Center for Energy Efficiency – XXI

Distributional effects of expected climate mitigation policies in Russia

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Moscow, November 2023

Contents

Introduction

Climate policies have complex and long-lasting consequences. An important shortcoming of recent climate policy developments is that they are weak in assessing the impacts on the economic agents and on their ability to formally or informally consolidate using various formal and informal[1] institutions to promote (or resist) these policies.

Russia's commitment to achieving carbon neutrality in 2060, declared in October 2021, was enshrined in the updated *Climate Doctrine of the Russian Federation* two years later. It makes a point that ensuring a balance between the economic efficiency and social justice and combating potential conflicts of interest is only possible within the political process framework. Here we face a problem of how justice is perceived. "Fairness is not about everybody getting an equal share; it is about everyone by right getting an unequal share."[2] Several concepts of equity can be used: distributive (fair distribution of costs and benefits across groups with different incomes or among regions); procedural (ensuring both the possibility of participation and the account of the views of different groups in decision-making processes), and recognitional (fair representation guarantees for under-recognized groups).[3]

Surveys of people across 20 countries (responsible for 72% of global GHG emissions) on different continents with different income levels showed that climate policy support is determined by three key factors: the effectiveness of policies (the effectiveness pillar); the impact on low-income households (the equality pillar) and personal interest (the motivation pillar). Therefore, assessments of how climate policies will affect the costs and who will benefit from these policies, how proportionately the burden is shouldered are important to mobilize support. These same surveys showed, mere outreach to inform people about possible adverse implications of climate change was ineffective in generating such support.[4]

The degree of inequality in the energy bills burden varies for different energy uses. In the EU, the Gini index is 0.29 for total household energy consumption, 0.41 for residential energy supply, and 0.47 for energy consumption by passenger transport. Such high values indicate substantial inequality.[5] The poorest households are facing the problem of energy (fuel) poverty, which is recognized very serious even in the rich EU, and the question of the "human right to energy", which is closely related to the right to sustainable development, arises. The chances of support increase if the policy has a progressive distributional effect (that is, the rich, who have a much larger carbon footprint,[6] should pay more). On the contrary, the regressive consequences of climate policies can significantly hamper their enforcement and implementation[7] if they are not offset by subsidies to vulnerable households. Society should know about it and recognize it as fair. In other

[1] Helmke G. and S. Levitsky. Informal Institutions and Comparative Politics: A Research Agenda. Perspectives on Politics. Vol. 2, No. 4 (Dec., 2004), pp. 725-740; Kaufmann W., R. Hooghiemstra, M. K. Feeney. Formal institutions, informal institutions, and red tape: A comparative study. Public Administration. Volume 96, Issue 2 p. 386-403. https://doi.org/10.1111/padm.12397.

[2] Alexandr Gelman. https://quote-citation.com/life/57190. (In Russian).

[3] Forrester S.P. and A.J. Satchwell. Developing an Equity Framework for State Regulatory Decision-Making. Electricity Markets & Policy. Energy Analysis & Environmental Impacts Division. Lawrence Berkeley National Laboratory. August 2023.

[4] Ibid.

[5] Eurofound (2021). Distributional impacts of climate policies in Europe. Publications Office of the European Union, Luxembourg.

[6] Gough, Ian (2013) *Carbon mitigation policies, distributional dilemmas and social policies*. Journal of social policy, 42 (2). pp. 191-213. DOI: 10.1017/S0047279412001018.

[7] Eurofound (2021). Distributional impacts of climate policies in Europe. Publications Office of the European Union, Luxembourg.

words, the key to mobilizing support and public acceptance is the effectiveness and progressive nature of policies. In this case, they may be perceived as a socially fair low-carbon transformation.

Assessing the socio-economic implications of climate policies has already some history behind,[8] but the relevance of such assessments has increased dramatically after the adoption of a variety of regulations in different countries to significantly intensify decarbonization processes. Otherwise, one might expect a decline in the level of ambition and a rollback in the implementation of policies, along with an erosion of credibility of the implementers. It is believed that even for the EU, distributional effects had not been sufficiently studied before climate neutrality policies were developed.[9] The key knowledge gaps include: the lack of empirical evidence on the trade-offs between the sustainable development goals and low-carbon transformation policies; insufficient understanding of the distribution of additional costs and benefits across different groups; lack of knowledge regarding the approaches that can improve stakeholder engagement.[10] To a large extent, these gaps in knowledge are a result of insufficient cooperation between different experts and insufficient use of a systemic approach to exploring the complexity dimension and multiple synergies and trade-offs when studying different trajectories of the energy transition.[11] Insufficient attention to long-term sustainability issues in the 2030 Agenda, which includes 17 interconnected Sustainable Development Goals (SDGs), and a high level of ambition over a quite short time frame have resulted in only 15% of the 169 SDG-associated targets being on track.[12]

Generally, literature suggests that climate actions broadly align with the SDGs,[13] and multiple studies show that the adverse impacts of climate policies on inequality can be fully offset or significantly mitigated by careful planning and stakeholder engagement, as long as the effects potentially affecting inequality are taken into account at all stages of policy design and implementation.[14] However, it is a common practice when ministries or departments of labor, social security, and health are not involved in the development of climate policy and evaluation of its consequences. Policies are typically developed by the ministries of economy, energy, ecology,

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[8] See analysis of the effects of different measures in: Zachmann G., G. Fredriksson and G. Claeys. 2018. The distributional effects of climate policies. Bruegel blueprint series. Volume 28; Eurofound (2021). Distributional impacts of climate policies in Europe, Publications Office of the European Union, Luxembourg; Ohlendorf N., M. Jakob, J.C. Minx, C. Schröder, J.C. Steckel. Distributional Impacts of Carbon Pricing: A Meta-Analysis. Environmental and Resource Economics (2021) 78:1–42. https://doi.org/10.1007/s10640-020-00521-1; Gough, Ian. (2013). Carbon mitigation policies, distributional dilemmas and social policies. Journal of social policy, 42 (2). pp. 191-213. DOI: 10.1017/S0047279412001018; Vona F. Managing the Distributional Effects of Environmental and Climate Policies: The Narrow Path for a Triple Dividend. Environment Working Paper No. 188. OECD (2021); Markkanen S. and A. Anger-Kraavi. (2019). Social impacts of climate change mitigation policies and their implications for inequality, Climate Policy, 19:7, 827-844, DOI: 10.1080/14693062.2019.1596873.

[9] Ibid.

[10] Halsnæs K., S. Some, M. Pathak. Beyond synergies: understanding SDG trade-offs, equity and implementation challenges of sectoral climate change mitigation. Sustainability Science. https://doi.org/10.1007/s11625-023-01322-3.

[11] Carr-Whitworth R., J. Barrett, M. Colechin, N. Pidgeon, R. Styles, S. Betts-Davies, E. Cox, A. Watson and O. Wilson. Delivering net zero in the UK: twelve conditions for success Environ. Res. Lett. 18 (2023) 074041 https://doi.org/10.1088/1748-9326/ace199

[12] Bennich et al. Recurring patterns of SDG interlinkages and how they can advance the 2030 Agenda, One Earth (2023), https://doi.org/10.1016/j.oneear.2023.10.008

[13] Ibid.; Denton, F., K. Halsnæs, K. Akimoto, S. Burch, C. Diaz Morejon, F. Farias, J. Jupesta, A. Shareef, P. Schweizer-Ries, F. Teng, E. Zusman, 2022: Accelerating the transition in the context of sustainable development. 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: 10.1017/9781009157926.019;

[14] Markkanen S. and A. Anger-Kraavi (2019) Social impacts of climate change mitigation policies and their implications for inequality. Climate Policy, 19:7, 827-844, DOI: 10.1080/14693062.2019.1596873.

etc.[15] Looking for methods to eliminate the unfavourable effects of certain climate policies it is important to strengthen the role of different social groups in the discussions. The concept of equity should be implemented at all stages of policy development and implementation – targeting ("what is to be done?"), tools development ("how to do it?"), and monitoring ("what has been done?"). All of these steps should ensure a fair distribution of the burden and guarantee stakeholder engagement. The social dialogue about fair energy transition with an assessment of the impacts of climate policies on different industries and on the population with different incomes is not yet widespread even in the EU states.[16] In Russia, such dialogue is yet to be launched.

This policy paper is the first attempt to scope in the distributional effects of a limited list of policies required to achieve carbon neutrality and to assess these effects for Russia. Chapter 1 presents the paper summary. Chapter 2 describes the concepts, methods, tools, and scenarios. For the purpose of such analysis a methodological approach called the "seven matrix method" was proposed to integrate the assessment of economic, social and political effects from climate actions. Long-term effects of climate policies were estimated using a "cloud" of interconnected models developed by CENEf-XXI. To assess the distributional (by income deciles) effects of the policies in the housing sector and personal transport, a special model – *DEFEND* (distributional effect of national decarbonization) – was developed. Chapter 3 summarizes the international experience in assessing the impacts of individual decarbonization policies on the distribution of incomes and expenditures. Chapter 4 shows the results of the last quarter of the century development on resource-based economy model. These results are a background for the evaluation of the decarbonization impacts. This chapter helps to understand, if there is really much to lose after all the losses already incurred by the long-term preservation of the state-controlled resource-based economy model. Chapter 5 looks to assess the impact of decarbonization on the income distribution of producers. It shows that development based on the resource-based model has led to what some authors are now blaming on decarbonization: the economic development has nearly stopped, the well-being of population is stagnating, and the declining real energy prices have not worked to spur economic growth. This chapter also shows that only the transition to low-carbon development will allow Russia to safeguard GDP growth, whereas conservation of the present development pattern will lead to a GDP decline (the "shagreen skin", or "negative growth", economy). Chapter 6 assesses the impact produced by a set of decarbonization policies on the distribution of consumer incomes and spending. It shows that competent socio-economic engineering can make climate policies neutral, in other words, to maintain a balance of income and expenses compared to their basic dynamics trajectory.

V. Bashmakov, K. Borisov, M. Dzedzicek, A. Lunin, O. Lebedev and A. Myshak contributed to updating the "cloud" of CENEf-XXI models and the to the development of the DEFEND model.

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For citation: Bashmakov I. Distributional effects of expected climate mitigation policies in Russia. November 2023. CENEf-XXI. Moscow.

[15] Eurofound (2021). Distributional impacts of climate policies in Europe. Publications Office of the European Union, Luxembourg.

[16] Eurofound (2021). Distributional impacts of climate policies in Europe. Publications Office of the European Union, Luxembourg.

1 Summary

1.1 Concepts, methods, tools and scenarios

Climate policies have complex and long-lasting consequences

An important drawback of climate policies development is the lack of attention to the assessment of their impact on:

- the position of economic agents;
- their ability to consolidate formally or informally, using various institutions, to promote or oppose these policies.

To carry out the analysis, a methodological approach called the "seven matrix method" was used:

1. *Matrix of scenarios;*
2. *Matrix of relationships between the model variables;*
3. *Matrix of change in the economic status of the main classes and social groups* (the key focus of this paper);
4. *Matrix of change in the country's position in the system of world economic relations;*
5. *Matrix of change in the institutional organization of society and the alignment of internal political forces*;
6. *Matrix of change in the country's profile in the system of international relations*;
7. *Matrix of solutions*, which correlates each major problem with the methods of addressing it.

This study takes into account the effects of decarbonization measures implemented both globally (regardless of Russian policies) and domestically

- The distributional effects were assessed using a system ("cloud") of interconnected models developed by CENEf-XXI.[17] The model parameters were updated using 2022 and 2023 data;
- A specially developed model – *DEFEND* (distributional effect of national decarbonization) was used to assess the distributional effects by deciles from climate mitigation actions in the housing sector and personal transport;
- The *4D* scenario was chosen as the basis for the calculations, because it can guarantee Russia's carbon neutrality by 2060.

1.2 The impact of individual decarbonization policies on the distribution of incomes and expenditures

The effectiveness and distributional impacts of an individual policy are largely determined by the institutional and social environment, in which this policy is implemented

- All of the GHG emission control policies can be divided into "framework" measures and special carbon regulation measures.
- "Frameworks" policies may have unexpected and significant effects on the environmental and climate policies;
- Special mitigation policies may be complementary or competing (for example, renewable energy support and emission trading policies);
- In addition to the environmental, climate and economic efficiency considerations, the reaction of both decision-makers and implementers depends on how these measures are expected to affect the distribution of incomes and costs.

[17] Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, 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

The effects of climate mitigation measures may come as either additional costs or benefits

The measures are:

- **regressive** (in terms of costs), if they disproportionately increase the share of costs in the incomes of the poorest households;
- **progressive** (in terms of costs), if they don't;
- **proportional** (in terms of costs), if the costs are evenly distributed across all income groups.

In terms of benefits, such as reduced energy bills, it is vice versa:

The measures are:

- **progressive** (in terms of benefits), if low-income households get more benefits in relation to incomes, than wealthier ones;
- **regressive** (in terms of benefits), if they don't;
- **proportional** (in terms of benefits), if they ensure equal distribution of benefits.

A measure is neutral if:

- it does not affect the balance of incomes and costs compared to the baseline trajectory.

Vertical distributional effects (across income groups) may be significantly smaller, than horizontal ones (within each income group). This makes it difficult to assess and control the distributional effects

There are several concepts of equity:

- distribution-based (equal sharing of costs and benefits among groups with different incomes or between regions);
- procedure-based (ensuring an opportunity to participate in the decision-making process and an account of all opinions);
- recognition-based (guarantees for fair representation of under-recognized groups).

Equity concepts should be implemented at all stages of policy development and implementation.

Ideally, a baseline is required for each equity metric to assess how an individual measure affects the distribution of incomes and expenditures

- Metrics can reflect indicators, such as the affordability of energy, low carbon technologies uptake, sustainability of the effects, public involvement in decision-making, ensuring reliable energy supply, etc.
- It is important to track all of the economic effects, not just the direct impact on the expenditures. For carbon pricing mechanisms, the effects depend on how the collected funds are used.
- In democratic societies, policy development should be heading towards proportionality.
- Uneven distribution of the effects is often used by autocracies as an unsupported by calculations argument against having an ambitious climate policy.
- In such countries, the poor, national minorities, trade unions, environmental activists and other groups, unlike large businesses, are typically unable to promote their interests.

1.3 Results of resources-based economic development in 2000-2023 as a background for assessing the potential impacts of decarbonization

"If only we understand that we need to work, then there won't be much harm and we won't lose too much."[18]
Question: is there much to lose yet after all the losses incurred by the state-controlled resources-based economic model?

- Some Russian economists are biased against the decarbonization as they fear the possible damage it can bring to the economic development: it is believed to slow down the economic growth, lead to a decline or stagnation in the living standards and to dramatic price hikes.
- However, the economic development based on resource exports has led precisely to what these authors blame decarbonization for:
  - economic growth has nearly stopped;
  - the living standards are stagnating;
  - declining real energy prices do not promote economic growth.

Post-1999 political and economic reforms, with all their diversity and implementation contradictions, had two common vectors that were developing in parallel:

- A rollback of political competition – the decline of democracy. After 1990, Russia had significantly progressed in global democratization rankings, but then in 1999 began to roll back, and in 2022 the democracy indices were even below those in the Soviet Union in 1990.
- A rollback of economic competition – the decline of efficiency. The goal of establishing state control over the main financial flows from the raw materials industries was achieved and share of the state-controlled sector was up from 31.2% in 2000 to 56.2% in 2021 (1.8 times); the author's estimate is more than 60% in 2022.

The economic growth has already slowed down

- Reduced competition and the transition to a purely extensive resources-based growth model with a decrease in, or stagnation of, the efficiency of basic production factors use brought Russia's GDP AAGR down from 6.5% in 2000-2008 to 0.9% in 2008-2022 (7-10-fold), or down to 0.6-0.7% – if one is not inclined to believe the latest sly figures from Rosstat.
- On average, GDP AAGRs dropped by 0.33% per each percent increase in the state-controlled sector index in 2000-2021 (mainly due to a decrease in the efficiency of key production factors use).
- In Russia when the state property index exceeds 55%, multifactor productivity drops to or below zero and the economic growth stops.

[18] © V. Chernomyrdin.

Living standards 'frozen' for 10 years. Rolling back the market reforms, along with maintaining the resource-based pattern of economic development, completely stopped the growth in real disposable income: in 2022, it was 3% below the 2012 level

- The redistribution of income in favor of wages and net taxes in 2000-2009 was accompanied by dynamic economic growth.
- The post-2009 reverse redistribution of income in favor of the large capital was accompanied by economic stagnation.
- After 2009, the government economic policy was aimed to preserve the resource-based model of economic growth, had a significant negative distributional effect: a fifth of the GDP was redistributed in favor of large businesses.
- The richest 20% of Russians get nearly half of the whole income, of which the even richer 10% account for about 30% of the whole income in the country.
- The stratification of Russian society by the level of wealth is driven by an oligarchic resource-based development model and has aggravated noticeably after 2009; the share of wealth of the richest 1% of Russians in the total wealth is 1.5-2 times up. These incomes and wealth are concentrated mainly in the hands of the owners of resource companies.

The rise in real energy prices was accompanied by energy efficiency improvement and acceleration (rather than a slowdown) of economic growth, and vice versa.

- A 12-70% decline in real energy prices for much of the industrial output in 2014-2022 failed to accelerate economic growth, yet slowed down or stopped energy efficiency improvements.
- The post 2008 trends led to:
  - first, a **super-coupling,** i. e. a nearly complete coincidence of the rate of change in GHG emissions with the rate of change in GDP in 2008–2021;
  - and then in 2022 to a **"reverse decoupling",** i. e. an increase in GHG emissions along with a decrease in GDP.

1.4 Decarbonization: impacts on producers' incomes distribution

Transition to low-carbon development will ensure Russia's economic growth, whereas conservation of the recourse-based model will, in the worst case, halve Russia's GDP, and in the best scenario will cut it by 7-26% (the "shagreen skin", or the "negative growth", economy)

- Where productivity growth and cost optimization are ignored by decision-makers, poverty comes.
- If Russia chooses to maintain its reliance on the resource-based economic model and fails to get its TFP up from the negative values, then GDP per capita in Russia will shrink.
- If it manages to increase TFP to 0, then GDP will be only 2-10% down in 2060.
- GDP per capita and personal consumption per capita can only grow if TFP is up to 0.4% or a higher value.
- This is attainable through the decarbonization of the economy through the uptake of the best available technologies, democratization, and strong competition.
- Transition to low-carbon development will keep GDP and non-oil-and-gas GDP growth rates positive, except in some years with particularly severe labour shortages.

Factor one fourth.

One key long-term challenge for Russia is the multiple erosion of its oil-and-gas rent, which has been a pillar for the Russian economy over the last quarter of a century

- By 2060, the share of oil-and-gas revenues in GDP and in consolidated and federal budget revenues will drop 4-fold.
- The share of the oil-and-gas revenues may be declining unevenly because of the volatile dynamics of oil and gas export prices.
- The government will be trying to increase the tax pressure on the oil-and-gas sector, but in the fall of 2023, the oil business won the battle for the motor fuel subsidies (damper) against the government, and hard-to-recover reserves will be impossible to develop, if the tax pressure grows.

Fuel oligarchs are a powerful group which strongly oppose low carbon transition in Russia by dictating the low level of ambition of its climate policy

- They are unable to influence global decarbonization processes, so if they want to maintain the shrinking market niches, they have to reduce the carbon footprint of their products and prove that Russian oil, gas, coal, metals, and other basic materials are the “greenest” in the world.
- As the product niches in foreign markets are gradually lost, they are desperately fighting for domestic markets and trying to slow down the low carbon transition in Russia.

Redrawing the economic landscape in favour of the non-oil-and-gas sector will meet with desperate resistance from the oil-and-gas business, but will inevitably entail redrawing of the country's governance.

- The non-oil-and-gas business is much more diversified, than the oil-and-gas business.
- Therefore, its growth will definitely be associated with the development of democratic institutions and competition – both political and economic.
- Otherwise, it will not be possible to increase TFP, and the economy will be stagnating or shrinking.
- Diversification of income sources will make it impossible to maintain the current ultra-centralized system of inter-budget relations, and so the role of regions in the country's governance will significantly increase.

The oligarchs of the basic materials industry (non-oil-and-gas) differ in their views regarding decarbonization policies and measures	• The long-negative attitude towards decarbonization is gradually changing. • Seven large companies have already made carbon neutrality pledges, and 31 of the 50 largest companies, which account for about 40% of Russia's GDP, have long-term programs to reduce GHG emissions.
The most significant distributional effects are generated by structural changes in the economy, which result from changes both in external factors (external demand for goods and services) and "framework" policies, including moving towards, or away from, the market economy and special decarbonization policies	• Development along the oil-and-gas and basic-materials path has reduced the share of wages in GDP, while transition to low carbon development will cause the wages share in GDP to increase and the profit share to decline. • Given the limited number of people employed in oil and gas production and processing, a gradual decline in this sector output will have little impact on the labour market, which is facing a persistent labour shortage. • Decarbonization-driven decline in coal production will have little impact on the national economy, but will significantly affect the economy and employment of coal-mining regions and will require proactive decisions to diversify their economies. • The accelerated development of knowledge-intensive industries and the growing share of the service sector will bring the share of salaries in GDP up and will flatten the incomes across the economy.
Institutions that promote low-carbon generation are emerging in the power sector	• Low carbon transition will cause a significant share of income to be re-distributed in favour of low-carbon generation and the electricity sector in general, thus – given slow growth in labor productivity, creating additional labour demand in the generation, transmission and distribution of electricity. • This additional labor demand can be met through the workers released from the heating sector, coal and oil-and-gas industries.
Deployment of carbon pricing mechanisms is becoming critical to maintain and expand the market niches for Russian basic materials	CBAM mechanisms could potentially bring: • Additional incomes in EC markets (with active decarbonization in the industrial sector); • Losses limited to 1,5 US$/year (with passive decarbonization policies). Such losses are only a third of what the Russian businesses have "naturally" lost from the 2022 sanctions.
Carbon regulations (carbon intensity standards, procurement of "green" basic materials, introduction of carbon pricing) will cause the prices of basic materials to substantially grow, yet the prices of final products will show only a limited	• Introduction of a carbon price will not push steel prices beyond the range of their "natural" volatility, as observed in 2021-2023. • The post-2015 downward trend in the profitability of the iron and steel industry did not hamper the increase in production. • The introduction of a carbon price will not take cement prices beyond the upper limit of their "natural" volatility range, as observed in 2021-2023 (US$ 85/t) on the 2037 horizon. Cement prices will then peak at US$ 100/t with subsequent reduction.

growth, and the general level of prices will not go much above the "natural" price volatility

- Introduction of a carbon price will not push ammonia prices beyond the upper limit of their "natural" volatility range, as observed in 2021-2023 (US$ 1,230/t).
- "natural" housing construction costs escalation, an increase in the costs of steel and cement resulting from the introduction of a carbon price is hardly visible (0.08% per year).

A slow growth in energy prices will be fully offset by a reduction in specific energy consumption, and therefore, the share of energy costs in incomes and expenses of industrial and transport companies will not grow

Introduction of a will limit the growth of energy prices:

- in freight transport to 0.5% per year (substantially below their "natural" increase);
- in agriculture to 0.8% per year. Experience shows, that this growth can be fully offset by energy intensity reductions;
- in the service sector to 1.3% per year. This growth can be fully offset by improved energy efficiency and increased production of renewable electricity and heat by prosumers.

1.5 Decarbonization: impacts on the distribution of consumers' incomes and expenses

In 2000-2022, the resource-based economic development model did not allow for a more equal distribution of income

- In 2013-2022, total real incomes of the population were 7.1% down.
- The richest 10% of Russians get 30% of incomes, while the bottom 10% get 2%, or 15 times less.
- The 2015-2022 change in the number and structure of employees indicates the resource-based economic development pattern. The fastest growth in the number of employees was observed in minerals extraction – 9%.

Literature review shows that:

- decarbonization has a regressive effect on the "skilled/unskilled workers": the former benefit more. However, this is not yet supported by empirical evidence;
- administrative (command) regulations lose it out to market policies in terms of even distribution of incomes.

Structural shifts in favor of low carbon activities will increase the share of wages in GDP and thereby flatten the income distribution

- Increased employment in the "green" economy along with some reduction in average salaries due to decline of the oil and gas sector share in GDP will work to flatten the income distribution.
- As we move toward carbon neutrality, there will be 30 million people employed in the global clean energy sector in 2030, while 13 million jobs will be lost in fossil fuel production.

In Russia, the burden of residential energy bills is regressive: it is 8.7% of incomes for the first decile and only 2% for the tenth decile.
With a full (subsidies eliminated) payment of energy bills, the proportion of the energy poor in Russia would be approximately 6% in 2022 (if the threshold energy costs share is taken to be 10% of income) or 19% (if the threshold is 7%)

- As the market economy develops, the balance between incomes and occupied living space in Russia is slowly restored from a nearly flat distribution in the Soviet era.
- Price instruments work effectively to improve energy efficiency in Russia wherever the users can technically control their energy consumption.
- The "minus one" phenomenon: energy efficiency is inversely proportional to the energy price. Therefore, comparatively low residential energy tariffs in Russia do allow Russian consumers to have lower energy cost share.
- In 2022, people in Russia spent 3.4% of their incomes to pay residential energy bills – same as in other countries.
- The distribution of energy cost share by deciles is also similar to other countries.
- In 2022, social support allowed to reduce the share of the energy poor in Russia to zero, if the energy cost share threshold is set at 10% of the incomes, or to 1-2%, if the threshold is set at 7%.

The introduction of administrative requirements to improve the energy efficiency of new housing has a generally progressive effect for the first four deciles

- The effect then becomes proportional, decreasing only slightly for the tenth decile.
- To compensate for the additional burden, it is necessary to subsidize the incremental costs of improving energy efficiency and develop energy efficient social housing programs for low-income families.
- Where subsidies are provided to cover the full incremental capital costs, the effect is neutral, i. e. there is no additional burden on any of the deciles.
- Providing social housing has a progressive effect (in terms of cost savings).

The introduction of administrative requirements to improve the energy efficiency of buildings through renovations has a regressive effect. Subsidies to cover 60% of the incremental costs produce a neutral effect balancing costs and annual energy savings

- In Russia, there are no valid federal-level documents which specify energy efficiency targets following renovations of apartment buildings or share of annual energy efficient renovations targets for apartment buildings.
- The mechanism for co-financing energy-efficient renovations of apartment buildings in Russia was tested, debugged, has proved its efficiency, yet was abandoned after the meager budget of this program was exhausted.
- An option was considered to revive and scale up the mechanism described in the Decree No. 18 by the Government of the Russian Federation of January 17, 2017.
- Full subsidies for energy efficient renovations result in a proportional effect in terms of costs and a progressive effect with an account of the resulting energy savings.

The effect of carbon pricing is regressive. It can be made neutral or progressive by changing the social support schemes without increasing the amount of such support

- The transition to carbon neutrality and bringing the carbon price to 108 $/tCO$_2$ in 2060 while maintaining the current social support schemes and pursuing a proactive low carbon policy, will reduce the share of residential energy bills in income from the average 3.4% in 2022 to 2.8% in 2060, and for the first decile from 6.8% to 5.7% respectively.
- There are a variety of social support mechanisms that could be tuned to follow the "*worst first*" principle.

Decarbonization first!

- The negative effect of introducing a carbon price can be limited or fully offset through proactive energy efficiency policies and promoting both grid- and distributed "green" generation of power and heat.
- Providing subsidies for the installation of PVs at residential buildings in equal shares for all deciles will reduce the burden, but will not change the regressive nature of the effect.
- The scheme in which the share of subsidy goes down as the income grows, will have a neutral effect.

The share of total transport costs in expenses is progressive: 5.1% for the first decile and 11.9% for the tenth decile

- For the tenth decile, the share of vehicles purchasing costs rockets, while the share of vehicles operation expenses drops.
- In Russia, the average share of personal transport fuel costs in income is close to the upper limit of the range for many countries.
- It is regressive in Russia: for the first four deciles it is 3.6-3.8%, and for the tenth decile it is 2%.
- Present liquid fuel subsidies for transport (damper) is equivalent to a negative carbon tax of (-100/tCO$_2$). It has a weak progressive effect (in terms of cost savings).

Three barriers to assessing the distributional effects for private road transport are:

- inconsistency of data on the car ownership;
- the uncertainty of perspective trends in the passenger car ownership by deciles;
- disagreement between the theoretical models of peak and saturation of car ownership.

In the *4D* scenario, decarbonization in transport relies on a significant change in the intensity and structure of mobility in accordance with the peak model

- An important argument in favour of choosing the peak model for Russia is the inability of Russian consumers in all deciles to significantly increase their car ownership due to:
  - a very slow expected growth in personal incomes;
  - the already observed sharp increase in car prices in 2022-2023 (which will likely continue). In Russia, the price elasticity of demand for new cars stays at -1...-1.6.

When subsidizing the purchase of electric vehicles:

- up to the ninth decile inclusive, a weak progressive effect is observed (in terms of cost savings);
- this progressive effect increases sharply for the tenth decile, yet not above 0.12% of income, on the background of 7-10% basic share of income spent to purchase cars in 2060.

