenario enables only a limited improvement in Russia's share in global GDP limiting its decline to 1.1% expressed in PPP and 0.6%, if estimated in exchange rates.

6.4.4 Limits of growth – is there a cap to hit?

Russian GDP growth in 2021-2060 is confined to 21%. Russia's share in global GDP even in this favorable scenario shrinks to 1.4% expressed in PPP and to 0.7%, if estimated in exchange rates. Combination 3 of economic drivers provides the most favorable conditions for the Russian economy to expand. With these assumptions TFP scales up to 0.8% per year, which is the maximum for European and Central Asian countries as estimated by the WB.¹⁹⁰ It is assumed that if TFP is to get that high, sanctions must be either much laxer or lifted, and there should be substantial progress in advancing the other factors listed above to improve TFP. It is further assumed, that the government will be capable of effectively promoting non-fuel export and stronger import substitution. To enable all this, international trade openness should be well balanced between the West and the East to approach the technology frontier and thus improve TFP. Demonstration of the ability to sustain economic growth and the stronger ruble would attract more skilled labor to run new low carbon technologies. Strong competition in emerging low carbon markets will force Russian businesses and government to launch policies to promote low carbon development in order to either maintain the market niches in traditional markets or (and) gain them in the emerging low carbon markets. If all of the above is coupled with favorable for Russia developments in global oil and gas markets (as sanctions are relaxed or fully lifted), this scenario will allow it to maintain the recent 0.5% GDP growth to 2060 (Table 6.4). The ageing population and declining workforce will impede more dynamic GDP growth.

Table 6.4 Major economic parameters with Combination 3 of economic drivers

	Units	2016-2020	2021-2030	2031-2040	2041-2050	2051-2060	2021-2060
GDP AAGR	%	0.4%	0.5%	1.1%	0.5%	0.5%	0.5%
Oil and gas GDP AAGR	%	0.2%	-0.6%	-0.2%	-1.1%	-2.9%	-1.5%
Non-oil and gas GDP AAGR	%	1.2%	0.7%	1.3%	0.7%	0.9%	0.8%
Oil and gas GDP share	%	17.4%	16.1%	12.0%	8.8%	6.3%	10.8%
Gross fixed capital formation/GDP	%	21.4%	21.9%	22.0%	21.6%	21.2%	21.4%
Oil and Gas investments share in gross fixed capital formation	%	19.3%	16.2%	17.8%	17.4%	14.4%	16.4%
Number of employees	million	71.2	69.7	66.7	63.4	57.8	64.4
GDP deflator AAGR	%	4.5%	7.1%	2.9%	2.0%	1.1%	2.9%
Non-oil and gas GDP deflator AAGR	%	7.1%	6.8%	3.1%	2.1%	1.0%	3.0%
Consolidated budget expenditures/GDP	%	35.7%	38.7%	41.0%	42.6%	43.7%	41.5%
Consolidated budget deficit/GDP	%	-0.9%	-3.7%	-6.1%	-7.9%	-9.0%	-6.7%
Average current accounts balance	US\$ billion	57.9	96.8	75.7	113.4	172.0	114.5
Exchange rate	rub./US\$	63.6	89.1	113.1	121.4	126.2	112.4
Annual average oil export	Mt	255.0	206.3	147.7	98.3	51.3	125.9
Annual average petroleum products export	Mt	147.3	145.8	161.0	174.2	144.7	156.4
Annual average gas export	bcm	230.5	183.3	180.5	167.9	148.4	109.0
Oil and gas investments	US\$ billion	323.9	702.6	970.6	1173.6	1115.7	792.7
Private consumption AAGR	%	0.7%	0.3%	1.4%	0.8%	0.9%	1.5%

Source: CENef-XXI.