The first deciles benefit more from the implementation of the concept of peaking the car ownership and their gradual electrification, which is necessary for the decarbonization of personal road transport

- These measures reduce the share of personal fuel expenditures for all deciles.
- The average share of fuel costs decreases from 2.9% in 2022 to 2.1% in 2030 and to 1.2% in 2060.
- This decline is associated with a decrease in the car ownership for the upper deciles and a practical stabilization for the lower ones due to the high car prices, and later with an increase in the share of electric vehicles, the prices of which are expected to be noticeably lower in 2060, than for fossil fuel cars, and the costs of ownership will converge around 2030.

Introducing a carbon price for motor fuels has a weak regressive effect. On average, with a 10 $/tCO$_2$ price in 2030, the ECS in income will be 0.05% up, and with a 108 $/tCO$_2$ price in 2060 it will be 0.3% up

- Both estimates are noticeably lower, than the gains from the decarbonization of personal road vehicles with a decrease in personal car ownership.
- An important factor in assessing the distributional effects of the introduction of a carbon price on motor fuels is the multiple difference in average annual vehicle mileage by deciles: for the tenth decile, it is almost an order of magnitude higher, than for the first decile.
- The maximum increase in the share of public transport costs in income driven by the introduction of a carbon price does not exceed 0.05%.

Even if a 3 USD/tCO$_2$ carbon price is introduced in 2031 and steadily grows to 108 USD/tCO$_2$ in 2060, the affordability of energy remains unchanged, and

- the energy cost share in GDP, in the NOGGDP, and in personal income will not exceed the levels observed in 2000-2022.
- Carbon price revenues will peak at RUB 8.5 trillion in 2047, and their share in GDP will peak at 2.4% in 2042. A fiscally neutral scheme for introducing a carbon price will not provide any additional pressure on business.

2 Concepts, methods, tools and scenarios

2.1 The 'seven matrices' method, distributional effects, and scenarios feasibility analysis

One important problem of any economic, environmental, or climate policy is the lack of assessment of the potential impact it may have on the economic agents and their ability to consolidate–formally or informally–by using a variety of institutes to promote or, on the contrary, stand up against these policies. The amount of research related to the distributional effects of climate policies is growing. However, these efforts are often confined to the estimation of impacts produced by these policies on the distribution of household incomes and spending across income groups (*equality*). To a lesser extent do they consider changes in the distribution of incomes and spending by sectors and regions, and to an even lesser extent do they assess the ability of individual groups of economic agents to promote or protect their interests during energy transformation and decarbonization processes. Such analysis requires a special methodological approach. One such approach, the 'seven matrices' method, was proposed by the author back in 1987.[19] It could provide a basis for assessing the feasibility of climate policies.

Many of the climate policies have complex and long-lasting implications, which can be estimated using various mathematical models. The key goal of macroeconomic forecasts is to formulate a science-based hypothesis regarding the economic prospects as a whole or some functional components thereof. This goal is only attainable if the forecasts build on a solid foundation formed by the systems consistency and development principles. The systems consistency principle indicates the need for a profound exploration of the diverse relationships between the investigated object and other objects, while the development principle indicates that the investigated object is not identical to itself in the course of time and changes when affected by internal and/or external forces.

These principles are particularly important for macroeconomic projections due to the specific nature of the object. Firstly, macroeconomic analysis takes researchers to a level where they need to look into the entire system of economic relations, including in production, distribution, exchange, and consumption. Depending on the goal of forecasting, the relations at individual phases or reproduction are investigated more or less completely; however, none of these phases can be ignored. Secondly, macroeconomic analysis looks into how classes or key social groups, rather than individuals or small groups, react to economic changes. And the third important thing is that the sources of economic change are analyzed as required by the systems consistency principle. The range of factors affecting the economic development can be split into three main groups:

- Natural-technical (which capture resource availability and technological development trends);
- Economic (which show that economic relations develop based on the inner contradictions);
- Social-political (which capture the ideological, social, and political impacts).

These three groups of factors ("three pillars"), or three sources of development, make a triangle, whose vertices are connected through direct and reverse relationships. The hierarchy of relations in this triangle can be traced along the chain 'productive forces – production relations – political relations'. This chain captures the direct relationships, which determine, in a general way and ultimately, the behaviour of each subsequent link. This is not a rigid determination; rather, it is a

[19] Bashmakov I.A. (1987). On macroeconomic projections and analyses of results (the 'seven matrices' method). Macroeconomic information processing system. Moscow, Nauka. Pp. 117—132. (In Russian).

certain intrinsic delineation to ensure that each subsequent link is moving autonomously and has certain independence.

In addition to direct deviations from the existing 'thresholds' of change, there are reactions, which work to correct–offset, or on the contrary, exacerbate (depending on the extent to which subjective activity is in line with the objective trends and laws)–these deviations. Albeit Marxism is out of fashion today, let us give one quote from Friedrich Engels: "The economic movement, upon the whole, asserts itself, but it is affected by the reaction of the relatively independent political movement which it itself had set up… The reaction of the state power upon economic development can take a three-fold form. It can run in the same direction, and then the tempo of development becomes accelerated; it can buck up against that development, in which case… in every large nation the state power is sure to go to smash for good; or it can block economic development along some directions and lay down its path along others… It is clear that in the second and third cases the political power can do great damage to the course of economic development and result in a great waste of energy and materials".[20] Acting in one of these three directions, the political power affects the economic development in a country by relieving or aggravating the social, economic and political contradictions; determines the economic growth rates and the effectiveness of resource use.

The practical implementation of the systems consistency principle requires an analysis and subsequent synthesis of not only the entire wide range of internal interactions which determine the development of an object, but also requires an exploration of the impulses that come from the 'outside'. Therefore, each group of factors that drive the system development includes factors of both internal and external origin. As a result, there are six groups of factors, whose interactions can be represented as a chequerwork (Table 2.1).

Table 2.1 Interaction of economy-driving factors

Groups of factors		No.	1	2	3	4	5	6
Natural-technical	External	1	a_{11}	a_{12}	a_{13}	a_{14}	a_{15}	a_{16}
	Internal	2	b_{21}	a_{22}	a_{23}	a_{24}	a_{25}	a_{26}
Economic	External	3	b_{31}	b_{32}	a_{33}	a_{34}	a_{35}	a_{36}
	Internal	4	b_{41}	b_{42}	b_{43}	a_{44}	a_{45}	a_{46}
Social-political	External	5	b_{51}	b_{52}	b_{53}	b_{54}	a_{55}	a_{56}
	Internal	6	b_{61}	b_{62}	b_{63}	b_{64}	b_{65}	a_{66}

Source: Bashmakov I.A. (1987). On macroeconomic projections and analyses of results (the 'seven matrices' method). Macroeconomic information processing system. Moscow, Nauka. Pp. 117—132. (In Russian).

In this chequerwork, a_{ij} ($i \leq j$) stand for direct relationships and b_{ij} ($i>j$) for reverse relationships. The elements on the diagonal capture the complex structural interactions within each group of factors; these interactions, along with the impulses passing through direct and reverse relationships with other factors, determine the direction and nature of change in this particular group.

Ideally, scenario projections developed to estimate the impacts of individual policies should account for the entire range of interactions presented as elements in Table 2.1. It would be the most meticulous and thorough approach to forming a science-based vision. However, such 'ideal' research would also take a lot of time. We claim that less thorough, yet acceptable, projections might be confined to the elements of Column 4 for scenario development and projection implementation and to Line 4 for the results analysis. Abstraction from at least one element in Column 4 might incur substantial errors in macroeconomic forecasting.

The very first step in the transition to projection experiments would be to determine the elements of interaction a_{14}, a_{24}, a_{34}, a_{54}, b_{64}. The system of interactions between the intraeconomic factors (element a_{44}) is embedded in the model (it is the model's structure). The above groups of factors

[20] F. Engels. Letter to K. Schmidt. October 27, 1890. // K. Marx, F. Engels. Complete works, Vol. 37, p. 417.

can only affect the model through a) changes in exogenous variables and b) changes in the coefficients and–sometimes–the composition of the equation variables.

The effect of changes in the basic groups of factors on the evolution of control variables can be determined by compiling *the first matrix – the scenario matrix*. By identifying all the elements in this matrix we can determine the impacts of all factors on the exogenous variable or on the equation parameters within the expected forecast horizon. This stage (formulation of scenarios) includes the following:

а) suggesting hypotheses regarding the perspective evolution of factors a_{14}, a_{24}, a_{34}, a_{54}, and b_{64}, as well as factors from the a_{44} group, which are not in the list of the model variables;

б) figuring out, based on these hypotheses, how exogenous variables and equation parameters will be evolving.

In macroeconomic models, nearly all exogenous variables are aggregated variables. Therefore, when the key hypotheses have been formulated, we can project the evolution of individual components of these variables (possibly, involving the already available projections). Economy is a dynamic system, so even with a fixed set of factors that determine a certain process, the relative power of some of these factors can change over time. One method to address this task is by analyzing and projecting the drift of the coefficients of the model equations resulting with a temporal shift in the calculation base for their estimation.[21] Dynamization of the model coefficients, where the functions capture the cause-and-effect relationships that determine their variation, can substantially improve the accuracy of projections. A number of coefficients, for example, price elasticity coefficients, are asymmetric by nature.[22] This stage of the projection process results in filling out a *matrix of scenarios* (Table 2.2). This matrix builds on the translation of qualitative considerations captured in the hypotheses (narratives, storylines) into the language of numbers. Each scenario is assigned with its own matrix.

The next stage of the projection process includes modeling of a particular scenario. Here another matrix is used, namely, *the variables interaction matrix* (A). Having the vector of the exogenous variables, we can use this matrix to determine the prospective evolution of the endogenous variables. This prospective evolution is the result of this stage of the projection process.

Could we stop here, having determined by what percentage, all factors fixed, a certain indicator will increase in year t+1 and decrease in year t+3? Yes, we could. However, such takeaways would be of little value, since, by choosing not to look at how the evolution of this indicator is mirrored in the economic and social interests of the economic agents, the authors of the projection will find themselves in an extremely difficult position when trying to say, how likely it is that this scenario will be implemented in reality. Confining the analysis of projection results to the purely economic sphere leads to the loss of some important incentives for scientific research coming from related disciplines, dilutes the goals of forecasting and diminishes the practical value of forecasts. Such approach confronts the consistency principle by abstracting in advance from the analysis of the

[21] Bashmakov I.A. On the dynamization of regression coefficients. In: Modeling global economic processes. Central Economic Mathematical Institute of the Russian Academy of Science. Moscow, 1985. (In Russian); Bashmakov I.A. Energy consumption and economic growth: drivers and limits to proportion change // Energetika. Aktualnye problem [Energy sector. Pressing challenges]. – 1988. Issue 1. – Pp. 50-62 (In Russian).

[22] Bashmakov I.A. Energy consumption and economic growth: drivers and limits to proportion change // Energetika. Aktualnye problem [Energy sector. Pressing challenges]. – 1988. Issue 1. – Pp. 50-62 (In Russian); Bashmakov I. Three laws of energy transitions. Energy Policy, Vol. 35, No. 7, pp. 3583–3594; Bashmakov I. 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; Bashmakov, Igor, Grubb, Michael, Drummond, Paul, Lowe, Robert, Myshak, Anna, and Hinder, Ben. 'Minus 1' and Energy Costs Constants: Empirical Evidence, Theory and Policy Implications. Available at SSRN: https://ssrn.com/abstract=4401851 or http://dx.doi.org/10.2139/ssrn.4401851.

direct impact of production relations on the political ones and of the reverse impact on the productive forces.

Table 2.2 The matrix of scenarios

Major groups of factors	Exogenous variables							Coefficients in model						
	Y_1			…	Y_n			K_1			…	K_m		
	t	…	t+τ	…	t	…	t+τ	t	…	t+τ		t	…	t+τ
Scenario 1														
a_{14}														
a_{24}														
a_{34}														
a_{44}														
b_{54}														
b_{64}														
Sum														
Scenario 2														
Scenario N														

Source: Bashmakov I.A. (1987). On macroeconomic projections and analyses of results (the 'seven matrices' method). Macroeconomic information processing system. Moscow, Nauka. Pp. 117—132. (In Russian).

In macroeconomic models, each indicator is a large aggregate, which can be disaggregated. Disaggregation is particularly important in determining how changes in endogenous variables affect the economic situation of the major classes and social groups. It enables the use of huge amounts of valuable information, which was discarded during the model development either due to its fragmentary nature or because it did not correspond to the level of aggregation, or because it was impossible to be quantified.

For example, the variable 'government spending' breaks down into government investments; government maintenance costs; military spending; education, healthcare, science, and social security spending; food subsidies; subsidies and loans to business; foreign investments; etc. Each of these components can be further disaggregated into smaller ones.

By projecting changes in variables onto the social-class structure of society we can develop a *matrix of change in the economic position of the major classes and social groups*. Social streaming of any society is a very untrivial task with no single solution. It can be addressed using a variety of criteria: class, standard of living, availability of resources, including access to power,[23] etc. (see Table 2.3).

[23] The list of resources in Tikhonova's classification includes economic resources – land ownership, possession of factories and plants, professional competencies, one's own workforce; political resources – power within a household, power at the workplace, party or social power, a charismatic leader; cultural resources – high-status consumer habits, 'good manners', privileged life patterns; social resources – access to high-status social contacts, public connections, membership in associations and unions; prestige – a good reputation, fame, servility or negligence, ethnic or religious purity; civil resources – one's own rights, contracts, voting right, membership in election assemblies, freedom of speech and meetings; personal skills, experience, workplace training (improving the qualifications), record of service, educational background, knowledge. Tikhonova N.E. Russian social structure: theories and reality / — Moscow, Novy Khronograph: Institute of sociology, Russian Academy of Science, 2014. — 408 p. — ISBN 978-5-84881-216

Table 2.3 Social and class streaming examples of the Russian society

Zhvitashvili, 2015	Tikhonova, 2014	Cherkesov, 2004	Zaslavskaya, 1997
Etacratic class. Government managers as owners of 'megacapital' in a society based on the dominance of high-status non-market groups. Includes decision-makers in areas that are key for the country development (top management), heads of government agencies and state corporations, regional elites, and lower-level officials. Social status determines the level of income through the ability to convert the political capital to the economic, cultural, social, and ideological capital, thus maximizing the rights of this class.	**High-resource group of the 'new capitalists'.** Have concentrated all of the important resources to obtain yet a much larger amount of resources, than could be provided by the economic resource they have. Can get the leading positions in the society.	**Bourgeoisie and top government bureaucracy**	**'Upper layer'**— includes elites and sub-elites in the economic spheres and government agencies
Monetary class – the major resource is the economic capital. Has a subordinate role in the state capitalism economy.	**Middle class** – is a medium-resource group. A substantial part of it is being exploited, because the income generated by the assets in their possession (by human capital in the first place) cannot ensure simple (leave alone expanded) reproduction, which is a critical pre-requisite of mere preservation of human capital in the information economy	**Servants of the bourgeoisie**	**Middle layer** (in other research also called 'middle class') — 20%
Paternalistic class – includes the remaining part of the defense and law enforcing agencies and retired people. These are the largest class of the Russian society.	**Low-resource group** – is a class of 'ordinary practitioners' with different individual situations; however, the structural positions of the class (resulting from the structure of the Russian economy and from the specific volume and structure of the resources available to this class) are generally such that it is put at a disadvantage and exploited.	**Intelligentsia and white collars**	**Base class** – the clerisy (experts), semi-clerisy (assistants to experts), technical workers ("office monkeys") and workers.
Employees		**Workers**	
Parcel peasants. Includes those who work at private farms to grow products they consume on their own. They are responsible for nearly 40% of agricultural output.		**Peasants**	
Underclass: immigrants from the former Soviet republics, fringe groups and unemployed. All having the smallest volume of civil rights.		**Underclass**	**Lower class** – semi-skilled and unskilled workers - refugees

Sources: Zhvitashvili A. Sh, leading research fellow, department of social structure, Sociology Institute of the Russian Academy of Science (117218, Krzhizhanovskogo St., 24/35, building 5, Moscow, Russia; zhvitiashvili-a@mail.ru). 2015. Issue 4, VLAST; Tikhonova N.E. Russian social structure: theories and reality / — Moscow, Novy Khronograph: Institute of sociology, Russian Academy of Science, 2014. — 408 p. — ISBN 978-5-84881-216; Unequal opportunity society: social structure of contemporary Russia / N.E. Tikhonova, S.V. Mareeva, V.A. Anikin, Yu.P. Lezhnina, A.V. Karavay, E.D. Slobodenyuk. N.E. Tikhonova Ed. – Moscow: Ves' Mir, 2022. – 424 p. DOI: 10.55604/9785777708731; Cherkesov B.A. Transformation of the social structure and stratification of the Russian society // Modern science-intense technologies. – 2004. – No. 4. – Pp. 106-108; URL: https://top-technologies.ru/ru/article/view?id=21933 (Accessed on: 08.09.2023); Zaslavskaya T.I. Social structure of the modern Russian society (Social science and the modern age). Moscow, 1997, No. 2.

It is important that changes in the projected values as obtained from the model runs can be projected onto this structure. Therefore, the basis for the stratification should be a combination of the industry focus, income level, and the institutional structure. The following social stratification could be used in Russia:

- top officials and large oligarchic business split into a) raw materials and hi-tech businesses, and b) state-controlled and private;
- medium business;
- small entrepreneurs;
- defense and law enforcement officials and public officers;
- intelligentsia, including people working in state-financed organizations;
- industrial workers;
- employees engaged in the commercial sector and small businesses;
- peasants;
- students;
- retired people;
- rural and urban underclass.

Based on the available information on how government programs progress in various sectors and how high they are on the agenda (in the eyes of the ruling circles) we can deduce, with a reasonable degree of confidence, which items of the government spending will be reduced in the first wave, should the total spending go down (Table 2.4). Of course, this is just one (incomplete) possible option. Let's see how this matrix is filled in using the example of a drop in the government spending (Table 2.5).

Table 2.4 Matrix of change in the economic situation of the key classes and social groups

Endogenous variables	Key classes and social groups				
	Top officials and large oligarchic businesses		…	Retired people	Rural and urban underclass
	Raw materials	Hi-tech			
X_1					
X_2					
…					
X_k					

Source: Bashmakov I.A. (1987). On macroeconomic projections and analyses of results (the 'seven matrices' method). Macroeconomic information processing system. Moscow, Nauka. Pp. 117—132. (In Russian).

The impact of change in other endogenous variables on the economic situation of businesses and individual segments of the population is explored in a similar way. When looking at how the economy affects the social system it is important to account for the growing wealth inequality, which is a huge explosive factor, especially when it is a result of the re-allocation of the government spending and is against the traditional ideas of social justice.

Table 2.5 Filled-in matrix of change in the economic situation of the key classes and social groups (example)

Evolution of the components of the "Government spending" aggregate	Change in the economic situation of the key classes and social groups
Reduction in government investment and procurement	Reduced incomes of government contractors, primarily small ones; growing unemployment in the construction and industrial sectors
Reduction in subsidies and subsidized loans	Reduction in small and medium business revenues
Wage freeze (reduction) in the public sector and reduction of government employees	Income reduction and unemployment growth among the intelligentsia and public officers
Cuts in government spending on social programmes and food subsidies	Decline in the living standards of the retired people, students, rural and urban underclass

Source: Bashmakov I.A. (1987). On macroeconomic projections and analyses of results (the 'seven matrices' method). Macroeconomic information processing system. Moscow, Nauka. Pp. 117—132. (In Russian).

Typically, macroeconomic models include variables that capture the country's foreign economic relations. When the evolution of these variables is projected onto the regional structure of the global market, a matrix of change in the country's position in the global economic relations can be developed (Table 2.6). This matrix captures the impact of projected change in the foreign trade on the economies of other countries and regions. This matrix is sort of a link connecting regional models with international trade models.

Table 2.6 Matrix of change in a country's position in the global economic system

Foreign trade endogenous variables	Countries and regions					
	West Europe	USA	China	Turkey	India	…
$^{x}b_{1}$						
…						
$^{x}b_{l}$						

Source: Bashmakov I.A. (1987). On macroeconomic projections and analyses of results (the 'seven matrices' method). Macroeconomic information processing system. Moscow, Nauka. Pp. 117—132. (In Russian).

Changes in the economic positions of various classes and social groups and exacerbating social and economic contradictions incur changes in the institutions and in the balance of domestic political forces. For example, large Russian businesses protect their interests through lobbies in the Presidential Office, government, Duma, and the Federation Council using the platforms of the Russian Union of Industrialists and Entrepreneurs and industry associations. This protection is, however, impeded by the "business for officials" scheme, which was developed as we are moving away from the principles of the market economy. It is important to understand, how the institutions will be changing and if they will be able to provide the good quality of public administration. All this will determine the ability of economic agents to protect their interests. Of course, such assessments cannot be unambiguous. Public mind is burdened with a whole complex of specific national, ethnic, and religious specificities of a country, which limits the application of the 'method of historical analogues'.

When we analyze the impulses passing through the feedback channels between the economic and socio-political subsystems, we should not forget that in countries like Russia, these feedback channels can be extremely extended or blocked, and the impulses can be not only delayed, but are often distorted. At this stage of the analysis, amateurism is unacceptable; it is important to ensure a professional and meticulous study of the issues related to institutional development and internal political struggle. This can't be appropriately undertaken, unless economists, sociologists, political scientists and other social relations experts join their efforts. This stage of the analysis should provide a filled in *matrix of changes in the balance of internal political forces* (Table 2.7).

Table 2.7 Matrix of change in the institutional organization of society and in the balance of internal political forces

Major classes and social groups	Major political parties and semi-political groups				
	Party 1	Party 2	Trade unions	Business associations	…
Top officials and large oligarchic businesses					
…					
Retired peope					
Underclass groups					

Source: Bashmakov I.A. (1987). On macroeconomic projections and analyses of results (the 'seven matrices' method). Macroeconomic information processing system. Moscow, Nauka. Pp. 117—132. (In Russian).

The elements of this matrix should capture changes in the composition and membership of political parties and semi-political groups (trade unions, industry associations, youth movements, etc.) and their supporters; revisions to the policies they pursue to promote the interests of certain forces behind these parties or groups; methods and forms of internal political struggle. The matrix includes only key political parties and semi-political groups. Such estimates can be obtained using traditional qualitative methods of expert forecasting. A party or group cannot protect its interests, unless the system is inclusive, and the opinion of this group can be heard and taken into account, i. e. unless there is a representative democracy in place.[24]

It may seem nearly impossible to develop such projections. However, there is a practical experience of such forecasting in Russia on a more than decade-long horizon (see Table 2.8). After 2008, Russia has gradually moved from a "decay" scenario (the slowest economic growth among the G20 countries) to a "hard hand" scenario, which put an end to economic growth whatsoever (see Chapter 4) and will not let the economy grow until 2060.[25] This is an inevitable result, where real democracy is replaced with a decorative one, and also the result of Russia's cultural tradition, which can be formulated as *"survival of alienated individuals, who are focused on handling tactical problems and having no idea of what awaits them in the future"*. Even in 2008, it was clear that all of the above would make it very difficult to identify the directions for modernization and form relevant coalitions.[26]

[24] Forrester S.P. and A.J. Satchwell. Developing an Equity Framework for State Regulatory Decision-Making. Electricity Markets & Policy. Energy Analysis & Environmental Impacts Division. Lawrence Berkeley National Laboratory. August 2023.

[25] Bashmakov I.A. Russia's foreign trade, economic growth, and decarbonization. Long-term vision. Moscow, April 2023, https://cenef-xxi.ru/articles/russia's-foreign-trade-economic-growth-and-decarbonization.-long-term-vision; Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, 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; Low Carbon Technologies in Russia: Current Status and Perspectives, https://cenef-xxi.ru/uploads/Technology_gap_b0cf666d23.pdf.

[26] Bashmakov I. Russia – 2050. Issues of Economy, 2008;(8):140-144. https://doi.org/10.32609/0042-8736-2008-8-140-144. (In Russian)

Table 2.8 Potential options for institutional change in Russia's policy

Metrics	"Decay"	"Hard hand"
The "nucleus" of the political institutions	1) monopoly of the actual executive branch leader for political decision-making; 2) lack of the open electoral competition among the elites; 3) hierarchical subordination of subnational authorities (the 'vertical of power')	
Constellation of political actors	Is close to the current system	Further concentration of power in the hands of the dominating actor
Actors' rent-seeking abilities	Close to the current level or improving	Close to the current level or shrinking
Incentives for institutional change	Absent or negligible	The need to overcome the inefficiency of institutions; Desire to do away with challenges to the dominant actor
Nature of institutional change	Imitational cosmetic changes which do not affect the 'nucleus' of political institutions	Substantial revision of the 'rules of the game', yet not affecting the 'nucleus' of political institutions
Vector of political change	Maintaining current political regime (status-quo)	Complete or partial replacement of the democratic 'façade' with autocratic mechanisms
Likely institutional change	Enhanced role of secondary institutions (satellite parties, consultants, etc.); Revised power distribution (the "ER" super-majority in the State Duma to be replaced with simple majority; simple majority in regional legislative bodies to be replaced with relative majority; slight expansion of power of legislative authorities; Doing the groundwork for substantial electoral competition on the subnational level (including participation restrictions for totally 'loyal' parties and candidates along with maintaining control over subnational authorities as part of the 'vertical of power')	Further restrictions on political parties and public associations (including those loyal to the current regime); Revisions to the legislation and enforcement practices to expand the authorities of the law-enforcement agencies and security services and to further restrict civil rights and freedoms; Rollback and/or degradation of secondary institutions; Narrowing the powers of parliament, transferring to the executive branch the right to adopt laws – with subsequent ratification by the parliament, transferring part of the powers from regional to the national authorities; Adopting a new Constitution, free from civil rights and freedoms and provisions stating the priority of Russia's international pledges over the domestic legislation
Ruling elite's strategies regarding other actors	Cooptation of real and potential independent actors	Suppressing real and potential independent actors
Other actors' strategies regarding the ruling elite	"Loyalty" (cooptation and transformation into satellites) or withdrawal (marginalization)	Withdrawal (emigration or marginalizaition) or non-conventional protest with subsequent repressions
The costs of maintaining the institutional balance	Growth (driven by increased side payments to coopted actors and other rent-seekers)	Growth (driven by increased control and suppression costs and side payments to law enforcement agencies and security services)
Side-effects of institutions from the national governance point of view	Corruption as a means of maintaining the actors' loyalty; Struggle of actors ("the Kremlin towers") for re-distribution of rent; Aggravating problems in the principal-agent relations	
Effectiveness of the institutions from the national governance point of view	Low	
Likelihood of improvement of the institutions' efficiency	Negligible	
Implications of the institutional changes from the point of view of the political regime	Maintaining the status-quo ("soft" autocracy)	"Hard" autocracy

Source: Gelman V. Russia is in an institutional trap. Pro et Contra. July—October, 2010.

Changes in domestic policy entail changes in the country's position in the system of global economic relations. Changes in the balance of internal political forces make the ruling elite aspire to enhance the positive trends in the foreign contacts and to neutralize the negative ones, as it sees them. In addition, economic means can be used to attain political goals, let's take Russian pipeline gas exports to Europe in 2021-2022 as an example.[27] Inadequate assessments of potential implications did not allow Russia to achieve the desired political effects. Potential effects that can result from the foreign economic policy are shown in the *matrix of change in a country's position in economic relations* (Table 2.9).

Table 2.9 Matrix of change in a country's position in international relations

Major countries and regions	Contacts with other countries: scale and forms				
	Economic	Technological	Ideological	Political	
				Diplomatic	Military
West Europe					
USA					
China					
Turkey					
India					
…					

Source: Bashmakov I.A. (1987). On macroeconomic projections and analyses of results (the 'seven matrices' method). Macroeconomic information processing system. Moscow, Nauka. Pp. 117—132. (In Russian).

The left column in this matrix includes the most important countries or regions from the international relations point of view, and the upper line includes forms of contacts with these countries. The elements of the matrix reflect the feasibility and projected effectiveness of a particular foreign economic or foreign policy action. It, of course, takes into account a counterparty's affiliation with a certain socio-economic system; membership in political and military alliances; obligations under bilateral agreements with other countries; political, ethnic, religious and other contradictions; and involvement in conflicts. Latana Democracy Perception Index,[28] which captures change in the attitude of other countries towards Russia, can be one tool for such analysis.

The previous stage of the analysis revealed the problems, which, if unresolved, can have the severest impact on both the internal political struggle and the country's position in the global economic system and international relations; it has also evaluated the effectiveness of certain measures. The following stage aims to identify the most likely set of solutions by developing the last, seventh, matrix – *the solutions matrix*, which assigns each large problem generated by a specific contradiction or a set of contradictions to a solution method (Table 2.10). By filling in this matrix we can formulate the final conclusions regarding the chance of addressing the problem using peaceful solutions, and if this is unlikely, we can determine that we are facing a crisis and see the forms it may take. There are some interesting analyses of potential changes in Russia's geopolitical situation and of the recommendations which the country did not follow.[29] In fact, it is important not only to make decisions, but also to implement them (governance). A rigid vertical system is quite effective in implementing punitive or mobilization decisions, but not so effective

[27] Bashmakov I.A. Russia's foreign trade, economic growth, and decarbonization. Long-term vision. Moscow, April 2023, https://cenef-xxi.ru/articles/russia's-foreign-trade-economic-growth-and-decarbonization.-long-term-vision; Behind the scenes of Russia's gas strategy, The gradual shutdown of pipeline gas exports to the EU, 4 July 2023, Russia's Gas Export Strategy and EU Market Upheaval: A Comprehensive Analysis (enerdata.net)).

[28] Democracy Perception Index 2023. Democracy Perception Index 2023.pdf (hubspotusercontent-na1.net).

[29] V. Chernega. What will Russia's foreign policy be like in 2023? Russia in the global policy. 01.12.2019. What will Russia's foreign policy be like in 2023? — Russia in the global policy (globalaffairs.ru).

in accelerating innovative development. The goal of attaining the technological sovereignty was declared in the USSR as early as in the 1930s. 90 years later, it is still not more than a slogan.[30]

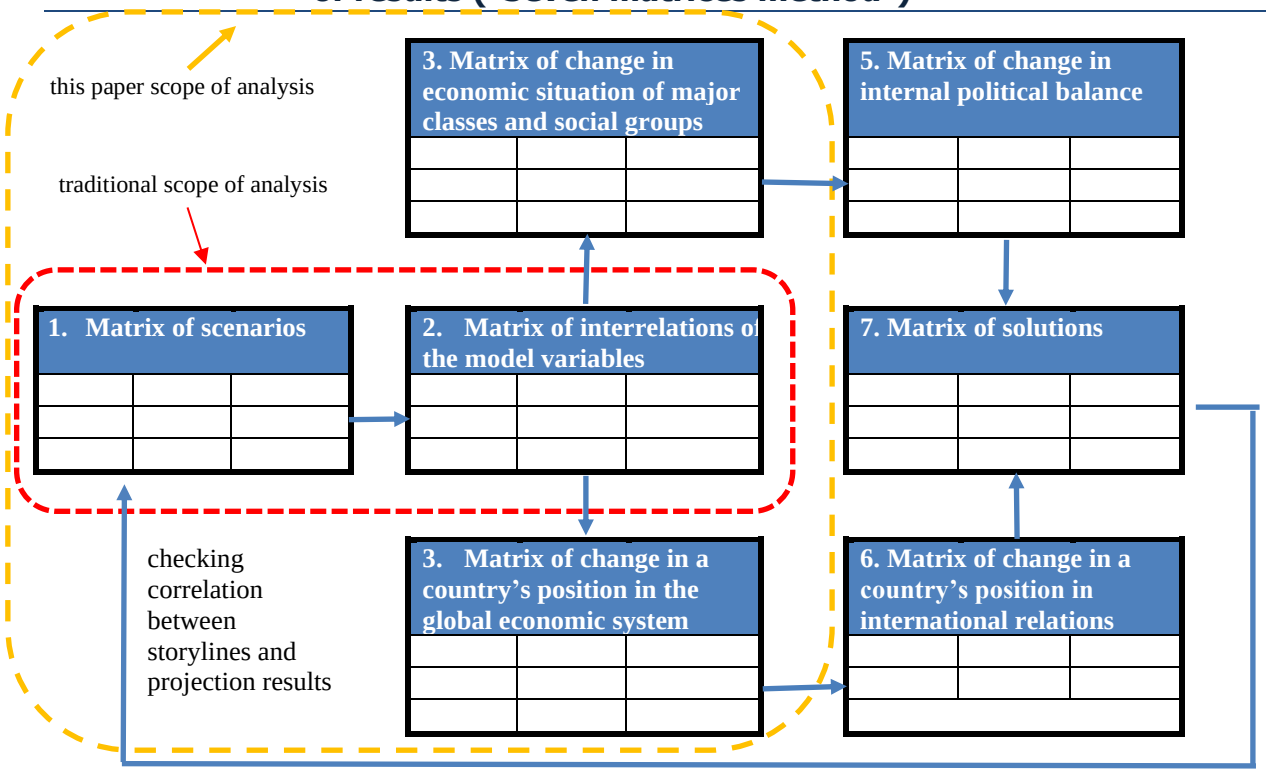
Table 2.10 Matrix of solutions

Major problems	Solutions				
	Scientific and technical	Economic	Ideological	Political	
				diplomatic	military
Problem 1					
Problem 2					
…					

Source: Bashmakov I.A. (1987). On macroeconomic projections and analyses of results (the 'seven matrices' method). Macroeconomic information progcessing system. Moscow, Nauka. Pp. 117—132. (In Russian).

The last stage of the analysis of projection results helps compare the initial hypotheses regarding the evolution of technical, economic, and social&political factors with the conclusions obtained. If the initial premises and final results largely coincide, then the given scenario has a good chance of being implemented. And vice versa, if they do not coincide, it is highly unlikely that the scenario will be implemented. This last stage closes the direct and reverse connection loops. Figure 2.1 shows the "how to" algorithm and analysis of results of macroeconomic projections using the 'Seven matrices method'.

Figure 2.1 Macroeconomic projections: "how to" algorithm and analysis of results ("Seven matrices method")



Source: Bashmakov I.A. (1987). On macroeconomic projections and analyses of results (the 'seven matrices' method). Macroeconomic information processing system. Moscow, Nauka. Pp. 117—132. (In Russian).

The main advantage of this "Seven matrices method" is that it enables the practical implementation of the systems consistency and development principles for the purpose of scientific forecasting, thus helping to analyze the interplay of the natural, technical, economic, and social&political

[30] Bashmakov I.A. Russia's foreign trade, economic growth, and decarbonization. Long-term vision. Moscow, April 2023, https://cenef-xxi.ru/articles/russia's-foreign-trade-economic-growth-and-decarbonization.-long-term-vision.

factors for each scenario. Therefore, the development of productive forces and production, social and political relations is determined by both internal contradictions and causal impacts as transmitted by other subsystems.

Good-quality implementation of the proposed algorithm is only possible on condition that there is close cooperation between experts in different areas: engineers, economists, historians, sociologists, political scientists, and experts in international relations. Such collaboration gives momentum to theoretical research in related disciplines. An economist-mathematician should come up with data on the evolution of economic indicators under given scenarios. Experts in related areas should then go into subsequent analysis.

Above is the ideal analysis algorithm. This paper will attempt to assess the effects of the decarbonization of the Russian economy using matrices 3 and 5. Matrix 3 will be analyzed in detail, whereas matrix 5 only sketchily.

2.2 Analysis tools

In the literature, the analysis of distribution effects mostly focuses on the effects of a variety of decarbonization policies (primarily carbon pricing or technical regulations, including standards and product bans) on the distribution of incomes and spending by quantiles and deciles (see Chapter 3). This study, however, looks at it from a broader perspective. Decarbonization processes both in the external world (regardless the policies applied in Russia) and in Russia (determined by the national policies and measures conducted by various economic agents) will substantially affect the sectoral structure of the gross output and GDP, and primarily, the role of the oil-and-gas sector in Russia.[31] It will also significantly impact the coal sector and the distribution of revenues among electricity and heat generation sources.[32] In the industrial and agricultural sectors, decarbonization will affect the output volumes and structure depending on the carbon footprint and reduction progress.[33] Depending on the progress in the localization of low carbon technologies, decarbonization will largely determine the directions of structural reforms in machinery.[34] The transport mix may change significantly: the share of pipeline and personal road transport will be decreasing, while the share of public and railroad transport will be growing. In the buildings sector, energy efficiency improvement costs will increase, whereas energy costs will go down. All this will lead to a significant redistribution of consumers' spending and suppliers' incomes in favour of lower carbon products. Since the monopolization of low carbon businesses is lower, and the income gap between the upper decile and the other deciles is smaller, such redistribution will probably have a larger impact on the distribution of spending and incomes by quantiles and deciles across the whole economy, than carbon regulation measures *per se* in the residential sector and personal transport.

Where GHG sources and sources of income need to be linked, there is always a problem of outlining the business boundaries. There are two major difficulties here. Firstly, it is important to ensure that energy consumption by various uses, as presented in energy balances, is consistent with the economic activities, as reflected in the national economic accounting. This problem arises because economic activities are not broken down to fit energy statistics, which focuses on the product and technological aspects. Secondly, it is important to have energy statistics consistency with the GHG emissions statistics. GHG emission inventories on fuel combustion do not split

[31] Bashmakov I.A. Russia's foreign trade, economic growth and decarbonization. Long-term vision. Moscow, April 2023. https://cenef-xxi.ru/uploads/Policy_paper_0b89e06980.pdf.
[32] Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, O. Lebedev, A. Lunin, A. Myshak. 2023. Low carbon technologies in Russia: current status and perspectives. Technology_gap_b0cf666d23.pdf (cenef-xxi.ru).
[33] Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, 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.
[34] Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, O. Lebedev, A. Lunin, A. Myshak. 2023. Low carbon technologies in Russia: current status and perspectives. Technology_gap_b0cf666d23.pdf (cenef-xxi.ru).

emissions from products or technologies, or aggregated economic activities which form the gross output or GDP. For Russia, the consistency of economic activities, GHG emissions and energy consumption breakdown is addressed in the MTFK-16-80-PG model, which is used to monitor energy efficiency improvement and to control energy related GHG emissions.[35]

A system ("a cloud") of interconnected models as developed by CENEf-XXI was used in this study to estimate prospective GHG emissions and to assess the distributional effects (see Figure 2.2).

The abovementioned model MTFC-16-80-PG is the information base for the development of other models. It is used to develop the Integrated fuel and energy balance (IFEB) and to conduct analysis by 16 sectors and 80 economic activities. Only 12 economic activities (which involve a large variety of products, such as production of electronic equipment, food, beverages, and tobacco) are shown as physical production indices. The other 68 activities are shown as natural physical indicators. This model ensures the full consistency of GHG sources and energy consumption by economic activities.

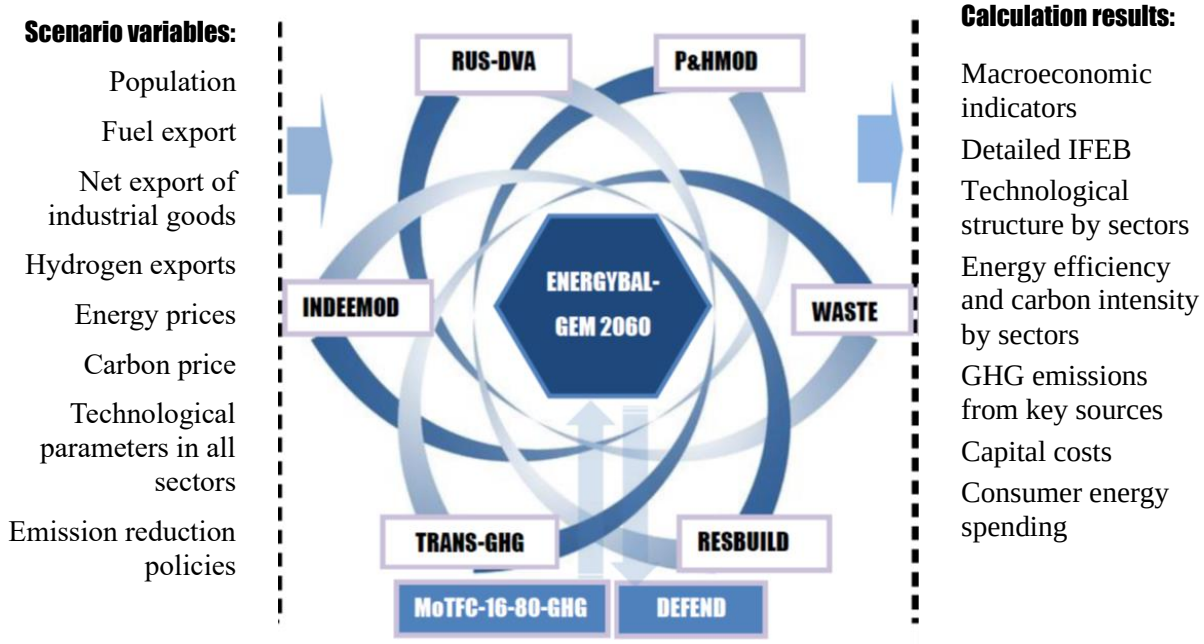
The "cloud" of models is centered around the nucleus – the key multisectoral dynamic simulation model ENERGYBAL-GEM-2060. In addition, the cloud includes a macroeconomic simulation model RUS-DVA (2 sectors – oil-and-gas and non-oil-and-gas, 5 products, 6 blocks – scenario variables; GDP production and distribution; investments; foreign trade; consolidated budget; and prices); a number of engineering-and-economic simulation models for the power and heat sectors (10 types of power and heat generation and energy storage systems); industrial model (around 60 industrial products, technologies, and production processes); transport (13 types of passenger transport and 8 types of cargo transport plus a few powertrains in each transportation mode; buildings – including multifamily and individual; 9 energy end-uses, 4 types of decentralized power and heat generation equipment, and 15 types of public and commercial buildings broken down by 5 processes; and a model to estimate emissions from the waste sector. The model parameters were calibrated on the 1995-2021(2022) data. The calculation step is one year, the projection horizon – to 2060. These models have been described in detail.[36] In ENERGYBAL-GEM-2060, energy demand in each sector is a function of the economic activity and specific energy consumption (SEC). The latter is a function of technologies improvements reflected in the sectoral models, and also of the capacity load (for industrial activities and pipeline transport), climate, amenities (in the housing sector), and of average energy prices corrected for inflation. Demand for individual energy carrier in each sector is determined by the relative prices. This allows for assessing the effects of market mechanisms on the structure of energy carriers used and thus on GHG emissions.[37] The SEC progress is determined based on capacity retirement, modernization, and commissioning parameters, as well as price competition between technologies with different energy efficiency or emissions performance. It is initially estimated in sectorial models, and then is corrected in ENERGYBAL-GEM-2060 depending on the energy price dynamics. The latter include carbon price. Sectorial models use a variety of functions to determine the structure of newly deployed technologies depending on the price competition parameters: levelized costs of power generation for power and heat sectors; levelized costs of manufacturing the major industrial products for industry; car ownership costs for road transport; building lifecycle costs for the buildings sector. ENERGYBAL-GEM-2060 model includes blocks to estimate GHG emissions from all sectors as shown in the national GHG inventory.

[35] Bashmakov I., A. Myshak, V.A. Bashmakov, V.I. Bashmakov, K. Borisov, M. Dzedzichek, A. Lunin, O. Lebedev, and T. Shishkina (2023). Russian energy balance, energy efficiency, and energy-related GHG emission accounting system. Energy Efficiency. 16:67. https://doi.org/10.1007/s12053-023-10132-6.

[36] Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, 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.

[37] Bashmakov I.A. Low Carbon Russia: 2050. CENEf. Moscow. 2009.

Figure 2.2 The "cloud of models" by CENEf-XXI



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

Rosstat's data on the distribution of incomes, expenses, living area, cars, and energy intense appliances by decile groups were used in the DEFEND model to study how evenly the pressure from the decarbonization measures is distributed. In many cases, sufficient information is not for a good quality analysis. For example, it is important to know, how the cars fuel efficiency, mileage, and price elasticates are distributed by deciles. Some analytical work allowed to reconstruct some of those parameters. In a few instances, distributional effects were estimated using proxy data for other countries.

2.3 Scenarios

In 2022, three scenarios were developed to assess the perspectives of the low carbon transformation of the Russian economy:[38]

- *4S – Stagnation, Sanctions, Self-Sufficiency* (also might be called "Forward to the Past", as opposed to the well-known "Back to the Future");
- 4D – *Development Driven by Decarbonization and Democratization*, which offers a chance of getting back to the global economy;
- *4F – Fossil Fuels for Feedstock*, which builds on the 4D scenario and non-energy use of the Russian fossil fuels.[39]

[38] Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, 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

[39] Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, 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 way to carbon neutrality: three 'fours' and one 'two'. Neftegazovaya Vertikal. No. 11, 2022. (In Russian); Bashmakov I. Scenarios of Russia's moving towards carbon neutrality. Energosberezheniye. No. 1, 2023. (In Russian).

These three "fours" are opposed to one "two"[40] – the government's *2F* (Forest First) strategy, which is the corner stone of the Low Carbon Development Strategy of the Russian Federation to 2050. It aims to address the problem of reducing net emissions with only limited reduction of GHG emissions in all sectors, but doubling the net absorption in LULUCF.

Decarbonization of the Russian economy is a difficult game. You can't win with the *2F* move alone. Only *4D* and *4F* ensure the win.[41] Chapter 4 shows how, by sliding towards the 4S storylines, Russia has already lost the economic growth, the efficiency of using key factors of production, the potential of improving the well-being of the population, and has moved from the 1998-2019 weak 'coupling' of GDP and GHG emissions to the 2020-2021 'supercoupling' and then further to the 2022 'reverse decoupling'. The *4S* scenario does not simply extrapolate the negative trends that have developed in the recent years, but allows for a much greater reduction in GHG emissions in all sectors compared to the *2F* scenario; however, for the purpose of attaining carbon neutrality it still requires an increase in absorption in LULUCF, even if to a much lesser extent, than *2F*.

4D is the only scenario that guarantees Russia's decarbonization in 2060. The storylines in this scenario are as follows:[42]

- Progress towards putting an end to Russia's military operation in Ukraine will relieve the sanctions and allow Russia to gain back some of the lost positions in global value chains;
- Active decarbonization policies in Russia will help the country to gain market niches in some global regions for its products with low or zero carbon footprint, and also to get access to the equipment and software for low carbon products and services;
- Democratization processes will be developing as the role of the oil-and-gas sector shrinks, and reliance on broader political and social strata will become the key factor for maintaining the social stability and developing the economic activity. This will enhance the economic competition (alongside the declining role of the state), reduce the level of the emigration sentiment of highly qualified workers and attract foreign labor to the Russian market, reduce corruption, encourage investment, and provide incentives for reward based on performance, rather than on personal loyalty;
- Relieving or laxing restrictions on hi-tech imports, encouraging competition to promote new technologies, and restoring access to international financing will improve the total factor productivity (TFP) and so accelerate the development of the non-oil-and-gas sector with improved alternatives to offset the loss of the oil-and-gas revenues;
- Growing opportunities to increase the production of low carbon products and services will spur the retirement of obsolete, and the modernization of the remaining, capacity;
- Increased demand in the domestic and global markets will substantially increase the commissioning of new capacities that meet the best available technology standards;
- The low carbon footprint requirement for products and services will provide incentives for the reduction of Scope 1 emissions by improving energy and resource efficiency,

[40] Bashmakov I. Russia on the way to carbon neutrality: three 'fours' and one 'two'. Neftegazovaya Vertikal. No. 11, 2022. (In Russian).

[41] Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, 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., V. Bashmakov, K. Borisov, M. Dzedzichek, O. Lebedev, A. Lunin, A. Myshak. 2023. Low carbon technologies in Russia: current status and perspectives. Technology_gap_b0cf666d23.pdf (cenef-xxi.ru); Bashmakov I.A. Russia's foreign trade, economic growth and decarbonization. Long-term vision. Moscow, April 2023. https://cenef-xxi.ru/uploads/Policy_paper_0b89e06980.pdf.

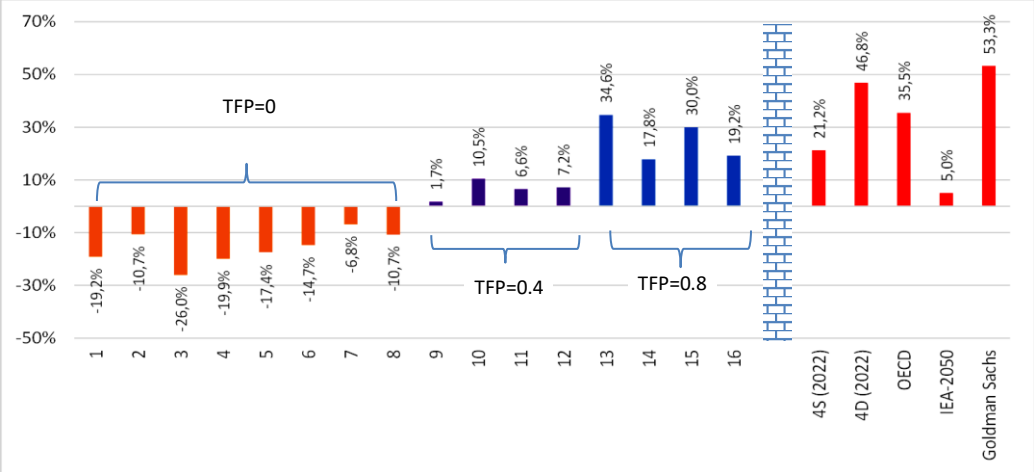
[42] Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENEf-XXI. https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060.

introducing the circular economy principles, electrification, deployment of CCUS and hydrogen technologies, and for the reduction of Scope 2 emissions by accelerating low carbon energy sector development in grid and off-grid systems; hydrogen-based technologies; CCUS; electric vehicles, and other low carbon technologies as they reach the commercialization stage;

- The urge to make low carbon technologies competitive in the early stages of their deployment and the potentially large geographic and product coverage by CBAM-like mechanisms will encourage the introduction of carbon pricing mechanisms at the national level.

Russia's economic prospects to 2060 depend on a number of possible combinations of the key drivers as listed in Figure 2.3. Perspective evolution options for each of these on the 2060 horizon have been considered in detail.[43] The estimates were adjusted (Figure 2.3) with an account of the available 2022 information and already available 2023 data, which have shown not just *"a focus on survival"*, but also the high ability of Russians to ensure survival.

Figure 2.3 GDP growth (decline) rates in Russia: 2020-2060



a) GDP in 2060 (in relation to 2021

№	Storylines							
	Sanctions	TFP	Employment	Fiscal policy	Foreign trade policy	Oil and gas export	Oil and gas prices	Carbon price
1	strong	0	low	moderate	poor import substitution	low	низкие	low
2	strong	0	low	2% annual growth in real expenses		low	низкие	low
3	strong	0	low	zero budget balance		low	низкие	low
4	strong	0	low	moderate		low	medium	low
5	strong	0	low	moderate		low	высокие	low
6	strong	0	low	moderate		high	medium	low
7	strong	0	high	moderate		medium	medium	low
8	strong	0	medium	moderate		medium	medium	low
9	abated	0.4	medium	moderate	Better import substitution	medium	medium	low
10	abated	0.4	high	moderate		medium	medium	high
11	abated	0.4	medium	moderate		medium	high	low
12	abated	0.4	high	moderate		high	high	low
13	abated	0.8	high	moderate	Better import substitution and promotion of non-fuel exports	high	high	high
14	abated	0.8	high	zero budget balance		high	high	high
15	abated	0.8	high	moderate		medium	medium	high
16	abated	0.8	low	moderate		medium	medium	high

б) Numbers on the left show the combinations of storylines, the results for which are graphically shown above

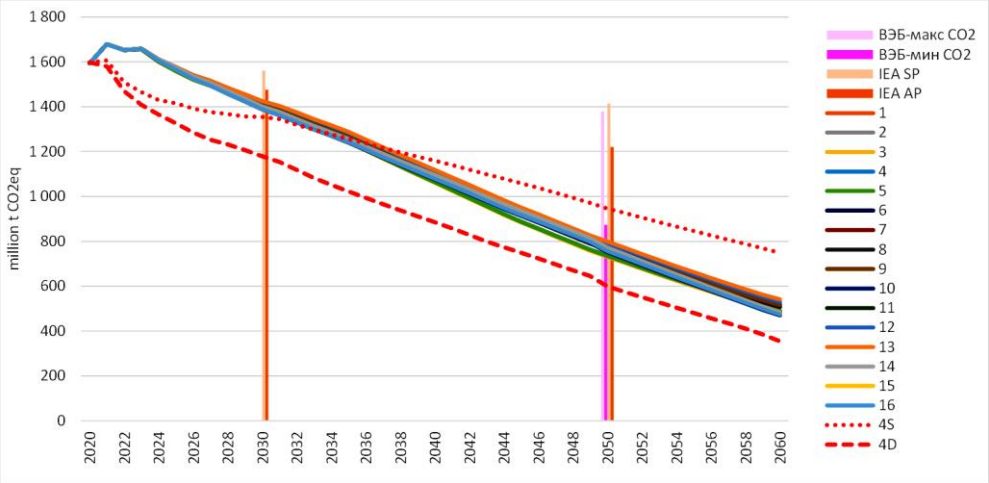
Source: the authors.

[43] Bashmakov I.A. Russia's foreign trade, economic growth and decarbonization. Long-term vision. Moscow, April 2023. https://cenef-xxi.ru/uploads/Policy_paper_0b89e06980.pdf.

Russia is yet to face a struggle for stagnation. If it doesn't succeed in increasing the TFP from the negative values (-1.2%) observed in 2010-2022 to zero or positive values in 2023-2060, GDP will be going down, while per capita GDP may remain unchanged, or even decrease, over the coming four decades. To increase the TFP even to zero is a difficult, or unsolvable, task, as long as the sanctions force the two-headed eagle look only East. In this scenario, the storylines include relaxation of the sanctions and improved access to new technologies, more effective import substitution, improved competition – both political and economic, to bring the TFP back to the positive values. A substantial progress towards the *4D* storylines will ensure the most favorable environment for the growth of the Russian economy and may bring the TFP up to 0.8% per year, which is the maximum value for the European and Central Asian states, according to the World Bank.[44]

The combination of factors number 10, supplemented with an assumption on a high carbon price, was chosen for further analysis. In *4D*, carbon neutrality pathways to 2060 are similar for all of the 16 combinations of economic drivers (Figure 2.4).

Figure 2.4 Evolution of energy related GHG emissions



Sources: the authors and Klepach A.N. (Ed.). Attaining the carbon neutrality target by the Russian Federation by 2060. VEB RF. January 2023; IEA. World Energy Outlook. 2022.

On the 2036 horizon, they are above the ranges as estimated in 2022, because in the short-term the Russian economy has demonstrated a better resilience to sanctions, than previously expected (even if due to a substantial increase in GHG emissions). Then they get back to the outlined range, but are consistently above the previous estimates for the 4D scenario, and carbon neutrality is only attainable providing current net absorption in the LULUCF sector is maintained. In terms of the emissions evolution, there is no huge difference between the scenarios.

[44] 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.

3 The impact of individual decarbonization policies on the distribution of incomes and expenditures

Both the effectiveness of a policy measure and its impact on the distribution of incomes and expenditures are largely determined by the institutional and social environment, where it is introduced and implemented, including the rationality of the decisions made; lobbying or eroding of the decision-making process by stakeholders; the government's ability to implement the decisions; institutional inertia; costs of developing and implementing relevant policies; the impact of the established values; etc.

In addition to the environmental and economic considerations, the reaction of decision-makers and decision-implementers is determined by their perception of the impact produced by these measures on the distribution of incomes and expenditures. Implementation of a balanced package of political instruments to limit or reduce GHG emissions is the best solution. Another important aspect is the '*second best'* principle: when a theoretically more advanced, yet difficult to implement, scheme is faced with limited resources, including human resources, it can produce a smaller effect, than a simpler, even if a less theoretically advanced scheme.

All GHG emission control policies break down into the "framework" and special carbon mitigation measures.[45] Framework policies entail GHG emission reduction as a side effect, whereas special policies as the target effect. However, all of these measures substantially affect the distribution of incomes and expenditures (Table 3.1).

Table 3.1 Distributional effects of some "framework" and special carbon mitigation policies

Measures	Brief description	Distributional effects
"Framework" policies		
Market and structural reforms	Structural reforms, tax reforms, privatization of state-owned companies, closure of inefficient companies, liberalization of trade and prices, liberalization of energy markets, demilitarization of the economy, reducing the economic monopolization, combating corruption	Substantial change in the economic structure and redistribution of incomes between sectors and production factors; substantial change in the distribution of incomes between classes and social groups, income quantiles and deciles
Energy security policies	Energy efficiency programs in all sectors, development of low carbon and alternative energy sources, including low carbon generation sources	Substantially reduce the incomes of fuel exporters and domestic fuel traders in favour of efficient equipment suppliers and alternative energy suppliers
Regulation instruments (enforcement and control)	Mandatory energy efficiency standards and pollutants emission standards, BAT deployment requirements, energy saving certificates ("white certificates"), bans on individual types of products, energy management requirements, waste management/land use/forest use regulations, etc.	Income flows for manufacturers of banned products are zeroed out. Where compliant products are more expensive, expenditures are redistributed among consumer groups with different income levels (large, medium, and small businesses and households)
Fiscal policies	Fuel tax, tax deductions and subsidies, fuel subsidies and subsidies to the low-income groups, tax credits	Significantly affect the disposable incomes of both taxpayers and subsidies recipients
Information instruments and market transformation instruments, energy efficiency labeling, etc.	Environmental and energy efficiency labeling programs, outreach programs and campaigns, energy savings calculators, mandatory energy audits, mandatory verification and monitoring systems, etc.	Can entail additional expenses, for example, for energy auditing, but also change decision-making stereotypes and can encourage cost-effective solutions to optimize the balance of costs and benefits.