Total 2060 GDP is 21% above the 2021 level. OG GDP scales 44% down, while NOG GDP is 35% above the 2021 level. Consolidated budget deficit exceeds 9% in 2060, but the government

¹⁹⁰ Falling Long-Term. Growth Prospects. Trends, Expectations, and Policies. Edited by M.A. Kose and F. Ohnsorge. 2023. International Bank for Reconstruction and Development / The World Bank.

debt to GDP ratio is down to 64% versus 86% for Combination 2 and 114% for Combination 1 scenarios. A stricter fiscal policy targeted to keep the consolidated budget fully balanced on revenues and expenditures limits GDP growth in 2021-2060 to 5.1%, and NOG GDP growth to 15.4%. By going down on oil and gas export and price assumptions from high to medium, we get 2060 GDP at 19% above the 2021 level, so the impact is moderate – only 2% for the whole timespan. GDP growth is much more sensitive to labor availability; when the high assumption regarding the number of employees is replaced with the lower one, GDP growth in 2021-2060 is limited to only 8.4%. Promotion of non-fuel export and effective import substitution can improve the current accounts balance and keep the ruble more stable. Moderate devaluation of ruble makes import technologies more affordable.

6.5 The effects of sanctions and decarbonization policies on Russia's long-term economic development perspectives

If Russia fails to bring TFP up from the negative values registered in 2010-2022 to positive values in 2023-2060, Russia's per capita GDP may stay unchanged for the next four decades or even decline. Then in 2060, Russia's per capita GDP will be 65% below the global average, 82-90% below that for advanced economies, 70% of China's and 38% of India's.¹⁹¹ In fact, it may be similar to that of Ghana or Ethiopia. On this trajectory Russia will obviously lose the status of a developed country. As workforce declines (the process which was largely propelled by the military operation in Ukraine), accumulation of fixed capital slows down, overall resource efficiency (energy efficiency and material efficiency) shows no or very little progress, the role of total factor productivity becomes crucial for the success of maintaining positive GDP growth rates.

To better capture the uncertainty associated with the impacts of possible variations in other economic drivers, several model-set outputs were added to those initially compiled for the three Combinations shown in Table 6.1. All together 16 combinations were considered (Figure 6.9), of which 8 correspond to TFP=0.

It is quite a challenge for Russia to bring TFP from its negative (-1.2%) value recorded in 2010-2022 even to zero, while the sanctions force both heads of the Russian national emblem eagle to look East. Even with former access to the western high-tech TFP stayed below zero. With sanctions in force, no access to the Western cutting-edge technologies, and the available alternatives from China or elsewhere being of either lower quality and productivity or more costly, the task of pulling TFP up from the negative zone is yet more challenging.