[45] Bashmakov I., Jepma C., Bohm P., Gupta S., et al. Climate Change 2001. Mitigation. / Chapter 6: Policies, Measures, and Instruments. / Metz B., Davidson O., Swart R., Pan J. editors – Cambridge University Press, 2001. P. 399-450.

Measures	Brief description	Distributional effects
Special carbon regulation policies		
Strategic policies	National low carbon development strategies; programmes, plans, and roadmaps; institutional measures; combinations of effective political instruments.	To a certain extent, discussions of these strategies and plans take account of the expected effects on the incomes and expenses of the economic agents. However, these effects are only seen when these strategies are being implemented.
Tariff mechanisms	Energy price control; energy subsidies for individual groups of consumers; guaranteed 'green' energy tariffs; 'white certificates' tariff schemes; elimination of energy subsidies	Substantially affect the distribution of incomes between the producers of different types of energy and between energy consumers with different income levels
GHG emission caps	Mandatory specific GHG emission standards for power plants and vehicles; mandatory standards for maximum acceptable proportion of flaring; mandatory standards for maximum acceptable landfill methane emissions	Increase the upfront expenditures if the permitted or compliance equipment is costlier, but can reduce the lifecycle cost of ownership for cars or lifecycle costs of buildings. Are more important for those who buy new equipment
Bans for certain products with high carbon footprint	A ban of trading carbon intense products and products with GHG regulated by the Montreal Protocol; a ban of gasoline or diesel-fueled cars sales; a ban of building coal-fired power plants or power plants without CCUS; a ban of connecting new residential buildings to gas supply systems	
Financial and loan mechanisms	Taxonomies; special carbon and 'green' funds; development of 'green financing', subsidies and subsidized loans for low carbon projects. Integration of 'green' financing	Help reduce the financial pressure on low carbon activities and expand their market uptake, so significantly affect the distribution of incomes and expenses
Carbon trade	GHG emission trade, including CBAM-like mechanisms	In sectors with limited competition results in the pass through costs and re-distribution of incomes in favour of producers; in other sectors in favour of manufacturers of low carbon products
Carbon tax	Carbon tax for a variety of economic activities	Substantially affect the disposable incomes of taxpayers with high carbon footprint and on consumers of products – subject to the degree of *cost passed through*[46]
Project mechanisms	Offset mechanisms	Re-distribution of incomes between buyers and sellers and buyers' cost savings to control GHG emissions
Government procurement	"Green" government procurement for minimum adverse climate impact	Re-distribution of incomes in favour of manufacturers of new, yet initially costlier, low carbon products
Voluntary agreements	Government/business agreements to comply with specified GHG reductions	Additional costs to business to avoid larger costs of market or administrative compliance
R&D	Research programmes; development and uptake of low carbon technologies; demo programmes	Reduced R&D costs of business through partial government financing

Source: the authors.

"Frameworks" policies may have unexpected and significant effects on the environmental and economic policies. For example, in China, economic growth goals are overweighted when moving from the national government to lower-level governments, thus substantially aggravating

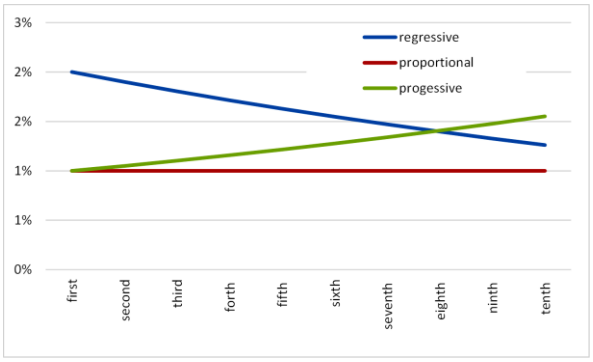
[46] The *cost pass through* parameter varies greatly across the sectors: it is 90-100% for cement and ethylene and only 30-40% for clinker. Cludius J., S. de Bruyn, K. Schumacher, R. Vergeer. Ex-post investigation of cost pass-through in the EU ETS – an analysis for six industry sectors, Energy Economics, Volume 91, 2020, 104883, ISSN 0140-9883, https://doi.org/10.1016/j.eneco.2020.104883.

environmental pollution in regions due to laxer environmental regulations, blocking the renovation of the industrial structure and hampering technological innovations. When a local government undertakes to achieve a very ambitious economic growth, it is likely to sacrifice environmental protection.[47] However, if the declared economic growth goal is attainable, then environmental pollution decreases. In the recent years, the Russian government has been setting unfeasible economic growth targets.[48] Following the logic of the Chinese research, this has been substantially hampering the implementation of the environmental[49] and climate policies.

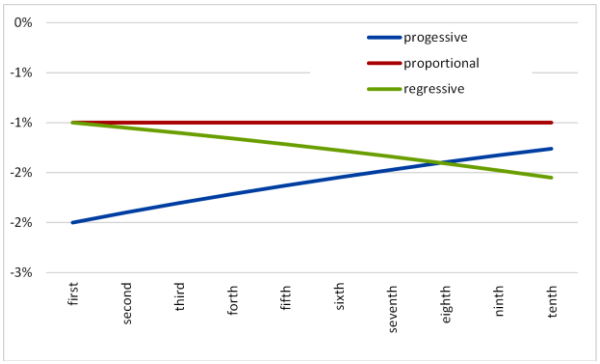
Special policies may be complementary or competing (for example, renewable energy support and GHG emission trading policies). They include hundreds of complex provisions and exceptions and are implemented in a complex interplay of factors, which affect the effectiveness of these measures. Therefore, it is difficult to estimate the effects of individual policies, and even more difficult it is to assess their distributional effects. For this reason, distributional effects are not really seriously taken into account when developing policies to achieve climate neutrality.[50] Typically, the distributional effects of climate policies are explored to determine how proportionate their pressure will be on people with different income levels and primarily on low-income groups.

The effects of climate mitigation measures may come as either additional costs or benefits. A policy is **regressive** if it disproportionately increases the share of costs in the incomes of low-income households. On the contrary, if the pressure is mostly on high-income households, the measure is **progressive** (in terms of costs). And if the costs are evenly distributed across all income groups, then such policy is **proportional**[51] (Figure 3.1). In democratic societies, policy development should be heading towards proportionality. If a policy has a regressive distributional effect, compensations should be provided to low-income groups, or the policy needs to be designed in a way so as to minimize the adverse distributional effects.

Figure 3.1 Distributional effects from climate policies: costs and benefits sides



Effects in the form of additional costs



Effects in the form of additional benefits – costs reduction

*A neutral effect is obtained where the effect of additional costs is equal to the effect of additional benefits.

Source: the authors.

[47] Yu Y., K. Li, S. Duan, C. Song. Economic growth and environmental pollution in China: New evidence from government work reports. Energy Economics. Volume 124, August 2023, 106803.
[48] Bashmakov I. Will there be economic growth in Russia in mid-21 century? Issues of Economy. 2011;(3):20-39. https://doi.org/10.32609/0042-8736-2011-3-20-39.
[49] What was to be done is described in the Report on the ecological development of the Russian Federation for future generations. State Council of the Russian Federation. Moscow, Kremlin. 2016.
[50] Eurofound (2021), Distributional impacts of climate policies in Europe, Publications Office of the European Union, Luxembourg.
[51] Zachmann G., G. Fredriksson and G. Claeys. 2018. The distributional effects of climate policies. BRUEGEL BLUEPRINT SERIES. Volume 28.

In terms of benefits, such as reduced energy bills, it is vice versa: if low-income households get more benefits relative to their income, than wealthier households, then the policy is **progressive** (in terms of benefits). Otherwise, it is **regressive** (in terms of benefits). Where benefits are evenly distributed, the policy is **proportionate.** To this classical categorization we could add a definition of a **neutral** measure, i. e. the one that does not cause the balance of incomes or expenses to divert from the baseline evolution trajectory. For such policy, additional costs are offset with the resulting savings.

Vertical distributional effects (across income groups) may be significantly smaller, than horizontal ones (within each income group).[52] This makes it difficult to assess and control the distributional effects. The experience in assessing the distributional effects of individual climate policies is described in Table 3.2. The uncertainty of estimates is partly due to the difference in which effects are estimated: direct or indirect; short-term or based on the return of the system to a general equilibrium position; short-term or over the life cycle of the technology, which is promoted by the policy.[53] It is shown for the U.S., that while estimates based on energy costs alone show a regressive effect of carbon pricing mechanisms, the overall effect can be neutral or even slightly progressive. This demonstrates the importance of tracking all of the economic effects, rather than the impact on spending.[54] Moreover, the effect depends on how the funds collected through the carbon pricing mechanisms are used.[55]

Table 3.2 Estimated distributional effects from climate policies

Sector	Distributional effect	Degree of confidence
Carbon pricing mechanisms		
Road transport	The estimates are controversial. Probably progressive estimates for low-income countries. Low-income households are less likely to own cars, but those who do spend a larger share of their income on fuel.	Moderate
Power supply	Regressive. Low-income households spend a larger share of their income to pay their electricity bills; in addition, their demand is nonelastic (for example, they often cannot afford to replace their old appliances).	Moderate
Heat supply	Regressive. Estimates of how much low-income population lose are less obvious, than estimates of losses from power tax.	Moderate
Air transport	Probably progressive, because air transport is mostly used by members of high-income households.	High
Water transport	Can be regressive, if low-income households spend a large share of their income to buy water transport-delivered imported goods.	Low
Per capita carbon emission quotes (standards) and emission trade	Progressive. However, this scheme would require a lot of exemptions for people living in inefficient houses or having special needs. Therefore, in 2008 the British government decided not to test this scheme	High. GHG per capita emissions for the 10th decile are 2.4 times higher, than for the 1st decile

[52] Vona F. Managing the Distributional Effects of Environmental and Climate Policies: The Narrow Path for a Triple Dividend. Environment Working Paper No. 188. OECD (2021).

[53] Estimates based on a review of the literature (53 publications assessing 183 effects in 39 countries) show a high level of uncertainty about the effects of carbon price mechanisms. Ohlendorf N., M. Jakob, J.C. Minx, C. Schröder, J.C. Steckel. Distributional Impacts of Carbon Pricing: A Meta-Analysis. Environmental and Resource Economics (2021) 78:1–42. https://doi.org/10.1007/s10640-020-00521-1.

[54] Rausch S., G.E. Metcalf, J.M. Reilly, and S. Paltsev. Distributional Impacts of a U.S. Greenhouse Gas Policy: A General Equilibrium Analysis of Carbon Pricing. Report No. 182. November 2009.

[55] Burtraw D., M. Domeshek and A. Keyes. A review of how the economic impacts of different carbon pricing policies may be distributed across households. Carbon Pricing 104: Economic Effects across Income Groups. May 4, 2020.

Sector	Distributional effect	Degree of confidence
Subsidies for low carbon technologies	Can be regressive, because new equipment is mostly purchased by high-income households. Subsidies in the form of tax exemptions are mostly provided to high-income households.	High
Government investments in low carbon technologies or additional infrastructure	Controversial estimates, which depend on how the demand for capital and unskilled labour grows and how (and by whom) the new infrastructure is used.	Low
Higher tax for high-carbon products (CBAM)	Controversial estimates. Low-income households have a larger reliance on high carbon imports, but unskilled workers can benefit from the protection of high-carbon industries (for example, coal industry).	Low
Car emission standards	More regressive, than carbon tax.	Moderate
Incentives for biomass use in transport	Progressive effect.	Low
Energy efficiency standards for new buildings	For the EU, the effects of the building standards are believed to be minimal.	Unclear
Agriculture (standards and taxes)	Probably regressive due to the higher share of food expenditures in low-income households' budgets; this, however, is partially offset by a higher proportion of carbon in high-income households' diet.	Low
Impact of climate policies on labour market	Probably regressive due to "higher skills" requirements in "green" industries; however, energy efficiency improvements in buildings could create jobs in the construction sector.	Low
RE subsidies in Germany (*feed-in-tariffs*)	Regressive, because they increase residential electricity tariffs, whereas industrial tariffs are not affected.	High
ETS in EU	Regressive, because companies benefitted from free permits, have access to cheap international offsets and get reimbursement of their indirect costs at the expense of consumers and governments.	High
Subsidies for purchasing electric vehicles	Progressive, because electric vehicles are mostly purchased by high-income groups. Depends on the subsidies scheme. Can be regressive, if there are subsidies for insurance (Austria).	High
Government investments in low carbon infrastructure	Progressive or proportional for investments in the development of public transport, cycling infrastructure, charge network for electric vehicles, bioenergy, waste management, and energy efficient social housing.	High

Sources: Zachmann G., G. Fredriksson and G. Claeys. 2018. The distributional effects of climate policies. Bruegel blueprint series. Volume 28; Eurofound (2021). Distributional impacts of climate policies in Europe, Publications Office of the European Union, Luxembourg; Ohlendorf N., M. Jakob, J.C. Minx, C. Schröder, J.C. Steckel. Distributional Impacts of Carbon Pricing: A Meta-Analysis. Environmental and Resource Economics (2021) 78:1–42. https://doi.org/10.1007/s10640-020-00521-1; Gough, Ian (2013) Carbon mitigation policies, distributional dilemmas and social policies. Journal of social policy, 42 (2). pp. 191-213. DOI: 10.1017/S0047279412001018; Vona F. Managing the Distributional Effects of Environmental and Climate Policies: The Narrow Path for a Triple Dividend. Environment Working Paper No. 188. OECD (2021).

A variety of equity concepts can be used:

- **distributional** (fair distribution of costs and benefits across groups with different incomes or among regions);
- **procedural** (ensuring both the possibility of participation and the account of the views of different groups in decision-making processes);
- **recognitional** (fair representation guarantees for under-recognized groups).

The concept of equity should be implemented at all stages of policy development and implementation – targeting ("what is to be done?"), tools development ("how to do it?"), and

monitoring ("what has been done?"). All of these steps should ensure a fair distribution of the pressure and guarantee stakeholder engagement.[56]

Ideally, a baseline is required for each equity metric to assess how an individual measure affects the distribution of incomes and expenditures. Metrics can reflect indicators, such as the affordability of energy, low carbon technologies uptake, sustainability of the effects, public involvement in decision-making, ensuring reliable energy supply, etc.[57] In addition, metrics, such as the gender, ethnical, and generation equity, could be considered.

Uneven distribution of the effects is often used by autocracies as an unsupported by the evidence or model calculations argument against having an ambitious climate policy. In such countries, the poor, national minorities, trade unions, environmental activists and other groups, unlike large businesses, are typically unable to promote their interests.

[56] Forrester S.P. and A.J. Satchwell. Developing an Equity Framework for State Regulatory Decision-Making. Electricity Markets & Policy. Energy Analysis & Environmental Impacts Division. Lawrence Berkeley National Laboratory. August 2023.
[57] Ibid.

4 Results of resources-based economic development in 2000-2023 as a background for assessing the potential impacts of decarbonization

The potential impact of decarbonization policies on the economic development can be assessed against a certain background. This background is the evolution of the Russian economy along the oligarchic resources-based pathway over the past 15-30 years. It is important to assess the impact of these economic policies on the economic growth and on the income distribution for the key economic agents.

"**If we realize, that we need to be working, there won't be much harm, and we won't lose too much".**[58] Some Russian economists have certain prejudices against the potential effect of the decarbonization on the economic development: they fear that it might slow down the economic growth, lead to a decrease in, or stagnation of, the standard of living, and determine an abrupt price growth.[59] They are warning that decarbonization may cause Russia to lose a lot. Can V. Chernomyrdin be right with his catchphrase as cited above? Importantly, it is not clear, if there is really much to lose after the losses that have been incurred by the preserved state control over the resources-based economy. This issue is discussed in the first section of this chapter, which shows that the resources-based economic development over 2008-2022 led to exactly what these authors are accusing the decarbonization of: economic development nearly stopped, personal incomes were not growing, and decreasing real energy prices provided no impetus for economic growth.

Post-1999 political and economic reforms (with all their diversity and contradictions in the course of implementation) had two general parallel vectors: 1) roll-back on political competition – the dawn of the democracy; and 2) roll-back on economic competition – the dawn of the efficiency. Democracy has turned into a decorative institution of the autocratic regime,[60] as a tough top-down command structure was rebuilt with the primary purpose to 'preserve the stability', that is, in fact, 'to keep the personal power'; in the Russian environment, this typically leads to stagnation or economic decline by providing zero development incentives.

After 1990, Russia noticeably advanced in the global democracy rankings, yet from 1999 onwards, it began to roll back, and by 2022-2023 the democracy indices were even below the Soviet 1990 values. The Varieties of Democracy (V-Dem) project evaluates four integral indices and a large variety of partial indices that describe the level of democracy. The electoral democracy index (Figure 4.1) is based on expert assessments and shows the extent, to which political leaders are elected in the course of a free and fair election process which guarantees the freedom of associations and expression of opinions. It varies between 0 (no democracy) and 1 (most democratic).[61] The Economist Democracy Index measures the democracy and some of the political institutions and freedoms.[62] After growth in 1990-1992, the index of electoral democracy stayed relatively high for a few years (in the developed democracies, it was 0.8-0.9 during the same period), but then was declining rapidly in 1999-2008. Two more notable declines were observed

[58] © V. Chernomyrdin.

[59] Porfiriev B., Shirov A., Kolpakov A. Low carbon development strategy: perspectives for the Russian economy. Mirovaya energetika i mezhdunarodnye otnosheniya. 2020. Vol. 64, No. 9. Pp. 15-25, https://doi.org/10.20542/0131-2227-2020-64-9-15-25; Porfiriev B.N., Shirov A.A., Kolpakov A.Y., Edinak E.A. Opportunities and risks of the climate policy in Russia. Voprosy Ekonomiki. 2022;(1):72-89. (In Russ.) https://doi.org/10.32609/0042-8736-2022-1-72-89; Shirov A.A. Sustainable development, climate, and economic growth: strategic challenges and solutions for Russia] https://cenef-xxi.ru; Shirov A. 2021. Presentation "The risks of the low carbon development policies for the Russian economy". The Institute of Economic Forecasting of the Russian Academy of Science. 2021.

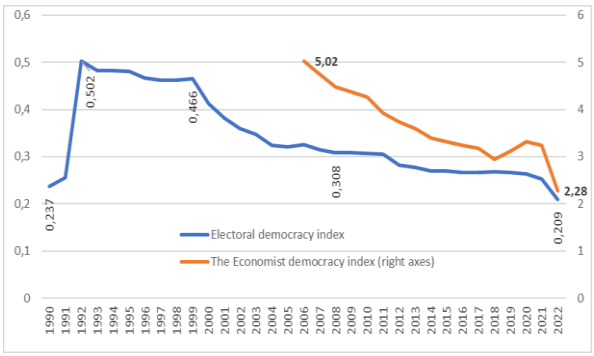
[60] Interactive Maps – V-Dem; The world's most, and least, democratic countries in 2022 (economist.com).

[61] In addition, the following indices are assessed: egalitarian democracy index, which shows, that personal rights and freedoms are equally protected across all social groups, and access to power is not determined by gender or social or economic position; deliberative democracy index reflects the deliberative principle of democracy in the process of state decision-making; Liberal Democracy Index reflects the protection of individual freedoms, supremacy of law, independent judiciary, effective checks and balances to limit the executive branch. The dynamics of all four integral indices in Russia is similar. See Interactive Maps – V-Dem.

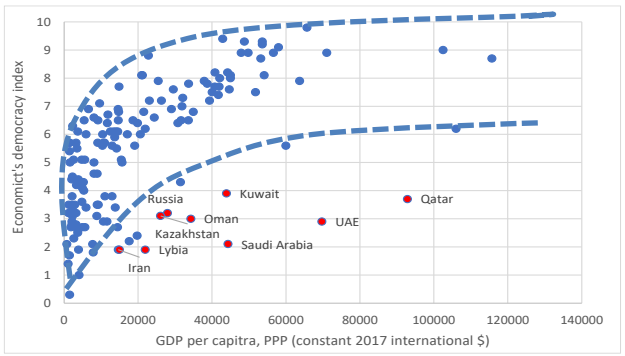
[62] The index is based on 60 indicators grouped into 5 categories; it measures pluralism, individual freedoms, and political culture. It classifies each country into one of the four types of regimes: full-scale demorcracies; imperfect democracies; hybrid regimes; and autocracies. The first report on the Democracy Perception Index was published in 2006.

in 2012-2014 and 2022. As a result, all four integral democracy indices, as described by the V-Dem project, were lower in 2022, than in the Soviet Russia of 1990.

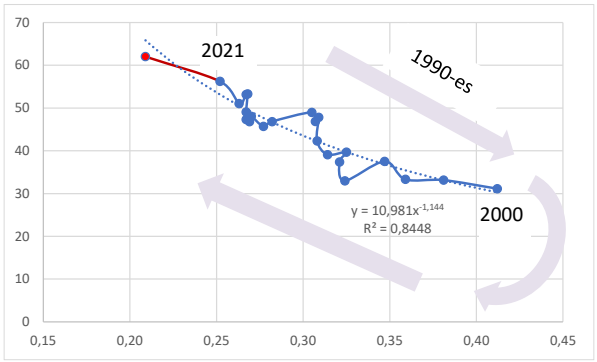
Figure 4.1 Democracy indices and state property index in Russia. "Back to the USSR"



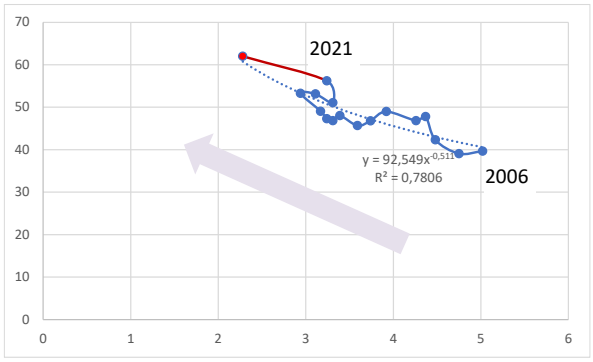
Democracy indices



GDP per capita and the Economist Democracy Index by countries



state property index (vertical axes) as function of electoral democracy index (2000-2022)



state property index (vertical axes) as function of Economist Democracy Index (2006-2022)

Source: authors based on data from Varieties of Democracy, V-Dem Interactive Maps – V-Dem; The Economist Democracy Index The world's most and least democratic countries in 2022 (economist.com); Indices (ranepa.ru). The 2022 value assessed by authors. GDP per capita in current dollars – WDI database.

Only in a few countries GDP per capita is above USD 20,000 and the Economist Democracy Index is below 5, they are mostly oil and gas exporters with unsustainable GDP per capita, because oil and gas rent is volatile and is likely to be exhausted as the global economy is moving towards decarbonization. Around 70% of the Russian population believe, that democracy is important (one of the lowest indicators among 53 world's leading economies) and less than 50% believe, that Russia is a democratic country (only 8 countries[63] out of 53 have a lower indicator). About 30% believe, that there is not enough democracy.

The goal of establishing the government's control over the key financial flows in the resources extraction and basic materials production sectors was attained. This caused the share of the government control sector of the economy (state property index) grow 1.8-fold – from 31.2% in 2000 to 56.2% in 2021[64] (the author estimates, that it exceeded 60% in 2022). Control over the economy and society was largely established in 1999-2008 and finalized in 2012-2022. The roll-back on democracy was accompanied by the growth in the share of the state controlled sector in the economy. Each percentage point reduction in the electoral democracy

[63] Iran, Hungary, Venezuela, Poland, Peru, Maroc, Nigeria, and Japan. Democracy Perception Index 2023. Democracy Perception Index 2023.pdf (hubspotusercontent-na1.net)

[64] Assessed by Institute for Applied Economic Studies, RANEPA. Indices (ranepa.ru)

caused the state property index grow by 1.1% (Figure 4.1). The Institute of comprehensive strategic research has estimated the results of Russia's economic development in 2008-2020 as follows:[65]

- Despite the ambitions goals and plans (as specified in the Concept of Russia's long-term social and economic development to 2020, including to bring personal incomes and the standard of living to match the indicators seen in the developed countries; to ensure the transition from the raw materials export-oriented model to the innovations-based economic growth, including by establishing a highly competitive institutional environment), the Russian economy failed to make a qualitative breakthrough over those 12 years, and many social and economic problems remain unsolved;
- The resources-based economic model and the reliance of the national government on the fuels and basic materials export revenues persist;
- Negative trends can be observed in the evolution of the standard of living;
- The institutionalization of economic policies has been attained by establishing state corporations with an access to financing, yet weak control over their performance and with a negative impact on the competitive environment;
- Modernization and infrastructure development rates in Russia remained slow;
- The level of ambition in the strategic planning documents noticeably decreased;[66]
- Economic policies in Russia have moved from large-scale reforms of the 1990s and early 2000s (which fundamentally changed the conditions of doing business in the country and laid the basis for economic growth) to limiting the economic growth for the sake of preserving the "macroeconomic stability" which eventually turned into stagnation.

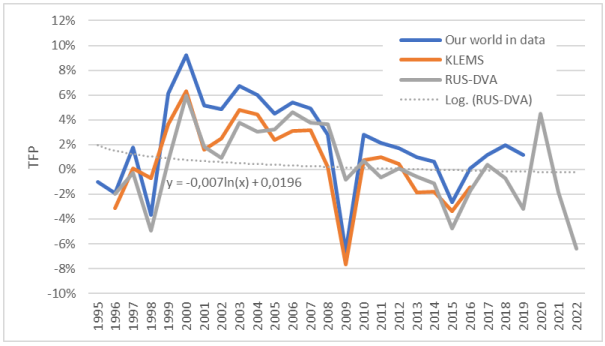
To this list we can add that the roll-back on competition in 2000-2008 replaced the rapidly growing efficiency of production factors – labour, capital, materials, and energy – with a slow growth in labour productivity, stagnation of energy intensity and materials intensity (Figures 4.2 and 4.3). In 2012-2020, TFP in Russian largest companies was 7% down. Private companies significantly outperform companies with direct government participation in terms of TFP because they operate in a more competitive environment.[67]

On average, each percent increase in the state property index[68] in 2000-2021 was accompanied by a 0.33% decrease in GDP growth rates (caused mainly by the declining efficiency of use of the key production factors), and where the share of the state-controlled sector exceeds 55%,[69] total factor productivity contribution is down to zero stopping the economic growth. Relatively high (like in 2021) GDP growth rates are attainable only as a result of a post-crisis rebound (for example, in 2021 after the COVID19 crisis). Alexey Kudrin claimed that a high share of state sector in the economy is a factor that slows down economic growth.[70] Indeed, the growing share of state sector and subsequent decline in the general efficiency of the economy led to a substantial slowdown in the economic growth after 2008 (see Figure 4.4). The

[65] Institute for comprehensive strategic research. Review of the macroeconomic situation. June 11, 2020. Makro_prognoz.pdf (icss.ru)
[66] Including the Low Carbon Development Strategy.
[67] Abramov A.E., E.D. Dzhaokhadze, A.D. Radygin, M.I. Chernova. Total factor productivity of Russian companies: Assessments, trends, and dynamic factors. Issues of Economy. No. 11, 2023.
[68] Privatization 30 years later: public sector size and effectiveness / A.D. Radygin, R.M. Entov, A.E. Abramov, M.I. Chernova, G.N. Malginov. – Moscow, Delo, RANEPA, 2019. - 76 p.
[69] =18,06/0,3308.
[70] https://lenta.ru/news/2022/01/13/kud2/

share of state sector, as estimated by RANEPA, does not include the public sector.[71] With the public sector included, the share of state-controlled sector in the economy escalates to 70%. This indicator is gradually getting back to the 86% observed in the Soviet Russia in 1990.[72]

Figure 4.2 Total factor productivity and the impact of state property index

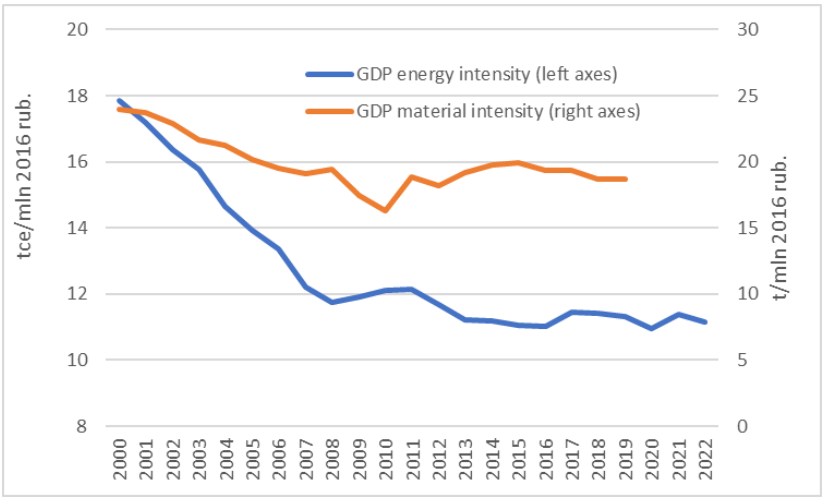


evolution of TFP for entire economy (Our World in Data and KLEMS) and for non-oil-and-gas sector (RUS-DVA model)

relationship between various assessments of TFP and state property index

Sources: Our World in Data (2023). Total factor productivity, 1970 to 2019 (ourworldindata.org); RUS-DVA - Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, 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; KLEMS. National Research University Higher School of Economics. December 2019; https://www.hse.ru/russiaklems/dataklems/; Indices (ranepa.ru)

Figure 4.3 Evolution of GDP energy and materials intensities

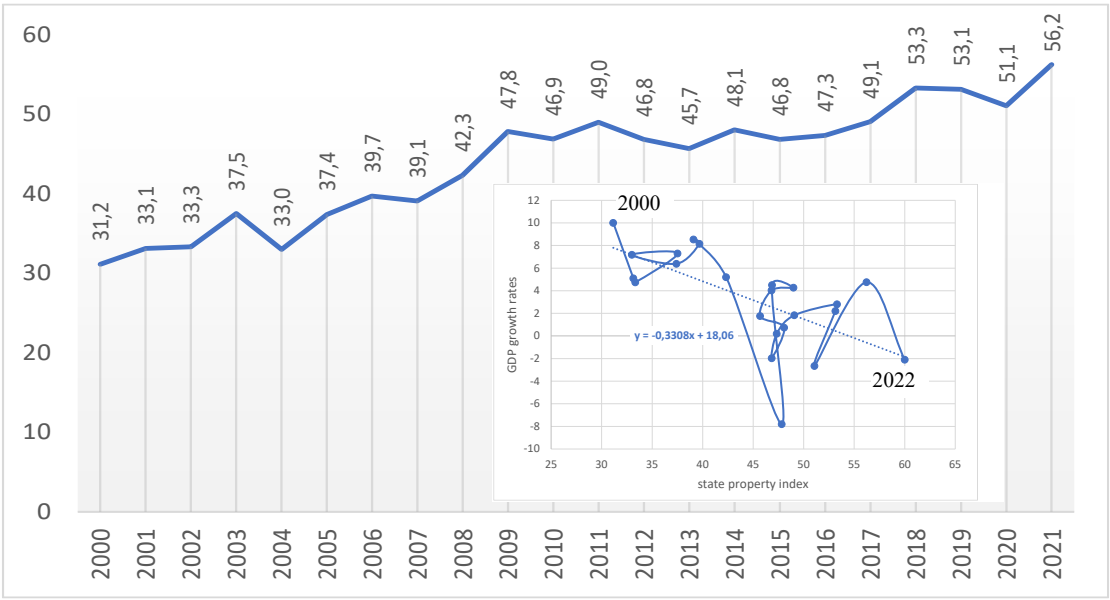


Sources: Energy intensity – Bashmakov I., A. Myshak, V.A. Bashmakov, V.I. Bashmakov, K. Borisov, M. Dzedzichek, A. Lunin, O. Lebedev, and T. Shishkina (2023). Russian energy balance, energy efficiency, and energy-related GHG emission accounting system. Energy Efficiency. 16:67. https://doi.org/10.1007/s12053-023-10132-6; materials intensity – consumption of metal and non-metal ores and biomass based on data from Global Material Flows Database | Resource Panel; GDP – data from Rosstat.

[71] Privatization 30 years later: public sector size and effectiveness / A.D. Radygin, R.M. Entov, A.E. Abramov, M.I. Chernova, G.N. Malginov. – Moscow, Delo, RANEPA, 2019. - 76 p.

[72] Karpov D.Yu. Public sector: institutional directions of development in Russian economy. Resume of PhD dissertation (Economics). Saratov, Russia, 2011.

Figure 4.4 State property index and GDP growth rates

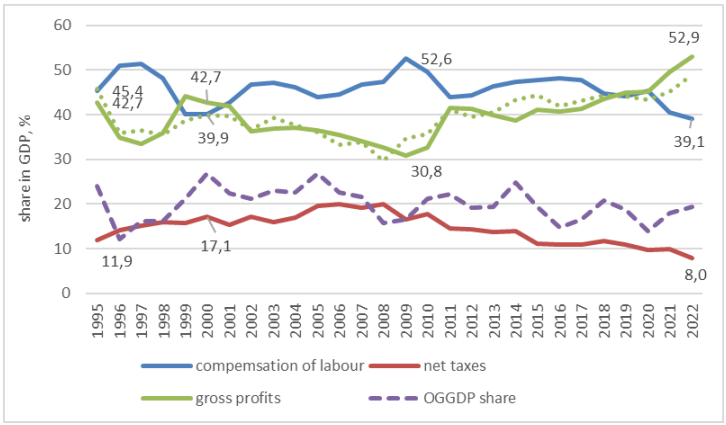


Source: Authors based on data from Indices (ranepa.ru)

Economic growth has already slowed down. Reduced competition and the transition to a purely extensive resources-based model, along with a decrease in, or stagnation of, the efficiency of the main production factors use have caused Russia's GDP growth rates drop 7-10 times: from 6.5% in 2000-2008 to 0.9% in 2008-2022 (or even to 0.6-0.7%, if you don't believe the latest 'revised' figures from Rosstat). Trust in Rosstat's data on GDP evolution is declining.[73] Rosstat has become a "source" of additional economic growth: by revising the data it has added at least 2.7% to GDP since 2018.

Standard of living 'frozen' for 10 years. The first set of proportions for the analysis includes GDP distribution by income sources. Three sources are considered: (a) compensation of labour; (b) net taxes on production and import; (c) gross profit and gross mixed incomes. The evolution of the GDP structure by income sources in 1995-2022 is shown in Figure 4.5.

Figure 4.5 Evolution of GDP structure by income sources in 1995-2022



Dashed line shows approximation of gross profit share based on Equation (4.1).

Source: Authors based on Rosstat's data

[73] Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, A. Lunin, I. Govor. 2022b. Russia's carbon neutrality: pathways to 2060. CENEf-XXI. https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060

Redistribution of income in favour of labor and net taxes in 2000-2009 was accompanied by dynamic economic growth. The post-2009 reverse redistribution of income in favour of large capital was accompanied by economic stagnation. The 2000-2022 period should be split by two intervals. In 2000-2009 (a period of dynamic economic growth), the shares of labour and net taxes were growing, while the share of gross profit was declining. During the 1990s and 2009 crises, the share of gross profit was declining, while the share of labour was growing. The share of profit was also declining due to the increasing share of net taxes. Therefore, over these years, a more equal distribution of income due to the growing shares of labor and net taxes was not slowing down economic growth.

After 2009, the government's economic policy, aimed at the conservation of the raw materials-based model, had an important negative re-distributional effect: one fifth of the GDP was re-distributed in favour of the large companies. In 2009-2022, along with extremely slow economic growth, the share of labor in GDP decreased by substantial 13.5%; the share of net taxes also dropped from 16.6 to 8%. This helped to increase the share of gross profit by 22.1%. In other words, one fifth of total GDP was re-distributed in favour of large businesses (primarily fuels extraction and processing and basic materials production). Important factors that determined growth in the share of gross profit in GDP ($Shprof$) included the share of oil-and-gas GDP ($Shoggdp$), which is characterized by a very high share of gross profit, and net taxes ($Shnettax$):

$$Shprof = 49.6 - 1.456 * Shnettax + 0.565 * Shoggdp \quad (4.1)$$

(15.512) (-8.455) (3.682) *t*-statistics

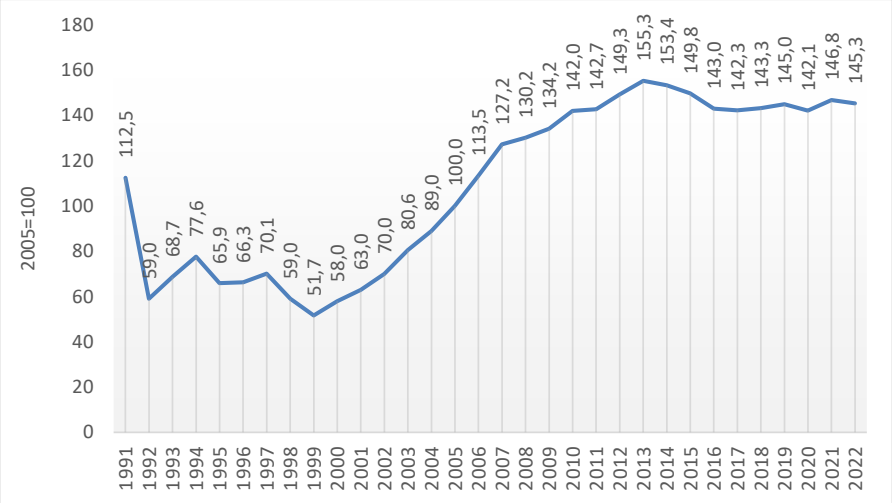
R^2= 0.86; F=35.9

Each percent change in the share of oil-and-gas GDP causes the share of profit to change by nearly 0.6%; and each percent of reduction in the share of taxes causes it to grow by almost 1.5%. From 2000 onwards, the share of oil-and-gas GDP has been eventually declining; this should have caused the share of gross profit in GDP to decline too. However, this did not happen. Changes introduced to the government's tax policy helped to not just maintain, but substantially increase the share of gross profit. The dynamics of the share of gross profit changed noticeably during the years of crises: in the crises of 2015 and 2022, this share did not decline, but grew due to noticeable reductions in tax pressure on business (2.8% in 2015 and 2% in 2022).

The roll-back on market reforms coupled with the conservation of the resources-based economic development stopped the growth in people's real disposable incomes: in 2022, they were 3% below the 2012 level. This result was obtained despite the regular upward revisions of statistical data by Rosstat.[74] If it were not for such revisions, real disposable incomes in 2022 were 3% below the 2010 level. Compensation of employees amounts to some 80% (ranging between 76 and 86% in 1995-2022) of gross household disposable incomes. Therefore, the declining share of labor in GDP, coupled with slow economic growth, had a substantial impact on the evolution of real disposable incomes (Figure 4.6). In 1995-2022, gross profit and gross mixed income contributed 13-22% to real disposable incomes. The change in these components and in the net income from property balance did not allow it to stop the trend towards stagnation of real incomes and avoid the loss of more than 10 years in the growth of the well-being of Russians.

[74] https://view.officeapps.live.com/op/view.aspx?src=https%3A%2F%2Frosstat.gov.ru%2Fstorage%2Fmediabank%2FKomment_doh_2021.docx&wdOrigin=BROWSELINK

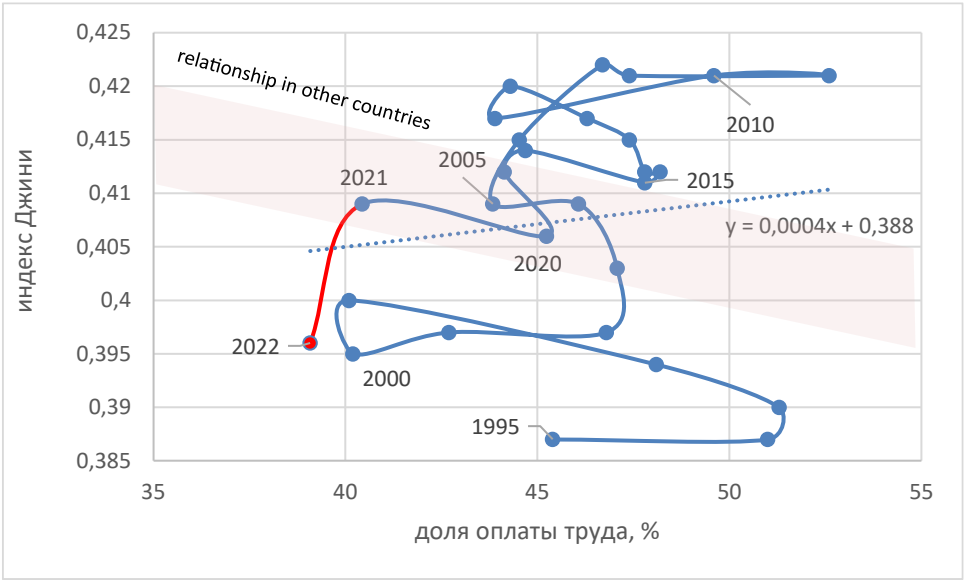
Figure 4.6 Evolution of real disposable income: 1991-2022



Source: authors based on Rosstat's data

The key indicator of the uneven distribution of people's incomes is the Gini coefficient. The lower it is, the more evenly incomes are distributed across quantiles and deciles. Figure 4.7 shows the relationship between the Gini coefficient dynamics and the share of labor compensation in GDP. Since wages are the key income of low-income groups, while profit is the key income for the richest, it is safe to say that the higher the share of labor, the lower should be the Gini coefficient. In Russia, the curve in Figure 4.7 followed this logic only during certain periods. However, in general, the trend slope over 1995-2022 shows an illogical sign. Particularly interesting is a 3% decrease in the Gini coefficient (based on Rosstat's data) for 2022 along a decline in the share of labor and real disposable incomes.

Figure 4.7 Gini coefficient as a function of labor share in GDP: Russia, 1995-2022

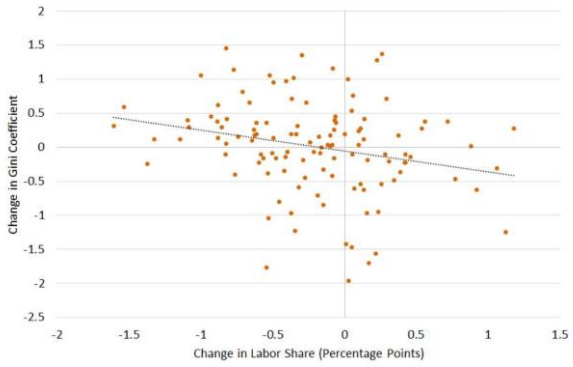


Source: authors based on Rosstat's data

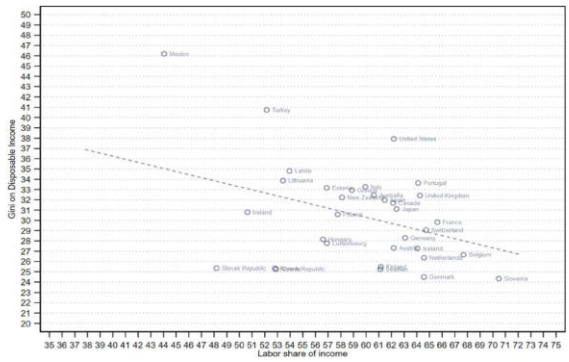
Rosstat's data on the Gini coefficient dynamics conflict the economic logic and the foreign experience,[75] (Figure 4.8)**, so cannot be viewed as reliable and therefore can hardly be taken as a basis for income inequality analysis in Russia.** It appears that following a 10.5 percentage points decrease in the share of labor (20.5%) in Russia in 2010-2022, a significant progress was made towards tackling the income inequality: the Gini coefficient decreased from 0.421 to 0.396 (by 6%). Analysis of the available scientific literature shows the opposite, while a regression analysis for 62 foreign countries (both developed and developing) has shown, that:

- Low share of labor in GDP correlates with higher Gini coefficient: where the share of labor drops by 1 percentage point, the Gini coefficient grows by 0.36%,[76] because a lower share of labor:
  - is reflected through lower incomes of two lowest quantiles;
  - is weaklier related to the shares of labor for the third and fourth quantiles;
  - is reflected through a higher share of income for the highest, fifth, quantile;
- The lower the quantile, the stronger the relation between the share of labor and the share of income for this quantile.[77]

Figure 4.8 Dependence of Gini coefficient on labor share in GDP for other countries



a)



b) trend slope is -0.297

Sources: a) How Income Inequality Is Affected by Labor Share (stlouisfed.org); b) Bises B., F. Bloise, A. Sciala. Labor share as an "automatic stabilizer" of income inequality. Accepted: 30 April 2023. International Tax and Public Finance. https://doi.org/10.1007/s10797-023-09782-0 Labor share as an "automatic stabilizer" of income inequality | International Tax and Public Finance (springer.com)

[75] See literature review in Erauskin I. The labor share and income inequality: some empirical evidence for the period 1990-2015. Deusto Business School, University of Deusto, Pº Mundaiz Donostia-San Sebastián, Spain. Applied Economic Analysis. Vol. 28 No. 84, 2020. pp. 173-195. Emerald Publishing Limited. 2632-7627. DOI 10.1108/AEA-04-2020-0028; EM-AEAJ200014 173..195 (emerald.com) How Income Inequality Is Affected by Labor Share (stlouisfed.org); Bises B., F. Bloise, A. Sciala. Labor share as an "automatic stabilizer" of income inequality. Accepted: 30 April 2023. International Tax and Public Finance. https://doi.org/10.1007/s10797-023-09782-0 Labor share as an "automatic stabilizer" of income inequality | International Tax and Public Finance (springer.com) Ng A., T.T. Theng and T. Z. Gen. WHAT EXPLAINS THE INCREASE IN THE LABOR INCOME SHARE IN MALAYSIA? ADBI Working Paper Series. No. 894 Asian Development Bank Institute. November 2018 https://www.adb.org/sites/default/files/publication/469216/adbi-wp894.pdf

[76] By 0.3%, according to Bises B., F. Bloise, A. Sciala. Labor share as an "automatic stabilizer" of income inequality. Accepted: 30 April 2023. International Tax and Public Finance. https://doi.org/10.1007/s10797-023-09782-0 Labor share as an "automatic stabilizer" of income inequality | International Tax and Public Finance (springer.com)

[77] Erauskin I. The labor share and income inequality: some empirical evidence for the period 1990-2015. Deusto Business School, University of Deusto, Pº Mundaiz Donostia-San Sebastián, Spain. Applied Economic Analysis. Vol. 28 No. 84, 2020. pp. 173-195. Emerald Publishing Limited. 2632-7627. DOI 10.1108/AEA-04-2020-0028. EM-AEAJ200014 173.195 (emerald.com)

The richest 20% of Russians get nearly a half of the total income; of these, the highest-income 10% account for nearly 30% of the total income in the country. Rosstat has come up with a quite opposite result: following a decrease in the share of labor by 10.5 percentage points in 2010-2022 the Gini coefficient was not 4% up, but dropped by 6%. At that, the share of the fifth quantile in the total income remained in the range of 47-48%. The funds ratio (i.e. the ratio of incomes of the top 10% and bottom 10% of the population) was up from 13.9 in 2000 to 16.6 in 2010, and then declined to 15.2 in 2021 and dropped to 13.8 in 2022. The decile coefficient (it shows how many times the incomes of 10% of the richest population exceed the incomes of 10% of the poorest population) also dropped from 7 in 2021 to 6.5 in 2022. With a growing share of gross profit in GDP such evolution cannot be explained. According to Rosstat, the share of income from business activities in household incomes was up from 5.7% in 2021 to 6.2% in 2022, while incomes from property declined from 5.7 to 5%. In other words, the sum of these two indicators remained almost unchanged during those years – 11.4 and 11.2% – and was above the values for 2017-2020.

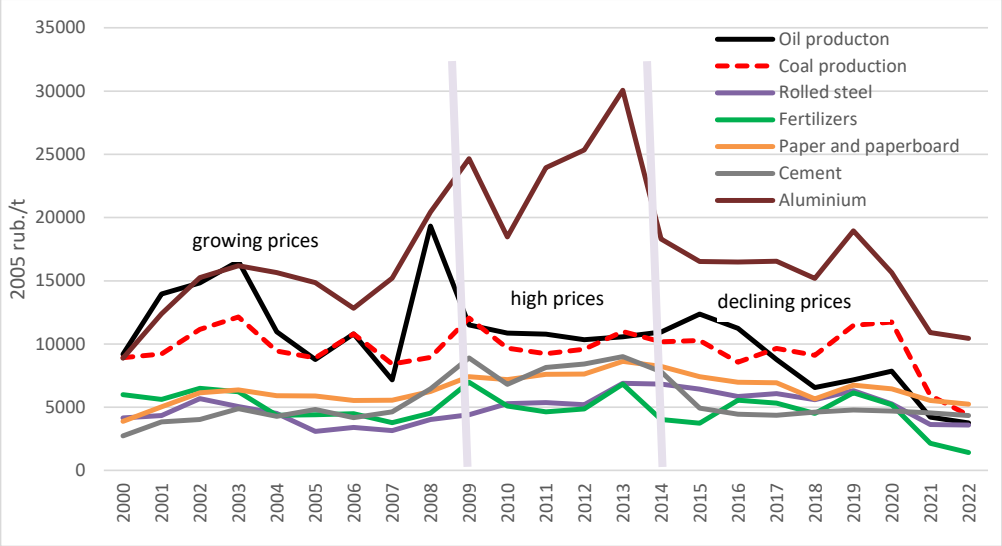
Based on the statistics for 19 countries, the share of profit in GDP shows a strong positive correlation with the share of income of the richest 1% of population and also shows a positive correlation with the Gini coefficient (the regression coefficient, depending on the model specification, is 0.2-0.4).[78] According to this logic, post-2009 substantial increase in the share of gross profit in Russia's GDP (Figure 4.5) should have caused the Gini coefficient to increase, rather than to drop.

The stratification of the Russian society by the level of wealth – resulting from the oligarchic, raw materials-based development – substantially aggravated after 2009, whereas the share of incomes of the richest 1% in the total income increased 1.5-2-fold. These incomes and wealth are mostly concentrated in the hands of the owners of fuel and basic materials companies. Rosstat does not provide information on the share of incomes of top 1% of the population. In other countries, each percent of growth in the share of profit in GDP causes the share of incomes of the top 1% of population to grow by 0.5-1.5%.[79] According to this logic, where the share of gross profit in GDP grows 1.7-fold and with an assumption that the share of the top 1% of population in Russia's total incomes was 10% in 2009, this share should have increased by 2022 to 15-20%. With such dynamics there is not a chance that the Gini coefficient could decrease. Russia stands 5th among the countries with the largest number of dollar billionaires (about 100). As of February 23, 2022, the 23 richest Russian billionaires (included in the list of 500 richest people in the world) had a combined net capital of USD 339 billion. 500 'super-rich' Russians account for 40% of the entire national wealth, including USD 640 billion in financial assets. The wealthiest Russians have accumulated a share of national wealth, which is 4 times the world average.[80] The owners of fuel and raw materials companies are on the top of the list.[81]

12-70% drop in real energy prices over 2014-2022 for a variety of industrial products did not allow it to accelerate economic growth, but slowed down or stopped energy efficiency improvements. Practically no analysis of the impact of energy price dynamics on the efficiency of energy use has been made in Russia. This impact can be estimated by comparing energy prices with the prices for manufactured products. Below these real energy prices are estimated for industry (Figure 4.9).

[78] Bengtsson E. and D. Waldenström. Capital Shares and Income inequality: Evidence from the Long Run IZA DP No. 9581 December 2015. Capital Shares and Income inequality: Evidence from the Long Run (iza.org)
[79] Ibid.
[80] Billionaires in Russia (tadviser.ru)
[81] List of Russia's richest businessmen (2021) — wikipedia.org

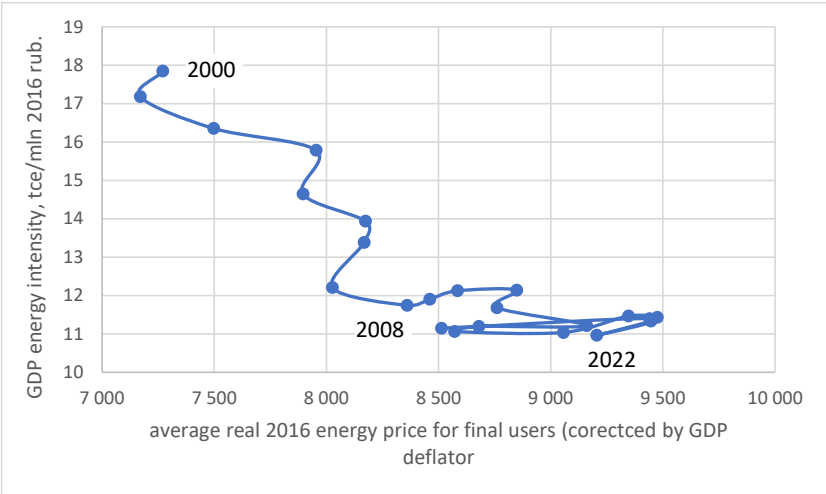
Figure 4.9 Evolution of real energy prices for individual products



Source: estimated by CENEf-XXI

The growth in real energy prices led to energy efficiency improvements and accelerated, rather than slowed down, the economic growth, and vice versa. The sampling in Figure 4.9 is divided into three parts: 2000-2008 – a period of growing relative energy prices, rapidly declining energy intensity and fast economic growth; 2008-2014 – a period of relatively high prices, slowly declining energy intensity and moderate rates of economic growth; and 2015-2022 – a period of declining prices with energy intensity and economic stagnation. By adjusting the average energy price across all end-use sectors by the GDP deflator one can evaluate the real energy price for all consumers (Figure 4.10). Its growth in 2000-2008 was accompanied by GDP energy intensity reduction and dynamic GDP growth, but subsequent stabilization of energy prices at around 8,500-9,500 rubles/tce and the roll-back on competition did not provide any incentives for both energy intensity reduction and GDP growth.

Figure 4.10 GDP energy intensity as a function of average real energy price

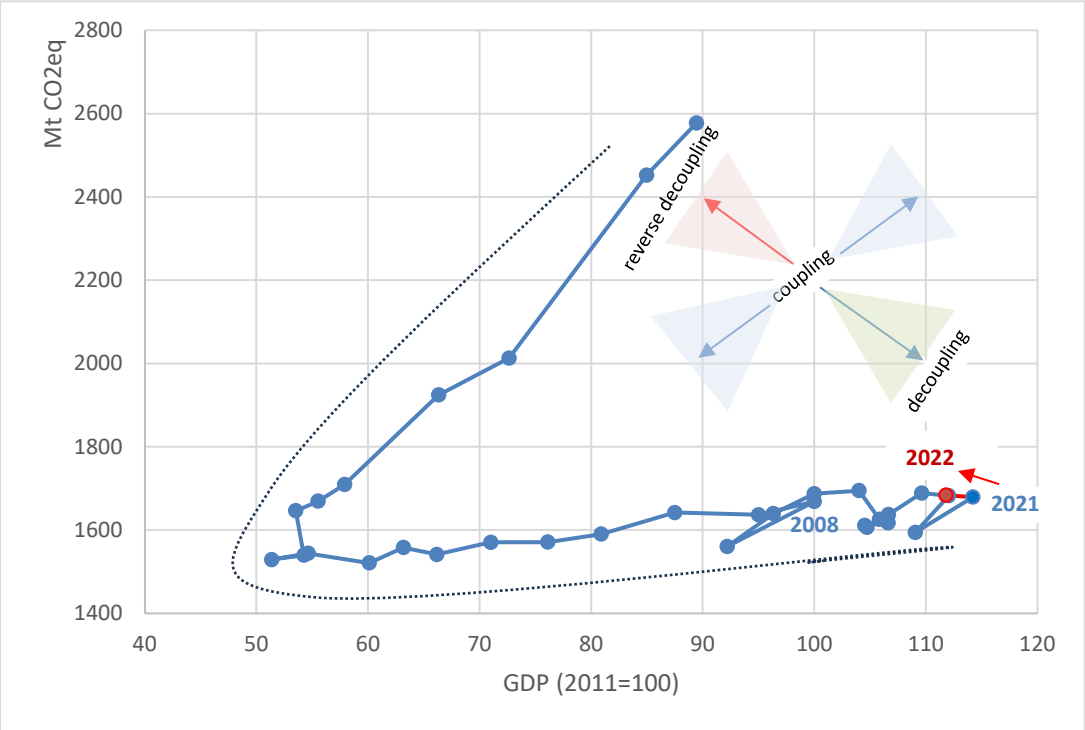


Source: estimated by authors

The trends that emerged after 2008 first led to supercoupling (i.e. a nearly complete coincidence in 2008-2021 of the evolution of GHG emissions and GDP) and then 'reverse

decoupling' in 2022 (i.e. GHG emissions growth against the background of GDP decline), see Figure 4.11. The strong 'coupling' in the 1990s gave way to a very weak one in 1998-2008. In 1997, 2000, 2002, 2007, 2013-2014, 2016, and 2019, decoupling was observed. Energy-related GHG emissions are estimated to have increased by 1% in 2022, despite a 2.1% decline in GDP. For the first time since 1990, energy-related GHG emissions were up, while GDP was down.