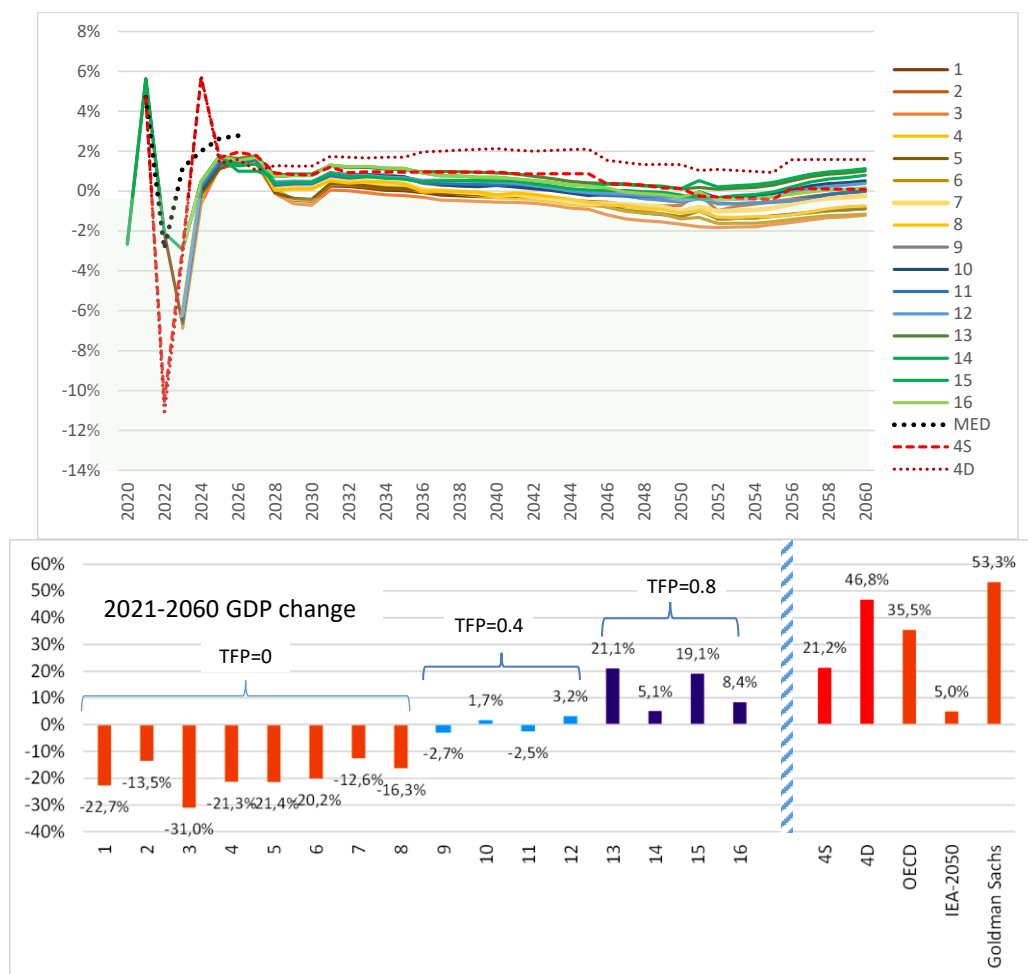
There are no pros in cons. If Russia succeeds in bringing TFP up to zero, then any combination of other economic drivers will result in 12-31% decline of 2060 GDP from the 2021 level. In the medium UN 2023 projection, Russian population goes 12% down in 2021-2060, so per capita GDP may stay unchanged or show 22% decline. This is not a totally new story for Russia, since in 1992-1996 this indicator was 15% down, and in 2013-2021 24% down. In 2021, Russian per capita GDP (US\$ 12,195) was nearly equal to the global average value (US\$ 12,236) and that for China (US\$ 12,556). It was 5 times above the value for India (US\$ 2,256), but nearly 6 times below the US level (US\$ 70,249).¹⁹² In 2060, global average is expected to nearly triple to 2021US\$ 34,700. Therefore, per capita GDP in Russia may amount to just a third of the world's average. In 2060, per capita GDP in the US is expected to reach 2021US\$ 112,300; in the EC 2021US\$ 83,500; in China 2021US\$ 40 300; and in India 2021US\$ 19,600. Of the 34 largest

¹⁹¹ Global and country-wide GDP per capita projections to 2060 were borrowed from Goldman Sachs. Daly K and T. Gedminas. Global Economics Paper. The Path to 2075 — Slower Global Growth, But Convergence Remains Intact. 6 December 2022.

¹⁹² All numbers in exchange rates from WDI [GDP per capita \(current US\\$\) | Data \(worldbank.org\)](https://data.worldbank.org/indicator/NY.GDP.PC.CD).

countries, which Goldman Sachs includes in its projections to 2060, only Ethiopia will have per capita GDP below the Russian value (Figure 6.10).