Figure 4.11 Energy related GHG emissions and GDP in 1991-2022



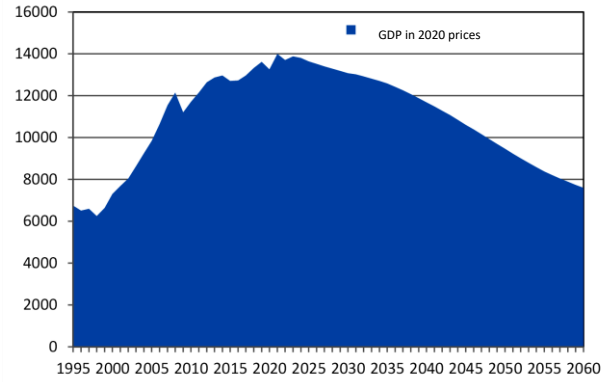
Sources: the authors based on data from Rosstat (GDP), National Inventory Report for 1990-2021, and authors' estimates of 2022 GHG emissions

5 Decarbonization: impacts on producers' incomes distribution

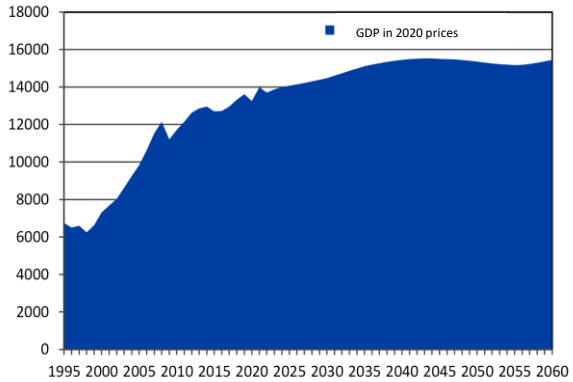
5.1 Macroeconomic effects

Transition to low carbon development will ensure Russia's economic growth, whereas conservation of the resource-based model will halve GDP in the worst case or cut it by 7-26% in the best scenario. If TFP in the non-oil-and-gas (NOG) sector stays at the average 2010-2022 value -1.2%, then Russia's GDP in 2060 will be 46% down (Figure 5.1), its oil-and-gas component will decline by 55% and NOG component by 44%. Maintaining the resource-based model coupled with a decrease in fuels and basic materials export revenues (which are an important source of investments), lack of competition in the NOG sector dominated by state corporations and so lack of incentives for innovative upgrades to the accumulated capital stock represent a 'negative economic growth' (*degrowth*), which causes Russian GDP to nearly halve. If TFP remains at -1.2%, there is no chance of maintaining positive GDP growth due to the shortage of labour and capital, which are key for extensive growth. In this case, GDP will be steadily declining – the "shagreen skin economy"[82] (Figure 5.1). This sad evolution is the background for estimating the effects of the low carbon transition.

Figure 5.1 Evolution of GDP



Raw materials-based model, TFP=1.2%



Low carbon transition, TFP=0.4%

Source: estimated by the authors.

If TFP is increased to 0,[83] then GDP reduction on the 2060 horizon will be limited to 2-10% (see Chapter 2). In the *4D* scenario, an assumption is made that the sanctions will be laxed and Russia will regain some of the lost positions in global value chains; active low carbon policies will help to retain and expand these positions; democratization will bring more competition to the economy and reduce the role of state; the need to increase low carbon output will accelerate the phase-out of dated production capacities and the modernization of the remaining capacities along with the uptake of new capacities based on the best available technologies; restrictions on high-tech imports will be laxed and Russia will regain access to international financing; low carbon footprint requirement to products and services will give momentum to energy and material efficiency improvement. All this will work to increase total factor productivity to 0.4%. In this case, in 2060, GDP will be 2-10% above the 2021 level (see Chapter 2 and Figure 5.1). It is very

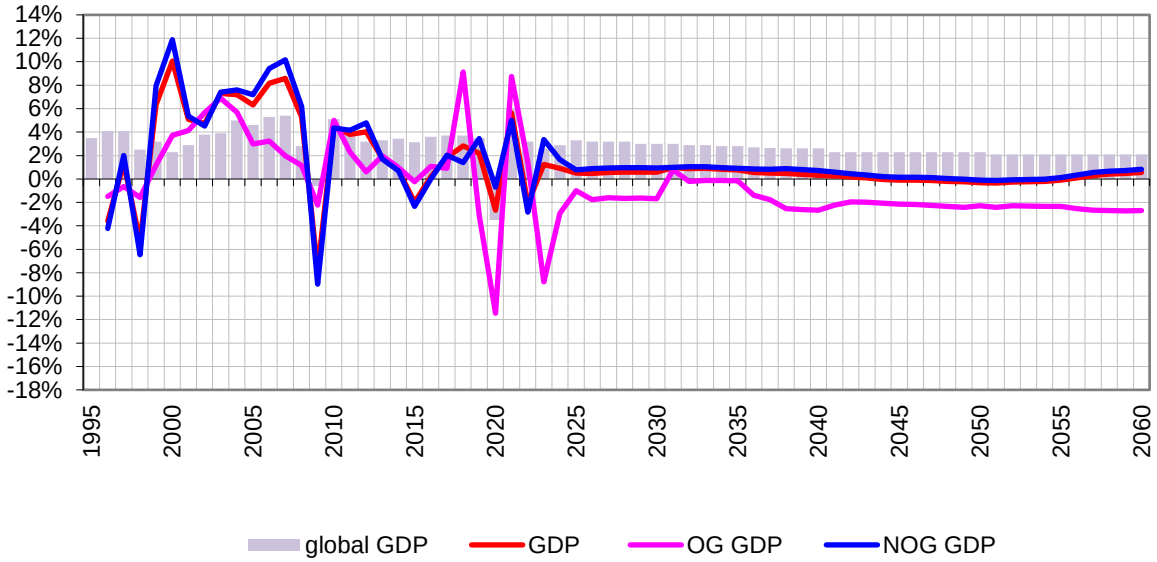
[82] Bashmakov I. Will there be economic growth in Russia in mid-21 century? *Issues of economy*. 2011;(3):20-39. https://doi.org/10.32609/0042-8736-2011-3-20-39.

[83] TFP depends on the openness of trade, the quality of institutes, macroeconomic stability, the quality of infrastructure, education, demographic parameters and investment trends. 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; 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; 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://mpra.ub.uni-muenchen.de/20127/ MPRA Paper No. 20127.

likely that in the coming decades, total factor productivity (TFP) in the NOG sector in Russia will be below, or around, zero, and there is no reason to believe that TFP in Russia will exceed 0.8%.[84]

Low carbon transition allows to keep GDP and NOG-GDP growing, except for a few years with a particularly severe labour shortage. The rates of change in the oil-and-gas GDP are negative nearly on the whole interval (Figure 5.2). This determines the fact that NOG-GDP growth outpaces GDP growth.

Figure 5.2 GDP and GDP components growth rates



Source: estimated by authors.

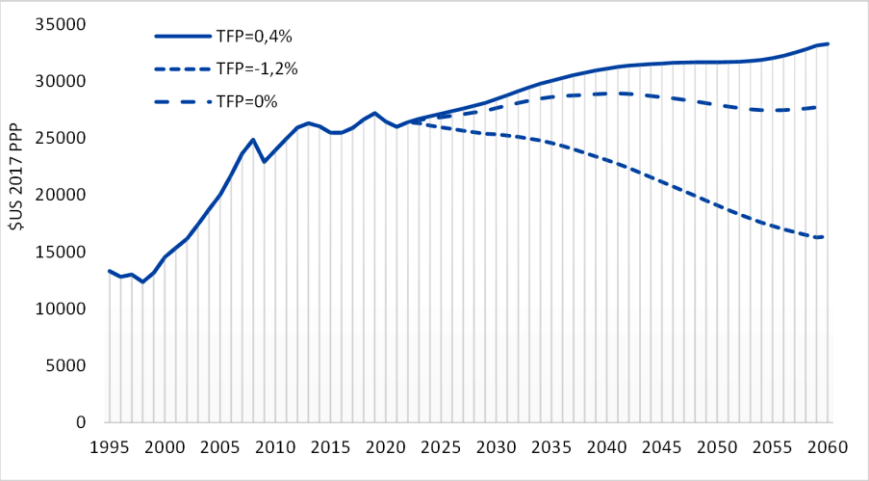
Where productivity growth and cost optimization are ignored by decision-makers, poverty comes. If Russia continues to rely on the resource-based economic model and fails to lift its TFP up from presently negative values, then its GDP per capita will be sliding down, and with -1.2% TFP in the NOG sector in 2060 GDP per capita will be back to the 2002 level (Figure 5.3), whereas personal consumption per capita will be back to the 2006 level (Figure 5.4). If TFP is up to at least zero (1995-2022 average), then GDP per capita in Russia could remain practically unchanged over the next four decades. In this case in 2060 GDP per capita will be 65% below the global average, 82-90% below the values expected in the developed countries, 70% lower than in China, and 38% lower than in India. In fact, this parameter in Russia will be close to that in Ghana or Ethiopia. On this pathway, Russia will likely lose the status of a developed country.[85] Personal consumption per capita in this case will be only 7.5% above the 2021 level. In this scenario, "Russia's economic power will continue to lag behind its sovereign claims".[86]

[84] Bashmakov I.A. Russia's foreign trade, economic growth and decarbonization. Long-term vision. Moscow, April 2023. https://cenef-xxi.ru/uploads/Policy_paper_0b89e06980.pdf.

[85] Ibid.

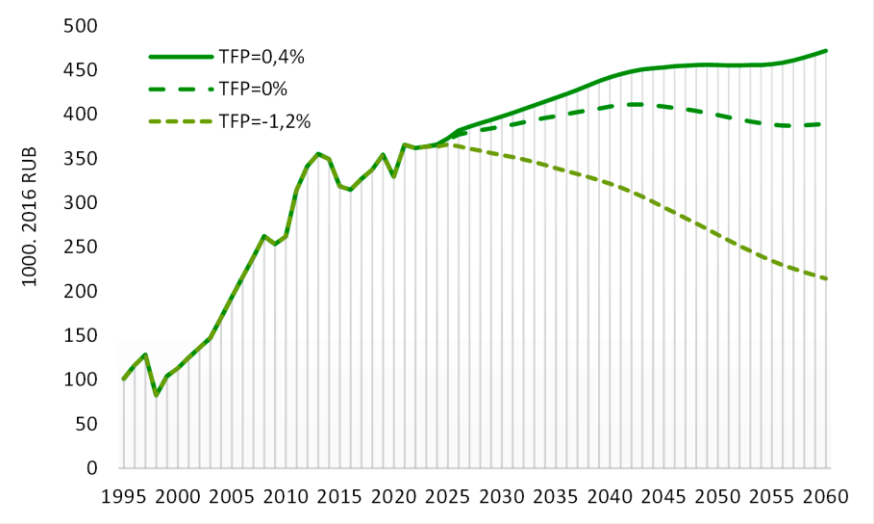
[86] V. Chernega. What will Russia's foreign policy be like in 2023? Russia in the global policy. 01.12.2019. What will Russia's foreign policy be like in 2023? — Russia in the global policy (globalaffairs.ru).

Figure 5.3 Evolution of GDP per capita



Source: estimated by the author.

Figure 5.4 Evolution of personal consumption per capita



Source: estimated by the author.

GDP per capita and personal consumption growth is only attainable by bringing TFP up to values close to, or above, 0.4% through low carbon transition based on the best available technologies uptake, incentivizing democratization and strong competition, in other words, on the pathway outlined in the *4D scenario (Development Driven by Decarbonization and Democratization)*, which involves the improvement of the institutes and business climate; open trade; return to the global economy; improved infrastructure; enhancement of skills and the ability to use them. Nearly all of the innovative energy, industrial, transport, and agricultural technologies developed in the recent years are low carbon.[87] Therefore, modernization and decarbonization have practically become synonyms. Generation of technological innovations which are important for effective import substitution, transition to the creative economy require relevant social environment, including respect for human rights and freedoms, freedom of speech, protection of property rights, and the presence of effective markets and regulations. All this ensures a possibility

[87] Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, O. Lebedev, A. Lunin, A. Myshak. 2023. Low carbon technologies in Russia: current status and perspectives. Technology_gap_b0cf666d23.pdf (cenef-xxi.ru).

to express one's opinion and to be heard, allows creative thinking to take precedence among production factors, such as land, labour, and capital.[88]

5.2 Oil-and-gas and non-oil-and-gas (NOG) GDP

One key long-term challenge for Russia is the multiple erosion of its oil-and-gas rent, which has been a pillar for the Russian economy over the last quarter of a century (Figure 5.5 and Table 5.1). In oil exporting countries, oil-and-gas revenues are the key driver behind the "imported growth" development pattern,[89] which occasionally turns into an "imported crises" pattern.[90] Classical economic development schemes are being significantly modified: the oil-and-gas sector is largely replacing the manufacturing sector by allowing for import of equipment, consumer and intermediate goods.[91] Therefore, it is important to split GDP, budget revenues, and export revenues into oil-and-gas and non-oil-and-gas components.[92] As long as Russia relies on its hydrocarbons exports, the parameters of the country's economic growth are determined beyond its borders and depend on oil and gas export revenues, which are volatile "windfall profits", rather than reliable "money earned at home".[93] These abundant revenues do not incentivize the economic diversification, nor do they promote competition, localization of production, or modernization. Over the past years, Russia has failed to use the oil-and-gas revenues to diversify its economy and create new drivers for economic growth.

Table 5.1 Evolution of the oil-and-gas sector role (%)

Proportion of oil-and-gas sector in:	2022	2030	2060
GDP	19.4	14.6	4.4
Consolidated budget	21.8	16.4	5.1
Exports	58.1	38.8	9.0
Investments	17.0	15.8	12.3

Source: estimated by the author.

Factor one fourth. By 2060, the share of oil-and-gas revenues in GDP and in consolidated and federal budget revenues will drop 4-fold. Their proportion in the federal budget (44-46%) is twice higher, than in the consolidated budget (20%). If the inter-budgetary revenue distribution scheme remains as is, this proportion in the federal budget will go down to some 10%. In 2022, oil and gas budget revenues were constituted 39% to the OG GDP. Part of this amount – 2.16 trillion rubles – returned to the oil companies as liquid fuel subsidies (damper payments). As a result, the net tax pressure went down to 32% of the OG GDP. New tax benefits were adopted for new oil fields with hard-to-recover reserves and depleted fields to stimulate oil production (production at depleted oil fields is about 140 million tons per year[94]). However, the Ministry of Finance insists that this new taxation scheme be postponed from 2024 to 2027. Along with a

[88] Howkins, J. (2022). ReThinking the Creative Economy. *Academia Letters,* Article 5870.ps://doi.org/10.20935/AL5870.

[89] Kudrin A., Gurvich E. (2014). A new growth model for the Russian economy. *Issues of Economy,* No. 12, pp. 4-36. (In Russian).

[90] Following this model, Russia had to face three painful crises (1998, 2009, and 2015–2016) and lost 17% of GDP in all, i. e. nearly 1% per year. Bashmakov I.A. Global energy: myths of the past and lessons of the future. *Issues of Economy*. 2018;(4):49-75. https://doi.org/10.32609/0042-8736-2018-4-49-75 (In Russian).

[91] Bashmakov I.A. Russia's foreign trade, economic growth and decarbonization. Long-term vision. Moscow, April 2023. https://cenef-xxi.ru/uploads/Policy_paper_0b89e06980.pdf.

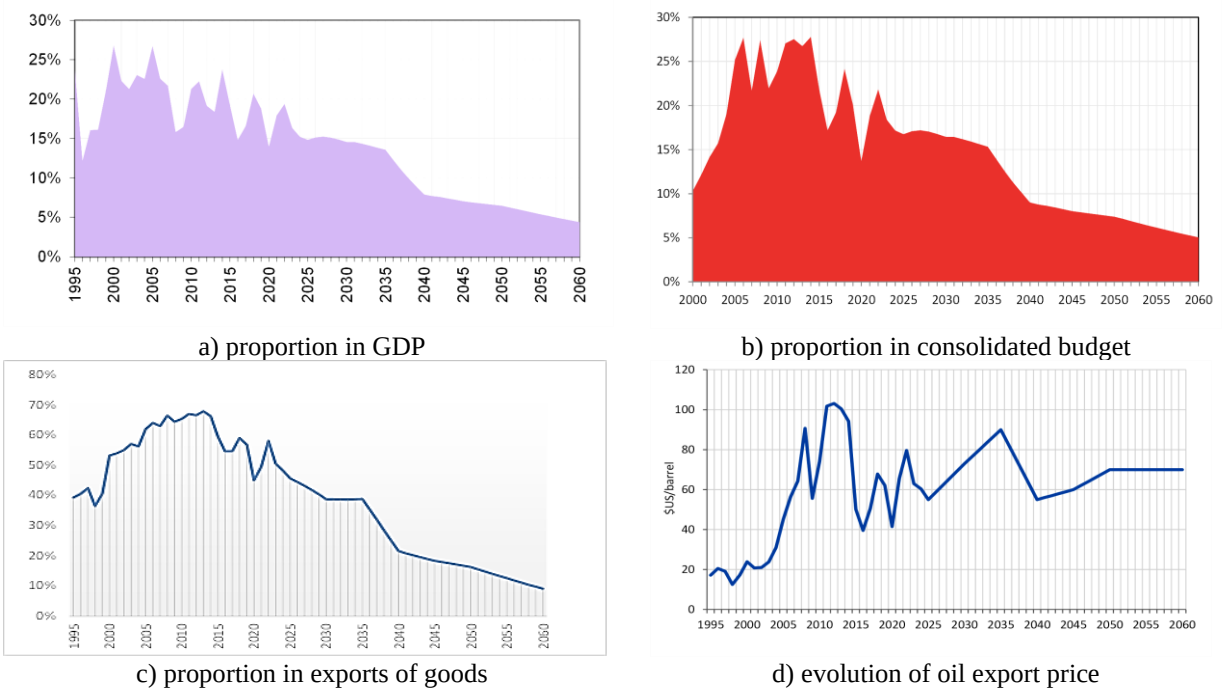
[92] Bashmakov I. The specificity of expanded reproduction in oil producing economies. // Global economy and international relations. 1983. No. 4. (In Russian).

[93] Bashmakov I. Non-oil-and-gas GDP as an indicator of the evolution of the Russian economy. *Issues of Economy.* 2006;(5):78-86. https://doi.org/10.32609/0042-8736-2006-5-78-86.

[94] Kommersant: Ministry of Finance proposed to delay the introduction of tax benefits for depleted deposits (tass.ru).

modest success in import substitution for hard-to-recover oil and gas technologies, this would limit the ability to maintain production at a high levels.

Figure 5.5 Evolution of the oil-and-gas sector's role in economy



a) proportion in GDP

b) proportion in consolidated budget

c) proportion in exports of goods

d) evolution of oil export price

Source: estimated by the author.

The share of the oil-and-gas revenues may be declining unevenly because of the volatile dynamics of oil and gas export prices (Figure 5.5). In the short term, this share will be largely determined by decreasing exports of oil and petroleum products due to the sanctions, including restrictions on equipment imports for oil production and petroleum products delivery, and low localization level for this equipment. In a longer term, it will be determined by the global low carbon transition.

The government will be trying to increase the tax pressure on the oil-and-gas sector, but in the fall of 2023, the oil business won the battle for the damper against the government. Reducing by half of the damper in September 2023 due to a deficit of the government's revenues resulted in a fuel crisis and gasoline and diesel fuel price hikes. This is one example of how reliance on oil and gas for development generates negative re-distribution effects. The damper is 31-33 thousand rubles per ton of gasoline or diesel fuel and depends on the export price ensuring equal profitability of fuel supply to the domestic and international markets.[95] The drop in the value of the ruble from about 30 rubles/USD in 2004-2013 to 60-74 rubles/USD in 2014-2022 caused the gasoline price to double. If the ruble continues to fall to 100-120 rubles/USD, and the damper payments go down, the gasoline price will be another 25-50% up. Then the question is, how will consumers pay to the oil companies: directly through higher prices or indirectly through the federal budget. From October 1, 2023, the damper payments were reinstated in full. Nevertheless, fuel prices have grown up and are unlikely to go down to the summer 2023 levels.

Redrawing the economic landscape in favour of the non-oil-and-gas sector will meet with fierce resistance from the oil-and-gas business, but will inevitably entail redrawing of the

[95] Tired of argument. Kommersant. 13.10.2023.

country's governance.[96] The balance between the power and role of the oil-and-gas elites and other businesses will change dramatically. While the oil-and-gas business has formal lobbying instruments (such as RSPP or professional associations), it tends to use mostly informal tools, because in Russia "political actors are stronger, than political institutes", and public administration in the fuel and energy sector, as well as informal political connections, were formed based on the power of these actors.[97] Examples include: targeted tax incentives for oil-and-gas companies; giving priority to the state-owned companies when it comes to the distribution of large deposits; giving priority to the Russian over foreign companies; using tough administrative pressure on obstinate companies, etc.[98] However, significantly reduced contribution from the oil-and-gas companies to GDP, government revenues, and the foreign trade balance will work to dilute the lobbying potential of oil-and-gas oligarchs.

The non-oil-and-gas business is much more diversified, than the oil-and-gas business, therefore, its growth will definitely be associated with the development of democratic institutions and competition – both political and economic. Otherwise, it will be impossible to increase TFP and the economy will be stagnating or shrinking (Figure 5.3). 2022 experience showed, that companies operating in a strongly competitive environment managed to adapt to the sanctions-caused shock faster.[99] Government non-oil-and-gas revenues in 2022 were 35% of NOG GDP. In other words, contrary to the widespread belief, tax pressure on the non-oil-and-gas sector was not lower, but higher than in the oil-and-gas sector. This means that the non-oil-and-gas sector is capable of generating revenues. The sources of these revenues are distributed across all sectors, in contrast to today's oil-and-gas revenues, which are concentrated in just one sector and work to support the centralized power and the illusion that it is independent from business. The non-oil-and-gas business is sure to strengthen its role in the national governance despite the desperate resistance of the government machine and oil-and-gas oligarchs. This struggle may give rise to political conflicts due to the "government's unwillingness to channel away the dissent within the system (by laxing the elections, demonstrations and meetings legislation, etc.)[100] However, reforms will have to be carried out anyway, since they will become a prerequisite for Russia's survival as a state in the competition with the giants, such as the U.S., China, the European Union, and later India.[101]

The role of regions in the country's governance will significantly increase. Diversification of the income sources will make it impossible to maintain the current over-centralized system of inter-budget relations, which is based on the withdrawal and re-distribution of the oil-and-gas rent. The national government will lose the control levers and means, which are currently in the form of budget subsidies, and so the centralization of power will be decreasing, while the role of the regional elites will be growing.

Fuel oligarchs are a powerful group which strongly oppose low carbon transition in Russia by dictating the low level of ambition of its climate policy. Since they are unable to influence global decarbonization processes, they have to reduce the carbon footprint of their products and prove that Russian oil, gas, coal, metals, and other basic materials are the "greenest" in the world,

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[96] "Politbureau 2.1" and "New Cold War": the elites looking for a 'new oil'. Communication holding "Minchenko Consulting". July 2021. (In Russian). «Политбюро 2.0» и «Новая холодная война»: элиты в поисках «новой нефти» (minchenko.ru).

[97] Schved A.I. Political interplay of the Russian executive authorities and oil-and-gas businesses in 2004-2012. Specialization 23.00.02 – Political institutes, processes, and technologies. PhD dissertation (Political science). Moscow. 2014.

[98] Ibid.

[99] Kuzyk M.G. and Yu.V. Simachev. Adaptation strategies of the Russian companies to the 2022 sanctions. NEA Journal, No. 3 (60), 2023, pp. 172–180.

[100] V. Chernega. What will Russia's foreign policy be like in 2023? Russia in the global policy. 01.12.2019. What will Russia's foreign policy be like in 2023? — Russia in the global policy (globalaffairs.ru).

[101] Ibid; and Bashmakov I.A. Russia's foreign trade, economic growth and decarbonization. Long-term vision. Moscow, April 2023. https://cenef-xxi.ru/uploads/Policy_paper_0b89e06980.pdf.

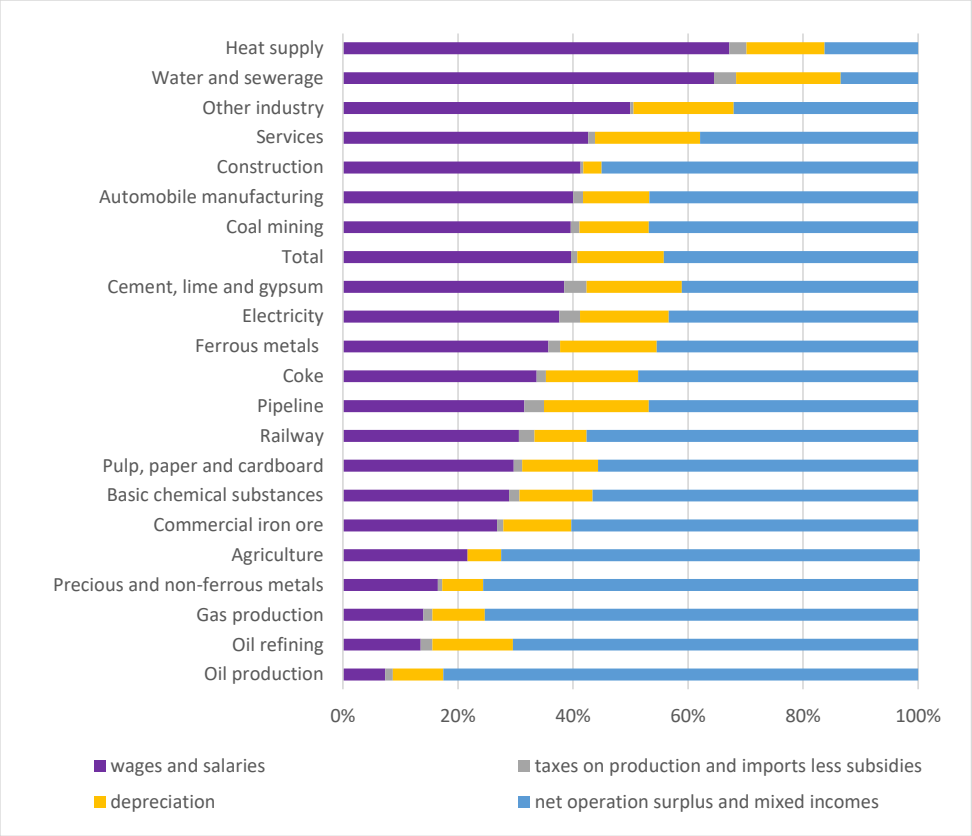
if they want to maintain the shrinking market niches. They are looking for new niches in the new markets, such as oil and gas chemistry and hydrogen markets (steam reforming and methane pyrolysis). They have the potential to become CCUS deployment champions. As the product niches in the international markets are being gradually lost, they are desperately fighting for domestic markets and trying to slow down the low carbon transition in Russia, including energy efficiency improvement and renewable energy development. Gas oligarchs are trying to oust coal businesses (gasification of the electricity and heat sectors) and oil companies (gasification of transport) from the domestic markets, whereas oil companies are trying to hinder the electrification processes in the transport sector. Both will be trying to compensate for their economic losses in the international markets by increasing domestic fuel prices[102] and at the same time they will be fiercely fighting for subsidies (damper), tax exemptions for fuel production in unfavourable geological conditions, and for niches in the petrochemistry markets. Unlike foreign oil-and-gas companies, Russian oil-and-gas businesses have virtually no ambition to diversify their activities by going beyond the sector. For example, Gasprom claims that its key directions of diversification are industrial production of hydrogen from natural gas, gas production from gas hydrates, and production of liquefied natural gas.[103] Such passive position in terms of diversification undermines the foundation of the long-term economic sustainability of Russian oil-and-gas companies.

Development along the oil-and-gas and basic-materials path has reduced the share of wages in GDP (see Chapter 4), **while transition to low carbon development will cause wages share in GDP to increase and the profit share to decline.** The most significant distributional effects are generated by structural shifts in the economy, which result from changes both in external factors (international demand for goods and services); "framework" policies, including moving towards, or away from, the market economy (see Chapter 3); changes in the domestic technological base, etc. The lowest proportion of wages in Russia is in oil and gas production and processing and in energy intensive and carbon intensive industries (Figure 5.6). Therefore, a decline in oil and gas production will lead to a decrease in the share of profit, an increase in the share of wages, and thereby will make the distribution of incomes across deciles more even (see Chapter 2).

[102] According to the Forecast of Russia's social and economic development in 2024 and over 2025 and 2026, "in order to ensure reliable natural gas supply to all consumer categories and to continue with social gasification programs and with the connection of new consumers to the gas grid, wholesale gas prices for all consumer categories will be 11.2% up in 2024 and 8.2% up in 2025. prognoz_socialno_ekonomicheskogo_razvitiya_rf_2024-2026.pdf (economy.gov.ru).

[103] Simonov K.V., Buriachenko A.O. The concept of multivector diversification of a Russian oil-and-gas company: prerequisites, directions, and opportunities. Management Science. 2022;12(4):20-35. DOI: 10.26794/2304-022X-2022-12-4-20-35.