Figure 6.9 Growth (decline) rates for Russian GDP: 2020-2060

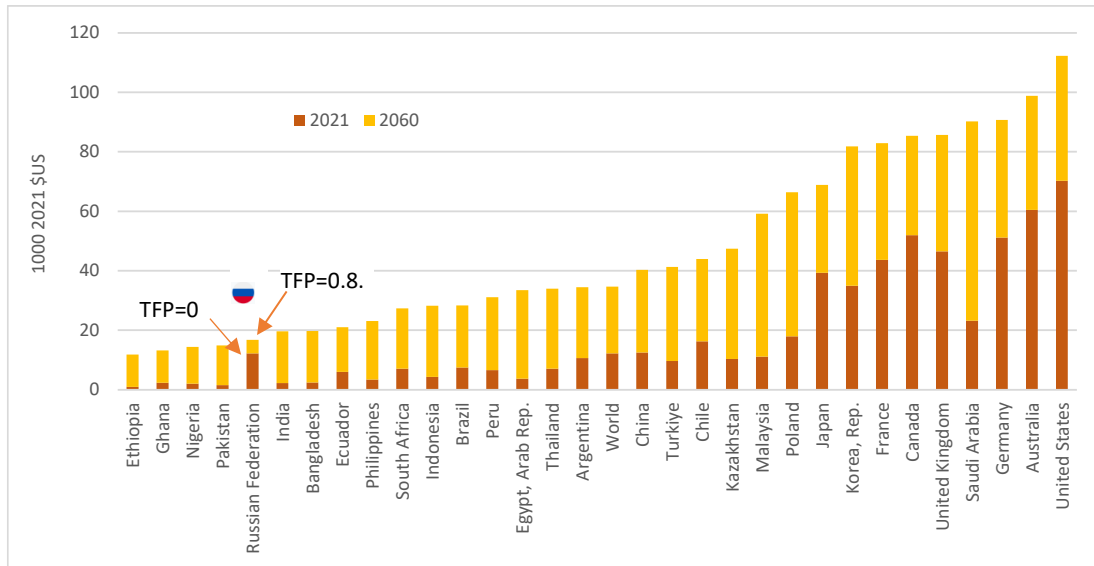


No	Sanctions	TFP	Employment	Fiscal policy*	Foreign trade policy	Oil and gas export	Oil and gas prices	Carbon price
1	strong	0	low	relaxed	weak import substitution	low	low	low
2	strong	0	low	real 2%		low	low	low
3	strong	0	low	zero deficit		low	low	low
4	strong	0	low	relaxed		low	medium	low
5	strong	0	low	relaxed		low	high	low
6	strong	0	low	relaxed		high	medium	low
7	strong	0	high	relaxed		medium	medium	low
8	strong	0	medium	relaxed		medium	medium	low
9	relaxed	0.4	medium	relaxed	stronger import substitution	medium	medium	low
10	relaxed	0.4	high	relaxed		medium	medium	low
11	relaxed	0.4	medium	relaxed		medium	high	low
12	relaxed	0.4	high	relaxed		high	high	low
13	relaxed	0.8	high	relaxed	stronger import substitution and non-fuel export promotion	high	high	high
14	relaxed	0.8	high	zero deficit		high	high	high
15	relaxed	0.8	high	relaxed		medium	medium	high
16	relaxed	0.8	low	relaxed		medium	medium	high

Sources: CENef-XXI; Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichok, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia's-carbon-neutrality-pathways-to-2060>; IEA. World Energy Outlook. 2022; Goldman Sachs. Daly K and T. Gedminas. Global Economics Paper. The Path to 2075 — Slower Global Growth, But Convergence Remains Intact. 6 December 2022; OECD (2018), GDP long-term forecast (indicator). doi: 10.1787/d927bc18-en (Accessed on 29 March, 2023) [Domestic product - GDP long-term forecast - OECD Data](#). Scenario conditions of the economy of the Russian Federation and basic projection parameters of Russia's social and economic development for 2024 and up to 2025 and 2026. Ministry of economic development of the Russian Federation (economy.gov.ru).

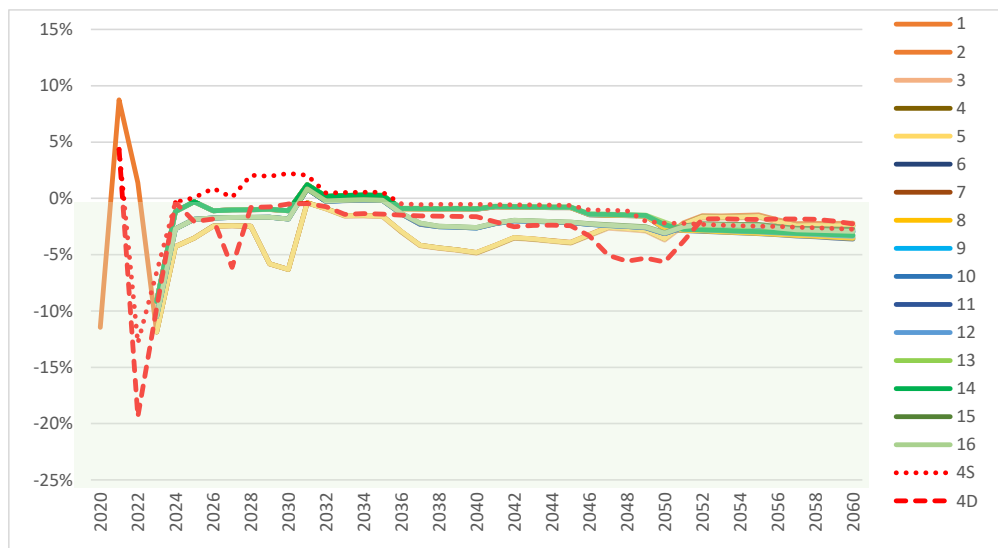
If the sanctions are relaxed, and more access to new technologies becomes available along with more effective import substitution, a higher level of TFP – 0.4% per year – might be attained, and 2060 GDP will be close to the 2021 level. In this case, per capita GDP will be 10-15% above the 2021 level, or 2021US\$ 13,400-14,000. This will only slightly improve Russia's position in the per capita GDP rating of the countries. The contribution from labor availability is more important, than from oil and gas exports and prices, to maintain Russia's economic growth.

Figure 6.10 Major economies ranged by expected per capita GDP in 2060



Sources: Data for 2021 from WDI database (http://databank.worldbank.org/data/download/WDI_excel.zip). Estimates for 2060 for all countries, except Russia, from Goldman Sachs. Daly K and T. Gedminas. Global Economics Paper. The Path to 2075 — Slower Global Growth, But Convergence Remains Intact. 6 December 2022. Estimates for Russia for 2060 are provided for combinations of drivers No. 13 (see notes to Figure 6.9). For other combinations Russian per capita GDP either stays unchanged or grows below what is shown for 2060.

If the economy is to show more visible growth, TFP should reach 0.8% per year, and this requires some relaxation of sanctions, effective import substitution, and non-fuel export promotion to the new non-fuel markets. Revised estimates of GDP growth are below those in CENef-XXI's 4D scenario (Figure 4.9), since maximum attainable TFP has scaled down from 1.5% assumed by CENef-XXI in 2022 to 0.8%. Only 2 OECD countries, South Korea and Ireland, managed to exceed 1.1% TFP level in 1995-2021 (Figure 6.5). Russia is unlikely to repeat this success in the decades to come. Consensus projections (Figure 4.3) show smaller GDP decline in 2023, than in the current CENef-XXI's projection. The 2024-2025 rebound falls within the range of consensus projections. Therefore, if 2023 decline is smaller, some upward revision of GDP growth in 2021-2060 will be required. It may possibly add some 0.1% per year to annual average growth rates, and the values in Tables 6.2-6.4 will not change much.