Figure 5.6 GDP income structure by sectors and energy-intense products in Russia in 2016

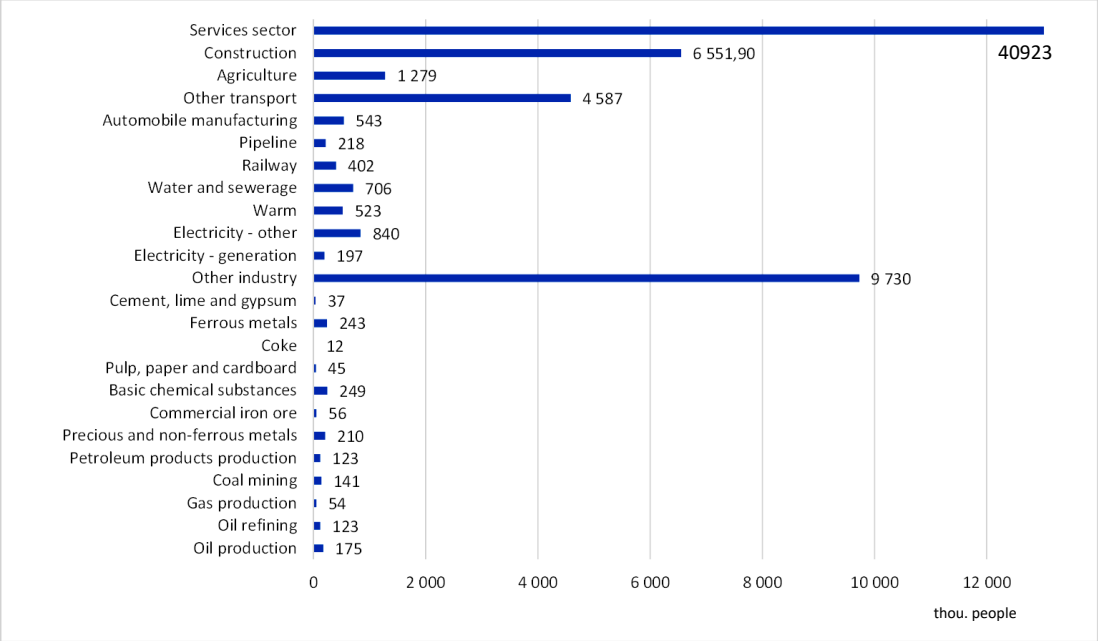


Source: estimated by the author based on Rosstat's data.

Given the persisting labour shortage and a limited number of people employed in oil and gas production and processing, a gradual decline in this sector output will have little impact on the labor market. In the 4D scenario, oil production will decline from 534 Mt in 2022 to 365 Mt in 2030 and to 184 Mt in 2060. A substantial part of oil goes for non-energy use. In 2022, 175 thousand people were employed in oil production (Figure 5.7). If labour productivity is frozen at the 2022 level, this number will be 55 thousand down in 2030 and 115 thousand down in 2060, or 0.16% of the total number of employees in 2022. The number of employees in this sector will be going down at a rate of 3% per year versus 0.5% per year reduction across the whole economy. Natural gas production will go down from 672 billion m^3 in 2022 to 657 billion m^3 in 2030 and to 434 billion m^3 in 2060. In 2022, 54 thousand people were employed in gas production. If labour productivity is kept at the 2022 level, this number will be 1,000 people down in 2030 and 19 thousand people down in 2060, or 0.03% of the total number of employees in 2022. The employment in the distribution of gaseous fuel through gas networks (151 thousand employees) may be affected to a larger extent. Domestic consumption of natural gas will not go down on the 2030 horizon, so in the mid-term the employment in the gas distribution sector will not be affected. However, on the 2060 horizon, network gas consumption may halve, and then the employment will go down too, yet the reduction in employment will not be geographically concentrated and will be distributed over time. Given the overall shortage of manpower, all this should not lead to any unemployment problems. Oil refinery will be up from 276 Mt in 2022 to 282 Mt in 2030 and then will drop to 151 Mt in 2060. In 2022, 123 thousand people were employed in oil refining. If labour productivity is frozen at the 2022 level, the employment in this sector will grow up in 2030, but in 2060 will be 56 thousand people down (0.08% of the total number of employees in 2022). Given that the average wage in the oil-and-gas sector is twice higher, than the national average, a decrease in employment by not more than 0.3% of the total 2022 number of employees will not

produce a significant impact on the distribution of wages. A gradual decline in employment along with the dominance of rotational work methods will not have a noticeable impact on the labour market.

Figure 5.7 Employment by sectors; in fuel extraction and manufacturing of carbon-intense products



Source: estimated by the author based on Rosstat's data.

5.3 Coal production

Decarbonization-driven decline in coal production will have little impact on the national economy, but will significantly affect the economy and employment of coal-mining regions and will require proactive decisions to diversify their economies. Coal sector contributes 0.4% to GDP. The balance of budget revenues and subsidies for coal consumers and for coal transport,[104] even if positive, does not make a large net contribution to the federal and consolidated budgets. A decline in coal production will have little effect on the income structure, because in the coal industry this structure is largely the same as the economy average (Figure 5.5). According to Rosstat, 125 thousand people were employed in coal production and processing in 2022 versus 143 thousand people as reported by the Ugol Journal.[105] Reduction in coal production will cause some of them to lose their jobs. In the 4D scenario, coal production will go down from 437 Mt in 2022 to 352 Mt in 2030 and to 90 Mt in 2060, due to the gasification of some regions, among other things. Reduced production and use of coal will have a great positive effect in terms of emission of pollutants and mortality reduction, yet will require that a solution be found in good time for social problems of coal monocities and regions with large reliance on coal, such as Kemerovskaya Oblast, where coal production is the dominant economic activity. If labour productivity is maintained at the 2022 level, then the employment will decrease by 24-28 thousand people in 2030, or by 0.04% of the total number of employees in 2022. In 2060, the decrease in the number of employees will be significant 99-114 thousand people. This sector will be suffering more than others from the decrease in the number of employees, and special policies will be required to shift part of the employees to low carbon production companies and to the service sector. However, this

[104] Korppoo, A. et al. (2021). The Russian Coal Sector in a Low-Carbon World: Prospects for a Coal Transition? Insights Report, Climate Strategies.
[105] Petrenko I.E. 2022 performance of coal industry in Russia. Ugol. March, 2023.

will not have a substantial impact on the total wages of all Russian employees. There are many options to diversify the economy of coal producing regions. It is important to timely launch regional programs to support the diversification of the economy of coal regions (primarily in Kuzbass) and programs to employ the released workers.[106]

5.4 Power and heat sector

During the low carbon transition, a substantial part of income will be re-distributed in favour of the low carbon generation and the power industry as a whole, thus (with moderate increase in labour productivity) forming additional labour demand. However, this will not strongly affect the income distribution structure, since in the power sector it is close to the economy average (Figure 5.6). In 2022, power generation was 1,167 billion kWh. In the 4D scenario, power generation will practically stay at the same level until 2030 and will grow up to 1,758 billion kWh by 2060. According to Rosstat, 667 thousand people were employed in power generation, transmission, and distribution in 2022, including 197 thousand people in generation, 375 thousand people in transmission and connection to the grid, 28 thousand people in distribution, and 67 thousand people in electricity sales. An increase in power generation, transmission, and distribution assuming fixed productivity will result in an increase in employment. A shift in the power generation structure from fuel-fired plants to hydro and nuclear plants and renewable energy will affect 197 thousand people engaged in the power generation. CENEf-XXI estimates, that specific employment per 1 kWh generated by hydro and nuclear plants is nearly twice higher, than the average value for thermal power plants, and even higher for renewable energy. Therefore, power generation forms additional labour demand. Even greater additional demand is formed in power transmission and distribution – 236 thousand people.

523 thousand people are employed in the centralized heat supply industry. In the 4D scenario, district heat production will stay close to the 2022 level (1,274 MGcal) until 2030 and will be down to 804 MGcal in 2060. If the productivity stays at the 2022 level, the number of employees will decline by 193 thousand people. This is less than the additional labour demand in the power sector, which can be covered by the workers released from heat supply, coal and oil-and-gas industries.

Institutions focusing on low carbon generation are gradually emerging in the power sector. The most powerful holdings are Rosatom and Rushydro. Associations of renewable energy producers (primarily RAWI, but also the Market Council, Russian Renewable Energy Development Association (RREDA), the Solar Energy Association, and hundreds of other companies) are noticeably strengthening and consolidating.[107]

5.5 Industry

Accelerated development of high-tech industries compared to basic materials industries will increase the share of wages in GDP and make the distribution of incomes across the whole economy more even. Industry (net of oil-and-gas sector) contributes 12-13% to gross value added, whereas energy intense sectors (iron and steel, building materials, pulp and paper, chemical products) only 4-5%. At the same time, the proportion of wages in the latter is much lower, than the economy average, while for other industries, including machinery and equipment manufacturing, it is substantially higher. Some 1 million people are employed in the energy intense industry. In the 4D scenario, production of base materials (steel, aluminium, cement, chemical and

[106] Korppoo, A. et al. (2021). The Russian Coal Sector in a Low-Carbon World: Prospects for a Coal Transition? Insights Report, Climate Strategies.
[107] https://sber.pro/publication/neischerpaemye-vozmozhnosti-karta-osnovnykh-igrokov-rynka-alternativnoi-energetiki-rossii

pulp and paper products) will grow, even if slowly, so no problems with be associated with employment. However, it will be important to substantially improve labour productivity.

Deployment of carbon pricing mechanisms is becoming critical to maintain and expand the market niches for Russian basic materials. Surveys of Russian companies show that the main drivers behind low carbon transition in Russia include foreign and domestic carbon regulations and the low carbon urge from customers, investors, shareholders, and financial institutions.The prices of CBAM products in the EU market are expected to grow for all suppliers, as the allocation of free quotas scales down. EU installation owners will pay for ETS quotas, and EU importers of CBAM products will pay for the certificates. As carbon prices grow, the demand for CBAM products in the EU market goes down driven by the negative price elasticity of demand. It is important to know relative (i. e. compared to the competitors), rather than absolute, increase in products prices due to the carbon fee, while erroneous estimates of CBAM-associated losses are based on absolute increase in price. The EU output can grow and carbon leakage can be prevented, providing CBAM-products manufactured in the EU, other things equal, are less carbon-intense, than those made by international competitors. Demand for product imports from individual countries may be driven down not only due to the shrinking demand in the EU, but also due to the increased supply from the low carbon competitors. As a result, market niches for imported goods get into the "low carbon vice".[109] Russian exporters do not lose their revenues, unless their products are more carbon-intense, than the goods supplied by the EU and other competitors. However, no big difference has been detected in the recent years.[110] If a tax-neutral carbon price for product exports is introduced in Russia, the exporters will not lose any of the EU or other markets.[111]

CBAM mechanisms could potentially result in additional revenues at the EU market (with a proactive low carbon policy in the Russian industrial sector) or in some 1.5 billion USD/year losses (with a passive policy). Such losses are only a third of what the Russian businesses have "naturally" lost from the 2022 sanctions. The Russian military operation and the resulting sanctions have closed the EU markets for some of the CBAM products (primarily for iron and steel products) for the coming years. Russian CBAM export revenues losses due to the EU sanctions could be estimated at 4.1-5.4 billion USD/year. This is more than a half of the Russian CBAM export revenues prior to 2022 and much above the losses that had been expected from CBAM.[112] With the most likely combination of factors, potential CBAM-associated losses of Russian businesses will not exceed USD 1-1.5 billion on the 2050 horizon. If Russia lags far behind the EU and other countries in low carbon transition in CBAM industries, then CBAM export revenues loss may amount to USD 5 billion to 2050 and become equal to the effect of the sanctions. At the same time, carbon neutrality transition in Russia coupled with the EU's passivity could deliver more than USD 8 billion/year in additional export revenues by 2050. If Russia and the EU are moving at the same pace, then Russia's export revenue loss may peak at 1 billion USD/year in the mid-2030s and halve by 2050; and the introduction of a tax-neutral carbon charge could even deliver additional export revenues.[113]

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[108] Dobroslavsky N. and D. Sesitsky. Decarbonization in incertainty: pathways and solutions by SKOLKOVO Moscow School of Management. 2022; 03062021.pdf (economy.gov.ru).

[109] Bashmakov I.A. CBAM and Russian export. Issues of Economy. 2022;(1):90-109. https://doi.org/10.32609/0042-8736-2022-1-90-109.

[110] Bashmakov I., M. Dzedzichek, A. Myshak, V. Bashmakov. Sanctions and CBAM: Implications for the Russian industry. CENEf-XXI. December 2022. New_CBAM_paper1_d679407855.pdf (cenef-xxi.ru).

[110] Bashmakov I.A. CBAM and Russian export. Issues of Economy. 2022;(1):90-109. https://doi.org/10.32609/0042-8736-2022-1-90-109.

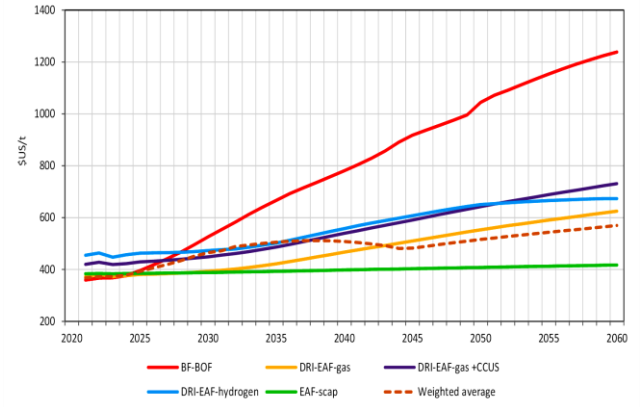
[111] Ibid.

[112] Bashmakov I., M. Dzedzichek, A. Myshak, V. Bashmakov. Sanctions and CBAM: Implications for the Russian industry. CENEf-XXI. December 2022. https://cenef-xxi.ru/articles/sanctions-and-cbam:-implications-for-the-russian-industry.

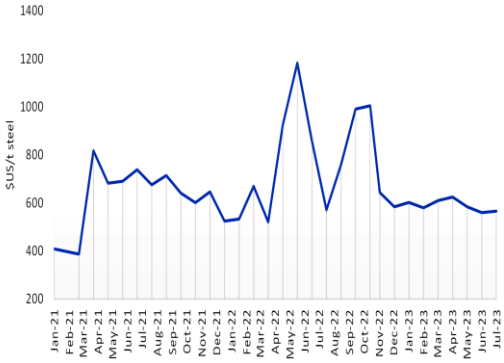
[113] Ibid.

The introduction of a carbon price will not push steel prices beyond the range of their "natural" volatility, as observed in 2021-2023. The introduction of a carbon price in 2031 and annual increase by 3 USD/tCO_2 to reach 108 USD/tCO_2 in 2060 will have a substantial impact on the steel production costs across a variety of the technologies, on the structure of the technologies deployed, and on the average price which will be up from 367 USD/t of steel in 2021 to 570 USD/t of steel in 2060 (Figure 5.8a). This is significantly lower, than the maximum values as observed in 2021-2023. In 24 months of the 31 months shown in Figure 5.8b, steel price was above 570 USD/t, and in 6 months it exceeded 800 USD/t.

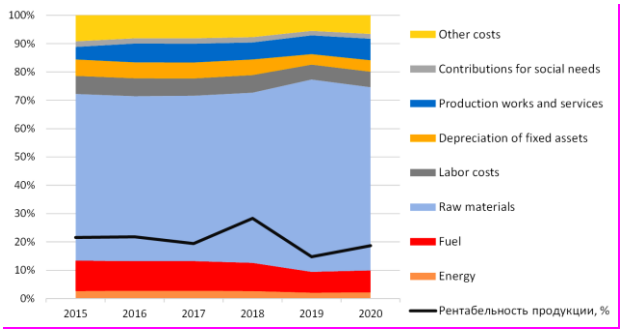
Figure 5.8 Evolution of prices, costs structure, and profitability in the iron and steel sector



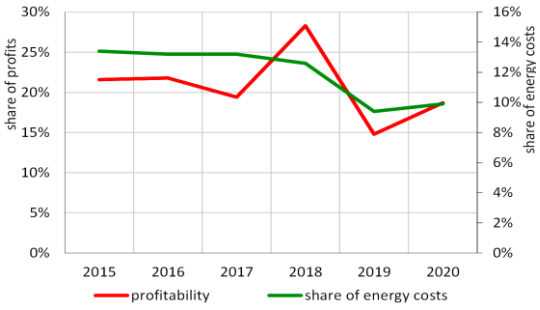
a) steel production costs



b) producer prices for non-alloy steel in ingots



c) proportion of energy costs in total production costs of leading Russian steel works



d) evolutions of energy costs proportion and profitability of leading Russian steel works

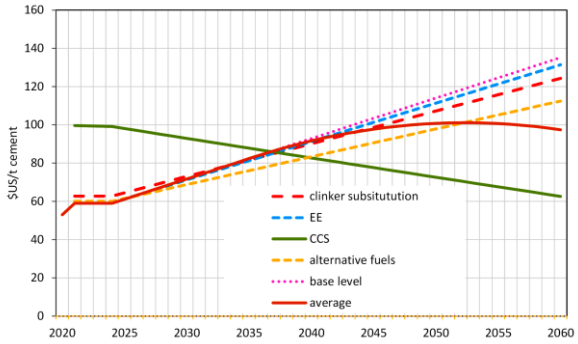
Sources: a) Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENEf-XXI. https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060; b) Rosstat's data on monthly price dynamics Rosstat — Prices, inflation (rosstat.gov.ru); and Central Bank's data on monthly dynamics of the ruble exchange rate Average exchange rate as per Russian Central Bank | Exchange rates (kursvaliut.ru); c) and d) estimated by CENEf-XXI based on annual reviews "Key performance indicators of the iron and steel industry in Russia in 2015-2020" ("Chernaya Metallurgia Bulletin" for 2015-2020).

The post-2015 downward trend in the profitability of the iron and steel industry did not hamper the increase in production. Steel output in Russia was up from 67.3 to 77.7 Mt over 2015-2021 and only due to the sanctions it was down to 72 Mt in 2022. The proportion of fuel and energy costs in the production costs of the leading Russian steel works was down from 11 to 8.3% in 2015-2020 (Figure 5.8c). However, this did not result in a higher profitability of the plants, which was down from 21.6 to 18.7% (Figure 5.8d) due to the growing other cost components, primarily raw materials. In this period, there was no correlation between steel output and profitability of the leading steel works.

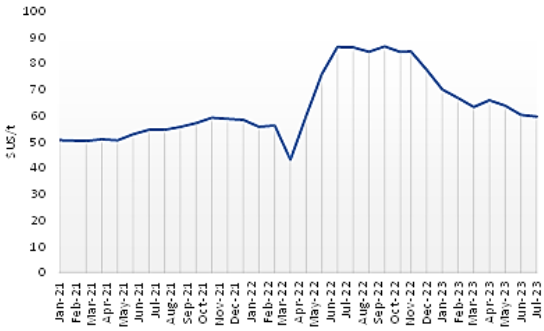
The introduction of a carbon price will not take cement prices beyond the upper limit of their "natural" volatility range, as observed in 2021-2023 (US$ 85/t), before 2037. Cement prices

will then peak at US$ 100/t with subsequent reduction. The following technologies were considered to assess cement price growth (Figure 5.9a): the use of clinker alternatives; energy efficiency improvement; electrification; low carbon electricity and heat; the use of alternative fuels, including biomass, hydrogen, and CCUS.

Figure 5.9 Evolution of levelized costs and producer prices in cement production



a) cement production costs



b) producer prices for cement

Sources: a) Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, 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; b) Rosstat's data on monthly price dynamics Rosstat — Prices, inflation (rosstat.gov.ru); and Central Bank's data on monthly dynamics of the ruble exchange rate Average exchange rate as per Russian Central Bank | Exchange rates (kursvaliut.ru).

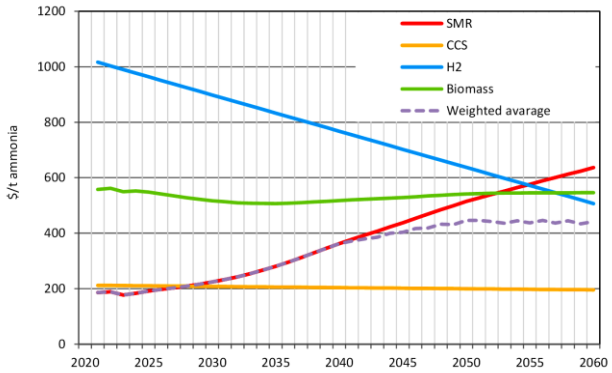
An important direction of making cement industry low carbon is through energy efficiency improvement, including reduced concrete/cement ratio while ensuring the required construction properties. Cement is a relatively cheap material, so it is often used excessively. The efficiency of cement use for concrete production can also be improved by using smaller particles to fill in the space between aggregates and thus to cut cement consumption by a third (down to 8 kg/1 m^3 of concrete and even less versus the current global average of 12-15 kg/1 m^3 of concrete). Additional improvements include the optimization of buildings design and reduction of waste and losses of concrete. Optimization of concrete production by using a binding agent could reduce the demand by 5% in 2030 and by 14% in 2050. These alternatives may completely offset the impact of higher prices of low carbon cement on the construction costs.[114]

Introduction of a carbon price will not push ammonia prices beyond the upper limit of their "natural" volatility range, as observed in 2021-2023 (US$ 1,230/t). Until 2045, this price will not exceed 400 USD/t, i. e. the price valid for 5 out of the 32 months shown in Figure 5.10. Higher ammonia prices determine the increase in the prices of nitrogen fertilizers, even if to a lesser extent; the latter depends on the consumption of ammonia and its derivatives (nitric acid, urea, etc.) per 1 ton of fertilizers.[115] Figure 5.10 shows that even if ammonia prices go beyond 400 USD/t, like in 2021-2023, the prices of nitrogen fertilizers stay within their "natural" volatility range.

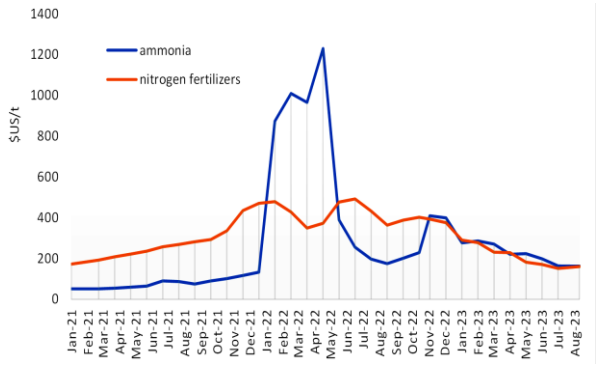
[114] For more detail see: Bashmakov et al. 2022. Industry. In: Climate Change 2022. Mitigation of Climate Change. Contribution of Working Group III to the IPCC Sixth Assessment Report (AR6) [Skea, J. et al., (eds.)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA; Bataille C. 2020. Low and zero emissions in the steel and cement industries: barriers, technologies and policies. OECD Green Growth Papers, OECD; GCCA. 2021. The GCCA 2050 Cement and Concrete Industry Roadmap for Net Zero Concrete. London, UK, 46 pp. https://gccassociation.org/concretefuture/wp-content/uploads/2021/10/GCCA-Concrete-Future-Roadmap-Document-AW.pdf; Bashmakov I.A. (2023). Development and decarbonization perspectives of the global cement industry. Fundamental and Applied Climate Science, Vol. 9, No. 1, p. 33-64, doi:10.21513/2410-8758-2023-1-33-64.

[115] Inventory ITS 2-2022. Ammonia, mineral fertilizers, and non-organic acids production. Moscow. 2022.

Figure 5.10 Evolution of levelized costs and producer prices for ammonia and nitrogen fertilizers



a) ammonia production costs



b) producer prices for ammonia and nitrogen fertilizers

Sources: a) Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, A. Lunin, I. Govor. 2022b. Russia's carbon neutrality: pathways to 2060. CENEf-XXI, https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060; b) Rosstat's data on monthly price dynamics Rosstat — Prices, inflation (rosstat.gov.ru); and Central Bank's data on monthly dynamics of the ruble exchange rate Average exchange rate as per Russian Central Bank | Exchange rates (kursvaliut.ru).

Carbon regulations (carbon intensity standards, procurement of "green" basic materials, introduction of carbon pricing) will cause the prices of basic materials to substantially grow, yet the prices of final products will show only a limited growth,[116] and the general level of prices will not go much beyond the "natural" price volatility. The effects of increased steel, cement, and ammonia prices were estimated based on the above data. The first step is to assess the maximum annual increase in real prices. This parameter was assessed for steel, cement, and ammonia at 3.9%, 3.6%, and 5.6% respectively. Average annual price growth for these products in 2021-2060 is much lower comparing with the maximum -1.1%, 1.3%, and 2.2%/ This well below the announced increase in real natural gas prices for industrial consumers (on average 3.35% annually in 2024-2025). In other words, an attempt to solve the problems of the resource-based economy (by increasing the revenues of gas companies from domestic sales in order to increase government revenues by withdrawing part of these revenues through an increased mineral production tax) has a greater annual pro-inflation impulse, than low carbon transition. The second step is to assess the pro-inflation effect using the 2016 Russian input-output model (this is the last year for which it is available) by the well-known calculation algorithms.[117] In not a single year does the impact of simultaneously rising prices of listed basic materials exceed 0.1% of the consumer price level; and on average for the entire period it equals 0.03%. The input-output model does not assume that specific consumption of basic materials goes down as the prices rise, so even these modest assessments are overestimated. This is a quite limited impact on the growth of consumer price index, which is optimistically expected by the Russian Ministry of Economy at 4-6% in the coming years (realistically could be much higher), and then is likely to decline to 2-3% in 2050-2060 (estimated by CENEf-XXI). During the process of reforming the subsidies system

[116] Bashmakov et al. 2022. Industry. In: Climate Change 2022. Mitigation of Climate Change. Contribution of Working Group III to the IPCC Sixth Assessment Report (AR6) [Skea, J. et al., (eds.)], Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA; Bataille C. 2020. Low and zero emissions in the steel and cement industries: barriers, technologies and policies. OECD Green Growth Papers, OECD.

[117] Przybyliński M. and A. Gorzałczyński. Applying the input–output price model to identify inflation processes. Journal of Economic Structures (2022) 11:5. https://doi.org/10.1186/s40008-022-00264-w; Weber, Isabella M.; Jauregui, Jesus Lara; Teixeira, Lucas; and Nassif Pires, Luiza. Inflation in Times of Overlapping Emergencies: Systemically Significant Prices from an Input-output Perspective. 2022. Economics Department Working Paper Series. 340. https://doi.org/10.7275/0c5b-6a92.

in Iran in 2010, the output and value added in the manufacturing sector were 3 and 7% down respectively, and the profit was 9% down. This was a result of energy price tripling over a year. Energy consumption did not go down due to the insufficient technological flexibility. Hi-tech companies were not as badly affected by the price shock, as resource companies. In contrast to this price shock, the increase in energy prices in the *4D* scenario, balanced with potential energy and material efficiencies improvement, removes the problem of economic damage.

Against the background of "natural" housing construction costs and prices escalation, an increase in the costs of steel and cement resulting from the introduction of a carbon price is hardly visible. In the second quarter of 2023, average housing price on the primary market was 129 thousand rubles/m^2 versus 56.9 thousand rubles/m^2 in 2017. Average annual growth rate in 2017-2022 was 16.6% in current prices and 9.7% in constant prices. Steel consumption per 1 m^2 of housing is 30-55 kg. With the manufacturers' price of 50-70 thousand rubles/ton of steel constructions, the cost of steel amounts to 1,500-3,800 rubles/m^2 in the housing costs. When a carbon price is introduced, the above value is 55% up (Figure 5.8), and the price increase equals 825-2,090 rubles/m^2, or 1,458 rubles/m^2 on average. Cement consumption, including concrete structures, equals 0.3-0.7 t/m^2.[119] If the price is 4-5 thousand rubles/ton of cement, the cost amounts to 1,200-3,500 rubles/m^2 in the costs of housing. When a carbon price is introduced, maximum cement cost is 70% up (Figure 5.9), and construction becomes on average 1,645 rubles/m^2 more expensive. The costs of steel and cement components add up to 3,100 rubles/m^2. Therefore, the maximum price increase resulting from a carbon tax will not exceed 3% of the current housing price in the primary market in 2060; the carbon factor will not be pushing the housing price up by more than 0.08% per year on average.

According to Rosstat, in October 2023, the price of a domestic passenger car was 1,028 thousand rubles. Iron and steel consumption per car varies between 290 and 1,400 kg. With producer prices between 50 and 100 thousand rubles/ton (75 thousand rubles/ton average), iron and steel contribute 22-105 thousand rubles/car to the car price. Introduction of a carbon price would mean maximum 55% increase in the cost of iron and steel. This could increase the price of a car by 12-58 thousand rubles in 2060.