Figure 6.11 Russian OG GDP growth (decline) rates: 2020-2060

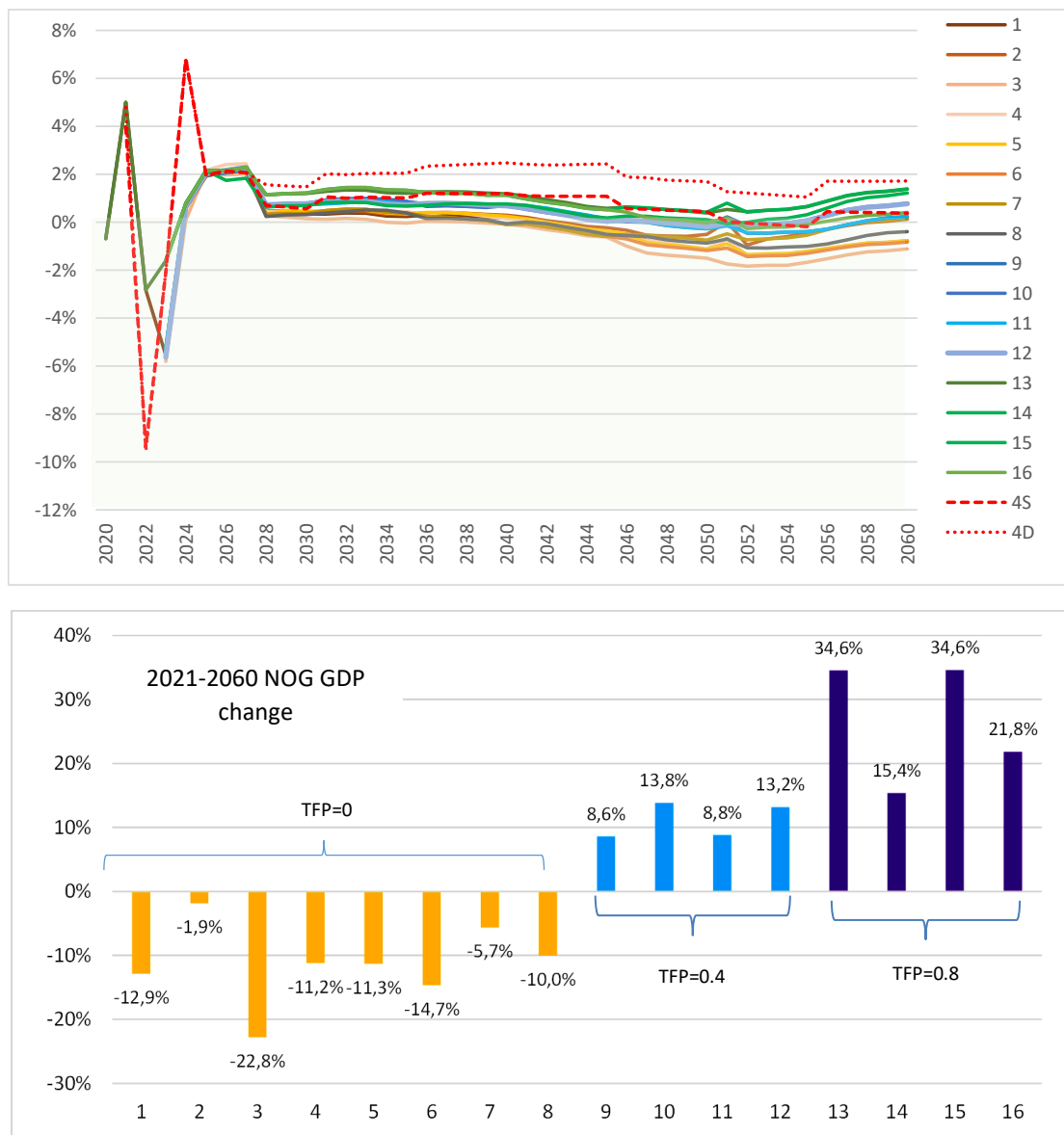
Description of numbered model runs is shown in Figure 6.9.

Sources: CENef-XXI.

Steady decline in oil and gas GDP (OG GDP) is one important factor impeding economic growth; it was initially associated with sanctions and energy security considerations and later with the effects of global decarbonization. Depending on the assumptions made about Russian oil and gas export volumes and the projections of their domestic use, the 2060 OG GDP is only 29-56% of the 2021 level (Figure 6.11). As the proportion of OG GDP goes down to 4-7% in 2060, its role as a GDP growth impeding factor declines. However, substantial investment in the oil and gas sector will be required to maintain even these low production levels and sustain and develop East-oriented fuel supply infrastructure (Tables 6.2-6.4).

If TFP is at zero, NOG GDP per capita will stagnate to 2060 at the 2021 level, as the expected decline in NOG GDP nearly matches the decline in the population (Figure 6.12). NOG GDP shows better performance, than the overall GDP; however, if it is to keep growing, TFP must go up well above zero. If it stays at 0.4% per year, then NOG GDP in 2021-2060 will be 9-14% up.

Access to the best available technologies on condition that sanctions are relaxed and democratization and strong competition are promoted, may bring TFP up to the maximum expected 0.8% per year, and so 2060 NOG GDP will be 15-35% above the 2021 level. Deep integration in global (rather than the East-only) supply chains, labor availability, and fiscal policies promoting development (professional training, R&D, subsidies for emerging technologies production and application), access to long-term large-scale financing at favorable conditions, improving business climate and governance are just some of the pre-requisites for getting TFP to the maximum possible level.

Figure 6.12 Russian NOG GDP growth (decline) rates: 2020-2060

Description of numbered model runs is shown in Figure 6.9.

Sources: CENef-XXI.

6.6 2060 carbon neutrality target: attainability challenge

The assessment made by CENef-XXI back in 2022¹⁹³ remains the only research which tested the attainability of Russia's announced carbon neutrality target by 2060. Other studies' time horizon is limited to 2050. A study *The Russian Federation To Attain The Carbon Neutrality Target In Or Before 2060* by Vnesheconombank's (VEB) Institute of Research and Expertise was published recently,¹⁹⁴ yet it also estimates the perspectives only to 2050, and it is unclear, why 2060 is mentioned in the title. The report draws the following conclusions:

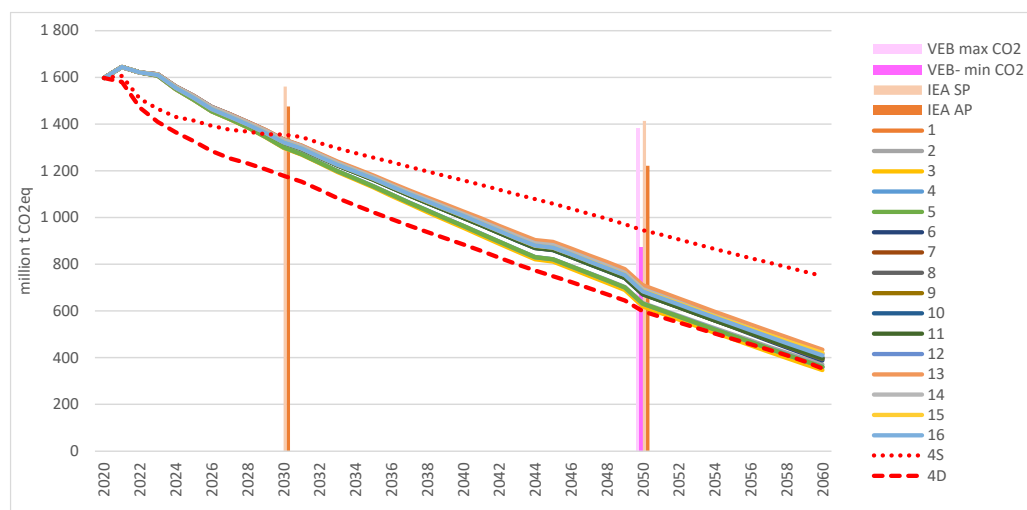
¹⁹³ Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichuk, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENef-XXI. <https://cenef-xxi.ru/articles/russia-s-carbon-neutrality-pathways-to-2060>.

¹⁹⁴ Klepach A.N. Editor. The Russian Federation to attain the carbon neutrality target in or before 2060. VEB RF. January 2023.

- Despite the current geopolitical tension, decarbonization remains in the Russian agenda;
- CO₂ emission will go down to 1,825 Mt CO₂ in 2050 in the conservative scenario and to 1,428 Mt CO₂ in the optimistic scenario;
- The net 630 Mt CO₂ target of the Russian LTS can only be attained with an account of the absorption capacity of forests and decarbonization measures; otherwise, net CO₂ emission will amount to 1,255 Mt CO₂;
- Higher decarbonization rate will annually require 46.9 trillion rubles in 2021 prices, or 0.73% GDP, in capital investment in 2022-2050;¹⁹⁵
- Because of the western sanctions, some decarbonization measures in Russia are limited, especially in energy efficiency improvement, renewables deployment and hydrogen use, because such measures largely rely on imported technologies;
- It is important to develop energy efficiency and energy use reduction technologies;
- As the reliance on imports in the oil sector is 55%; in the coal sector 45%; in the power sector 31%, Russia may become uncompetitive in the sectors where it has a certain share in the international markets.

However, it is not clear, how the estimates were obtained. The Report lists the technologies which should be developed in the first place, but the recommendations need to be supported. It is important, however, that financial institutions maintain interest in the decarbonization agenda.

Figure 6.13 Evolution of energy-related GHG emissions



Other estimates to 2050 were provided in IEA's 2022 World Energy Outlook, also for CO₂ only (Figure 6.13). They are quite pessimistic in terms of Russia's ability to reduce CO₂ emissions by 2030 and 2050, despite the fact that IEA uses GDP growth assumptions close to the results described above with 2050 Russian GDP just 5% above the 2021 level (Figure 6.9). Other recent projections with a longer time horizon (for example, the one provided by Shell) do not separate Russia within their regional aggregation.

The trajectories to attain carbon neutrality by 2060 have changed their shapes (Figure 6.13). In the short-term, the Russian economy demonstrated a better, than expected, resilience to sanctions, and this resulted in a higher level of emissions driven by economic activity. The

¹⁹⁵ In the conservative scenario, the LTS requires 20.4 trillion rubles in 2021 prices, or 0.46% GDP, annually to 2050. Albeit this is not specifically mentioned in the Study, incremental capital costs do not exceed 0.26% GDP.

trajectories shown in Figure 6.13 were assessed based on the updated information for 2022 developments in all sectors. Model-set (Figure 6.1) parameters were correspondingly calibrated and assumptions were corrected based on the most recent trends and plans. Only 4D scenario was selected to check how new developments influence the GHG emissions trajectory and only energy-related emissions were compared. Some short- and medium-term plans with renewable deployment and low carbon transformation in industry and transport are delayed (see below). This was captured in the model assumptions.

In the medium-term, hampered access to low carbon technologies delays their uptake and so keeps GHG emissions at higher levels. A few illustrations are given below. Sanctions and withdrawal of some foreign wind manufacturers from Russia (Vestas and Siemens completely closed down their production of wind turbine components in Russia and renounced their maintenance and wind project construction obligations) had a knockdown effect. Russian wind capacity additions grew from 1,439 MW in 2021 to 2,298 MW in 2022, but 501 MW were postponed to 2023-2024. It gave a push to the Russian industry to improve the level of key components localization to have domestic production of multi-megawatt wind turbines. Rosatom will invest 2 billion rubles in its own production of blades. The plant will be located in the Vestas' premises, and production of 360-380 51-meter-long blades per year is scheduled for 2025. Russia has a high level of PV manufacturing localization.

Metalloinvest's low carbon development strategy requires that new DRI capacity be commissioned before 2026 to produce 4 Mt with potential subsequent transition to hydrogen as reductant. In 2021, Metalloinvest signed agreements with Primetals Technologies consortium and Midrex Technologies for equipment supply for the new DRI plants in Lebedinsky MPP and in Zheleznogorsk. However, because of the sanctions the supply of European-produced process equipment under the projects was terminated. Therefore, construction projects for new DRI facilities are being re-considered and postponed until further arrangements.¹⁹⁶ In 2021, a contract was signed between NOVATEK and the German Uniper SE for the supply of 1.2 million tons of low carbon "blue" ammonia from the future Obsky MCC project. The project is supposed to have the capture and underground storage of CO₂. The sanctions forced Uniper SE to leave the project. They also prohibit delivery of the process equipment for LNG production to Novatek, and so the future of the low carbon "blue" ammonia supply project is unclear.

In the longer-term, the 2060 carbon neutrality target is still attainable, yet expected energy-related emissions in 2060 will be up to 80 MtCO₂ above the 4D (2022) scenario level. This is how many additional sinks in the LULUCF sector will be required for the 2060 carbon neutrality. All the 16 trajectories are above the 4D trajectory drawn back in 2022 (Figure 6.13). Cumulative additional energy-related GHG emission in 2022-2060 is 3-5.4 MtCO₂eq. The critical condition for dynamic GHG emissions reduction is the availability of low carbon technologies (either domestic, or imported from countries which have not imposed or have lifted sanctions on such technologies supply to Russia). This problem deserves a special study – "Low carbon technologies in Russia. Present status and perspectives" – which will follow later this year with a detailed sector-by-sector and technology-by-technology analysis.

¹⁹⁶ Interfax: "Metalloinvest" to revise the goals and timelines of capacity development strategy <https://www.interfax.ru/business/867458>.