The oligarchs of the basic materials industry (non-oil-and-gas) differ in their views regarding decarbonization policies and measures. The long-negative attitude towards decarbonization is gradually changing. Seven large companies (including En+ Group and Metalloinvest) have already made a carbon neutrality pledge, and 31 of the 50 largest companies, which account for about 40% of Russia's GDP, have long-term programs to reduce GHG emissions.[120] From 2023 onwards, large GHG emitters are required to annually report their GHG emissions. After the 2022 sanctions restricted Russia's access to the advanced technologies, many companies cut their low carbon transition spending (by 22%), yet did not remove it from the list of their strategic goals. Many Russian companies are included in international low carbon ratings (CDP and others). There is also a Russian carbon footprint rating of the largest companies. In 2022, Russian companies' key activities to this end included energy efficiency, technological reboot, forest/climate projects, fuel shift in transport and equipment to gas and electricity.[121]

[118] Zarepour Z. and N. Wagner. How manufacturing firms respond to energy subsidy reforms? An impact assessment of the Iranian Energy Subsidy Reform. Energy Economics 124 (2023) 106762.
[119] Standards for materials and products consumption per 1,000 m2 of reduced total area of residential buildings – technical regulations for labour protection in Russia (ohranatruda.ru).
[120] Dobroslavsky N. and D. Sesitsky. Decarbonization in incertainty: pathways and solutions by SKOLKOVO Moscow School of Management. 2022; 03062021.pdf (economy.gov.ru).
[121] Ibid.

5.6 Transport

Low carbon transition will determine a reduction in fuel transport (both pipeline and railroad), including coal and petroleum products, and so will increase the proportion of salaries in total incomes and beyond 2030 will decrease the number of employees. In the 4D scenario, pipeline transport turnover will go down in 2021-2060 from 2,653 to 1,338 billion t/km, and railroad transport turnover will decline from 2,639 to 1,408 billion t/km. This will primarily affect oil pipeline transport (74% reduction) and to a lesser extent gas pipelines (26% reduction). The proportion of salaries in these economic activities is lower, than Russia's average. Therefore, these structural shifts entail a more even income distribution across the economy. In 2022, 218 and 301 thousand people respectively were employed in these sectors. No decrease in railroad and gas pipeline transport is projected on the 2030 horizon, whereas oil pipeline transport will be 32% down. If labour productivity is fixed on the 2022 level until 2060, the number of employees will be 109 and 140 thousand people. This decline will be emerging gradually. Part of the employees released from the freight railroad transport will be absorbed in the growing road, water, air, electric urban, and railroad passenger transport. Industry and services, which are facing workforce shortages, will be able to absorb all the remaining released workers.

The effects of a carbon price in freight transport will be limited to 0.5% annual energy price growth (substantially below their "natural" increase). They are mainly associated with the rising fuel and electricity prices. The latter aspect is particularly important in the light of the expected intensification of the transport electrification process. The share of fuel and energy costs in transport gross output is 17-20%. Introduction of a carbon tax, which will reach its 108 USD/tCO_2 maximum in 2060, will increase the real energy price by 4-20% for different types of transport. In other words, average annual growth is limited to 0.5%, which is much below the "natural" growth in real prices in the road transport, which was 3.2% on average in 2000-2022.

When energy prices grow slowly, this growth is fully offset by reduced specific energy consumption, and so the share of energy costs in the incomes and expenses of industrial and transport companies is not increasing. Regression analysis of factors which determine the value and evolution of energy intensity of GRP of the constituent entities of the Russian Federation (for all consumers, except residential) shows, that where average energy price is 1% up, energy intensity of GRP is 1% down. Therefore, constituent entities of the Russian Federation with lower energy prices have the same shares of energy costs in GRP, as those with high energy prices. An increase is ultimately offset by reduced energy intensity, and so energy prices are an effective energy efficiency policy. In 2007, the author formulated three laws of energy transition.[122] The first law states, that "*in the long-term, energy costs to income ratios are relatively stable with just a very limited sustainable fluctuation range".* This law is empirically confirmed by data for many countries both for the whole economy and for individual sectors.[123] This was called the "minus one" phenomenon,[124] i. e. ultra-long-term real energy price elasticity of energy intensity is

[122] Bashmakov I. 2007. Three laws of energy transitions. Energy Policy, Vol. 35, No. 7, pp. 3583–3594.

[123] Bashmakov I. Three laws of energy transitions and economic growth. National Accounting Review (in print); Bashmakov I. 2017. 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., Grubb M. 2016. "Minus one" and energy costs constants. Paper presented at the XVII April International Academic Conference on Economic and Social Development, National Research University Higher School of Economics, Moscow, April 19—22; Court V., Fizaine F. 2017. Long-term estimates of the energy-return-on-investment (EROI) of coal, oil, and gas global productions. Ecological Economics, Vol. 138, pp. 145–159; Court V., Jouvet P.-A., Lantz F. 2018. Long-term endogenous economic growth and energy transitions. The Energy Journal, Vol. 39, No. 1, pp. 29–57; Fizaine F., Court V. 2016. Energy expenditure, economic growth, and the minimum EROI of society. Energy Policy, Vol. 95, pp. 172–186; King C. 2015. Comparing world economic and net energy metrics, Part 3: macroeconomic historical and future perspectives. *Energies*, Vol. 8, pp. 12997–13020.

[124] Grubb M., Bashmakov I., Drummond P., Myshak A., Hughes N., Biancardi A., Agnolucci P., Lowe R. Minus 1: Empirics, theory and implications of the 'Bashmakov–Newbery range of energy expenditure'. Report to the Institute

minus 1. Substantial price shocks can be offset within 25-33 years, whereas some 1% increase in real prices could be offset within a year.

5.7 Agriculture

Introduction of a carbon price will increase energy prices for agricultural consumers by no more than 0.8%. The experience shows, that this growth can be fully offset by energy intensity reductions. The share of fuel and energy costs in gross agricultural output is 5%. In 2000-2013, real energy prices in the agricultural sector were growing on average by 1.3% per year; specific energy consumption was declining by 8.8%, the share of energy costs was going down, while the output was growing by 3% per year. In contrast, in 2015-2022, real energy prices were declining, energy intensity was going up by 1.5% per year, whereas the output growth slowed down to 2.4% per year. Thus, declining energy prices did not encourage output growth. This study estimates only effects of direct energy-related emission control policies and indirect electricity and heat generation-related emission control policies, whilst emissions from crops and livestock were not considered.

5.8 Services sector

As the share of services in GDP grows, the share of salaries will be increasing and the income distribution will become more even. In the services sector, the share of salaries in the value added is much higher, than the average across the economy, and 3 times higher, than in the oil-and-gas sector (Figure 5.6), which will be gradually giving way to the services. Of all sectors, the services sector contributes the most to the employment in Russia – 41 million people (Figure 5.7). With priority development, it will be able to absorb all of the workforce released in other sectors.

Carbon price will not additionally increase energy prices in the services sector by more than 1.3% per year. This growth can be fully offset by improved energy efficiency and increased production of renewable electricity and heat by prosumers. The share of fuel and energy costs in the gross output in different services subsectors generally varies between 2 and 5%. The energy saving potential in the services sector, even if only the already deployed technologies with moderate costs are used, exceeds 40%.[125] If untapped, it can fully offset the price growth. In addition, the 4D scenario assumes a substantial increase in on-site power generation in the services sector (10 billion kWh up) and a significant volume of heat production by solar water heaters and heat pumps; this could help cap the spending on grid energy.

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of New Economic Thought, 2017, published by UCL, March 2018; Bashmakov I.A. and A. Myshak, 2018. "Minus 1" and Energy Costs Constants: Sectorial Implications. Journal of Energy. Volume 2018, Article ID 8962437. https://doi.org/10.1155/2018/8962437; Bashmakov, Igor and Grubb, Michael and Drummond, Paul and Lowe, Robert and Myshak, Anna and Hinder, Ben. 'Minus 1' and Energy Costs Constants: Empirical Evidence, Theory and Policy Implications. Available at SSRN: https://ssrn.com/abstract=4401851 or http://dx.doi.org/10.2139/ssrn.4401851; Bashmakov I. 2017. The first law of energy transitions and carbon pricing. International Journal of Energy, Environment, and Economics, Vol. 25, No. 1, pp. 1—42.

[125] Bashmakov I.A., V.I. Bashmakov, M.G. Dzedzichek, A.A. Lunin, O.V. Lebedev. Contrary to logic: evolution of specific energy and water use by public sector organizations. Energosberezhenie, No. 7. 2020; Bashmakov I.A. Benchmarking and calculators for express-assessment of the energy efficiency potential in buildings. Energosberezhenie, No. 8 and 9. 2020; Bashmakov I.A. Policy measures to improve energy efficiency in Russian buildings: forecast up to 2050. Issues of Economy, 2016;(3):75-98, https://doi.org/10.32609/0042-8736-2016-3-75-98; Bashmakov I. 2016. Improving the Energy Efficiency of Russian Buildings, Problems of Economic Transition, 58:11-12, 1096-1128, DOI: 10.1080/10611991.2016.1316099.

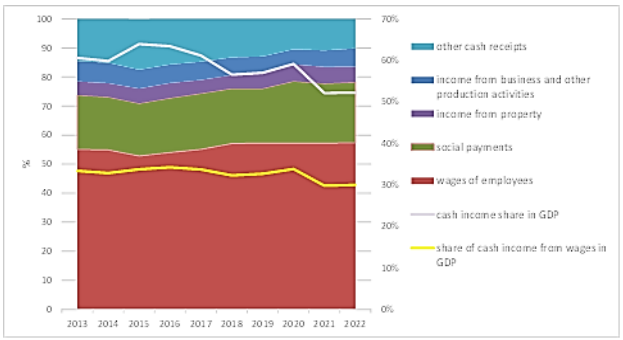
6 Decarbonization: impacts on the distribution of consumers' incomes and expenses

6.1 Change in the distribution of incomes

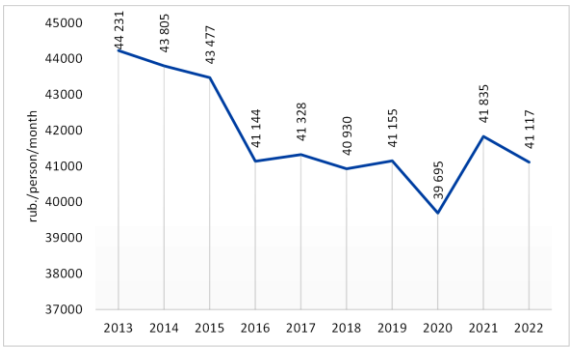
6.1.1 Retrospective

In 2000-2022, the resource-based economic development model did not allow for a more even distribution of incomes. In 2013-2022, total inflation-adjusted incomes of the population were 7.1% down. The share of wages in GDP was down to 39% in 2022 (the lowest level since 1991). In the oil-and-gas sector it is noticeably lower, than in the rest of the economy (see Chapters 4 and 5). The ratio of total cash income of the population to GDP (as reported by Rosstat in the income-expenditure balance) was down from 60.6% average in 2013-2022 to 52% in 2021-2022, and the share of wages in the overall monetary income of the population in GDP dropped from 33.3% to 30% (Figure 6.1). If the amount of cash income in current prices is adjusted for inflation, it shows a substantial drop in 2013-2016 and subsequent stagnation (Figure 6.1). Strangely, the increased share of profit in GDP was not reflected in the contribution from the entrepreneurial income to the total cash income or in the property income. In 2013-2022, the total share of these two aggregates fluctuated in a quite narrow range (11-11.8%), and in 2022 it was below the 2020-2021 levels, despite the fact that the share of profits in GDP increased.

Figure 6.1 Structure and evolution of real monetary income of the Russian population by sources



a) structure of cash incomes of population and their share in GDP



b) evolution of total monetary income of population in 2013 prices (adjusted by the consumer price index)

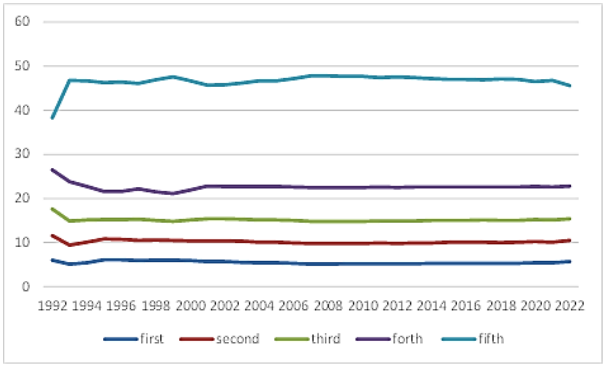
Source: the author based on Rosstat data (urov_13kv_nm.xlsx (live.com)).

In 2022, the structure of cash income by sources remained virtually unchanged, and so the Gini index could not possibly show such a substantial decrease in 2022, as it did, according to Rosstat. Rosstat's data on the evolution of this index show that the distribution of incomes was becoming more even in the recent years; however, this is not consistent with the economic logic, foreign experience (Chapter 4), and even Rosstat's own data on the sources of income. The Gini index can be estimated for the market income (cash income before taxes) or disposable income.[126] Cross-country analysis shows, that the Gini index for the market income is 1.5-1.7 times higher, than for the disposable income.[127] Rosstat provides long series on the distribution of total monetary income only by quantiles. No noticeable improvement in the distribution of total cash income can be detected. The share of the fifth quantile in 2010-2021 remained at 46.8-47.7% and then magically dropped to 45.6% in 2022 (Figure 6.2) against the background of a substantial increase in the profits share in GDP.

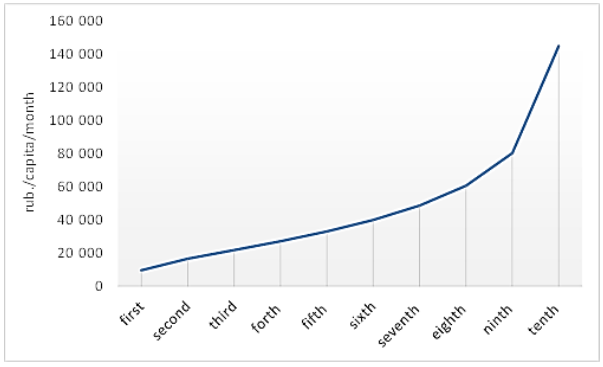
[126] According to Rosstat, it includes wages, income from business and other production activities, social payments, property income and other cash receipts, but does not include invested funds. New Methodology (rosstat.gov.ru).

[127] Bises B., F. Bloise, A. Sciala. Labor share as an "automatic stabilizer" of income inequality. Accepted: 30 April 2023. International Tax and Public Finance. https://doi.org/10.1007/s10797-023-09782-0 Labor share as an "automatic stabilizer" of income inequality | International Tax and Public Finance (springer.com).

Figure 6.2 Distribution of total monetary income by quantiles and deciles



a) shares of quantiles in the total monetary income evolution in 1992-2022



b) distribution of total cash income by deciles in 2022

Source: the author based on Rosstat's data.

The richest 10% of Russians get 30% of income, while the bottom 10% only get 2%, or 15 times less. This follows from the data by Rosstat, which recently started to provide statistical data on the total cash income distribution by deciles (Figure 6.2). However, there are reasons to believe that the income gap is even wider.[128] Rosstat also shows the following dynamics of the population with monetary incomes below the poverty line (the subsistence level): 17.7 million people in 2010; 19.6 million people in 2015; 16 million people in 2021; and 14.3 million people in 2022.[129] It remains a mystery, how the number of poor people could decline so significantly in the crisis year of 2022. The share of the population with per capita cash income below 40% of the median level remained relatively stable in 2013-2022 (11.3-11.8%) and in 2022 was down to 10.5%. The corresponding share of incomes below 50% of the median is 18-18.5% falling to 17.1%, and below 60% is 25-25.5% falling to 24.2%. The drops in 2022 are apparently associated with payments and compensations related to the participation in the military operation at Ukraine.

The 2015-2022 change in the number and structure of employees indicates the resource-based economic development pattern. The number of employes in the minerals extraction sector showed the fastest growth – by 9%. It was followed by construction (2.3% up, largely due to investments in the basic materials sector), the service sector (1% up, due to a 10.5% increase in the number of bureaucrats engaged in the "administrative activities and related additional services").[130] The number of people employed in agriculture, hunting and forestry was 17.6% down, in manufacturing 2.8% down, in the production and distribution of electricity, gas and heat (2017-2022) 4.4% down, and in transport and communications 3.6% down.

6.1.2 Potential impacts of decarbonization

Structural shifts in favor of low carbon activities will increase the share of wages in GDP and thereby flatten the income distribution. The set of models used does not allow for a detailed assessment of how the low carbon transition will affect the distribution of incomes by quintiles or deciles, as these effects depend on a variety of factors, including changes in wages and profits and in social support schemes, tax system developments, etc. The former group of effects are difficult to assess given the labor shortage and the uncertainty of the future effects of automation and labor productivity evolution. The progress with profits significantly depends on the degree of participation in the global economy, the market power of companies in different sectors, and the

[128] In 2023, Rosstat introduced a new methodology, and data on the evolution of cash income of the population in 2018-2021 substantially increased.
[129] tab2-2.xlsx (live.com).
[130] 05-05_2017-2022.xls (live.com).

government structural policy. Only general estimates can be made. Chapter 5 shows that the *4D* scenario expects accelerated development of low carbon heat and power generation, manufacturing (as low carbon output grows, and so do localization levels for low-carbon technologies), development of low-carbon transport and services. These are economic activities with significantly higher shares of wages in value added, than carbon-intensive industries. Higher quality of workforce and therefore higher salaries are required to improve the multifactor productivity, which is the basis of the *4D* scenario.

Literature review shows that the functional distributional effects of environmental policies (wages-to-profit ratio) are moderately regressive in the long run.[131] However, these results were based on practices with distortions, such as free quotas allocation in the EU carbon trade system, large fossil fuel subsidies, carbon leakages, energy tax exemptions for energy-intensive industries, etc. Another conclusion is that administrative (command) regulations lose it out to market policies in terms of effective distributional effects.[132]

Theoretically, low carbon transition has a regressive effect on the "skilled-unskilled" scale: the former benefit more. However, there is no empirical evidence for this. Literature review shows that environmental policies lead to a relative decline in unskilled labour demand, and that in terms of upscaling the use of green technologies demand for technical personnel (engineers or technicians) appears to be larger, than, say, for IT specialists. It is important to understand, how large the costs are for the re-distribution and re-training of workers released from the "red" economy. It is also important to take into account that "green skills" are of a general nature and when changing the sphere of employment, many workers in the "red" economy will not need much additional education or training.[133]

More than a half of the 65 million people employed in the global energy sector are employed in clean energy. The energy transition has already seen employment in the renewable energy sector double over 10 years. According to IRENA and the ILO, in 2022 there were nearly 13.7 million jobs in the renewable energy sector alone (solar, bioenergy, hydropower and wind energy). As we move toward carbon neutrality, there will be 30 million people employed in the global clean energy sector in 2030, and 13 million jobs will be lost in fossil fuel production.

The balance of increased employment in the green economy and the jobs lost in the red economy will lead to a more equitable distribution of income. The IEA estimates that around 45% of jobs in the energy sector are highly skilled versus a quarter of jobs in the whole economy. However, the wages of those employed in the coal, oil, and gas industries are above the economic average.[134]

6.2 Change in the distribution of expenditures

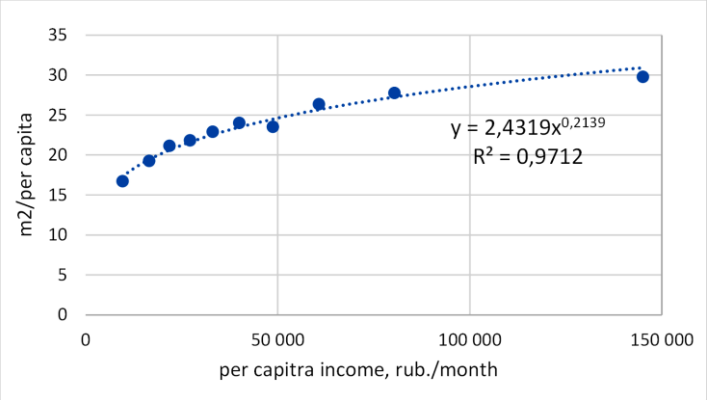
6.2.1 Retrospective

As the market economy develops, the balance between income and living space per capita is slowly being restored in Russia. In command economies, income has no significant impact on the distribution of per capita living space.[135] The balance between income and housing space was destroyed, and the distribution function of housing space by income remained flat for decades and only began to change after the transition to a market economy was launched. In 2022, the elasticity coefficient of the living space from income in Russia was 0.21 (Figure 6.3). The existence of a

[131] Vona F. Managing the Distributional Effects of Environmental and Climate Policies: The Narrow Path for a Triple Dividend. Environment Working Paper No. 188. OECD (2021).
[132] Ibid.
[133] Ibid.
[134] https://www.euractiv.com/section/energy/opinion/alleviating-energy-poverty-with-fossil-fuels/.
[135] Buckley R.M. and E.N. Gurenko. Housing and income distribution in Russia: Zhivago's legacy. The World Bank Research Observer, vol. 12, no. 1, 1997.

minimum guaranteed ('social') living space and the fact that housing is considered a basic need means that this coefficient is less than one in all countries. In Russia, it may be rising for a while before it stabilizes. In the EU, the Gini index for residential energy use is 0.41.[136] In Russia – for the above reasons – it is lower.

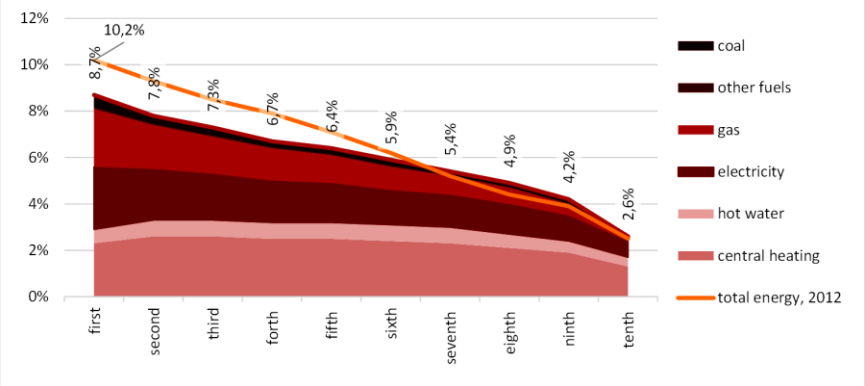
Figure 6.3 Living space per capita as a function of income. 2022



Source: the author based on Rosstat's data.

In 2022, the average share of residential energy costs (ECS) in income was 3.4%. The average ECS in consumer expenditures varied in the range of 6.5-6.8% in 2012-2018 and then went steeply up to 7.8% in 2019 and to 8.3% in 2020 with a subsequent drop to 6.4% in 2021 and to 6% in 2022 (Figure 6.4). The main contribution comes from the district heating costs. The share of district heating costs is less determined by the income level, since it is mostly linked to the living space, which is only slightly linked to the income. Regression analysis conducted for more than 80 Russian regions showed that where per capita income is 1% up, the use of district heat for space heating is only 0.18% up. This is even lower, than the elasticity coefficient shown in Figure 6.3, since wealthier people buy housing in new, more energy-efficient buildings. Up to the income level of 40 thousand rubles/person/month (sixth decile), the elasticity coefficient for the ECS for district heat is zero, and for higher income levels it drifts to (-)0.48. A similar dependence on income exists for centralized hot water supply. The electricity and gas uses are closely related to income: demand to income elasticity coefficients are 0.5 for electricity and 0.9 for gas.

Figure 6.4 ECS in consumer expenditures distribution by deciles in 2022



Source: the author based on Rosstat's data.

[136] Büchs M., N. Cass, C. Mullen, K. Lucas and D/ Ivanova. Emissions savings from equitable energy demand reduction. Nature energy. Published online: 17 July 2023. https://doi.org/10.1038/s41560-023-01283-y.

Energy price instruments in Russia work effectively wherever the residential customers can technically control their energy use. Panel regression analysis carried out for more than 80 Russian regions showed that where heat price is 1% up, the use of district heat for space heating is 0.22% down. This demonstrates a limited technical capability to adjust heat supply depending on heat prices – i. e. low technical elasticity. The share of households complaining about insufficient heat comfort is 12.5% in the first decile, but even in the tenth it is quite high – 9.9%. District heat control mostly takes place at heat sources, central heating points or building level heating points. Since for domestic hot water (DHW), electricity, gas, and other fuels full control is in hands of consumers, 1% increase in the average price of each of these energy carriers brings energy consumption 1% down. This is the "minus one phenomenon": with time energy efficiency becomes inversely proportional to energy price.[137]

Comparatively low residential energy tariffs in Russia are no advantage for the Russian consumers. The "minus one" phenomenon ensures that the ECS and its distribution by deciles is approximately the same as in other countries. The average ECS is close to the first threshold of households' ability to pay for energy supply to their homes. This threshold is similar for different countries, irrespective of the development stage: 3-5% of the household income, or 4-7% of their consumer expenditures. The further one goes beyond this threshold, the lower the payment discipline, or the level of comfort drops to, or below, the level of survival.[138]

With a full payment of energy bills, the share of the energy poor in the Russian population would have been approximately 6% in 2022 (if the threshold share is taken to be 10% of income) or 19% (if the threshold is 7%). The ECS for the first decile households was 10.4% in 2022. Analysis of the distribution of deciles by ECSs in 2022 (Figure 6.5) shows that the ECS is above 10% for 6% of households. The second threshold for households' ability to pay their energy bills is the marginal ECS for the poorest group of households. When it gets above 7–10% of income,[139] or 9–13% of consumer expenditures (excluding support for the "energy poor"), no measures, no matter how severe, can increase energy payments collection rate; and if the accumulated debt is large and power supply can be cut off, then energy consumption drops to the level of mere survival. This second threshold is key for the development of programs to support the energy (fuel) poor.[140] The burden on the poorer family budgets (first to sixth deciles) in 2012-2022 was down, whereas on the better-off households (seventh to tenth deciles) somewhat increased (Figure 6.4).

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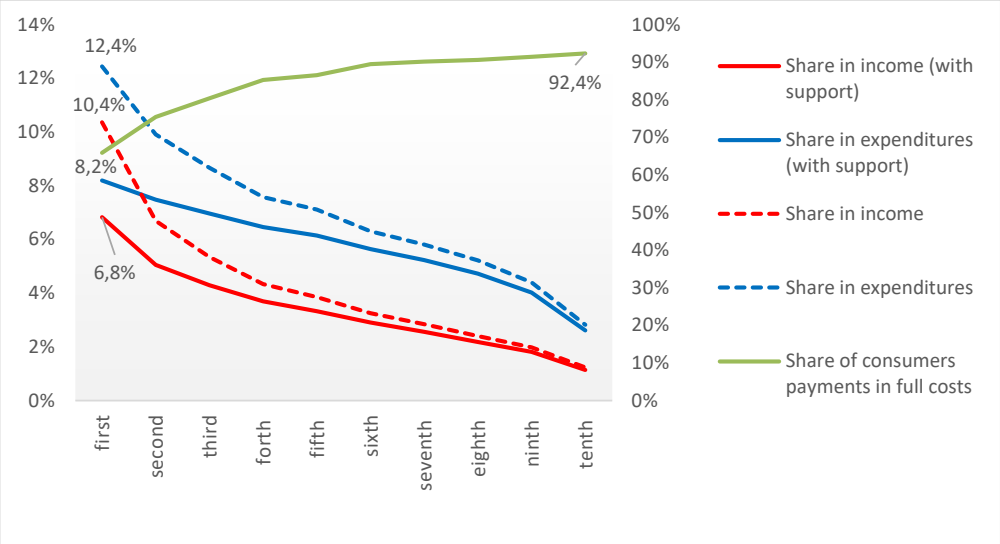
[137] Bashmakov I., M. Grubb, P. Drummond, R. Lowe, A. Myshak, and B. Hinder. 'Minus 1' and Energy Costs Constants: Empirical Evidence, Theory and Policy Implications. Available at SSRN: https://ssrn.com/abstract=4401851 or http://dx.doi.org/10.2139/ssrn.4401851.

[138] Bashmakov I. Readiness and Willingness of Population to Pay for Housing and Communal Services. *Voprosy Ekonomiki*. 2004;(4):136-150. (In Russ.), https://doi.org/10.32609/0042-8736-2004-4-136-150; Bashmakov I. *Affordability of Utility Services in Urban Housing: Energy and Water Efficiency Solutions*, The Centre for Energy Efficiency (CENEf), Moscow, Russia, 2006; Bashmakov I.A. and A. Myshak. "Minus 1" and Energy Costs Constants: Sectorial Implications. Journal of Energy. Volume 2018, Article ID 8962437, https://doi.org/10.1155/2018/8962437; European Commission, "Commission staff working paper. An energy policy for consumers," 2010, http://ec.europa.eu/energy/sites/ener/files/documents/sec(2010)1407.pdf; Eurostat, Living Conditions in Europe, 2014 Edition, European Union, 2014.

[139] In England, households were classified as fuel poor if they had to spend more than 10% of their disposable household income (before tax, but including benefits) to maintain a "satisfactory" home comfort. For heating, this means providing 21◦C in the main living area and 18◦C in other rooms. In 2022, 3.28 million, or 13.4% of households in England were classified as energy poor. In the UK at the beginning of 2023, the number reached 7.5 million households. Hinson S. and P. Bolton. Fuel poverty. The House of Commons Library 24 March 2023 Fuel poverty in the UK - House of Commons Library (parliament.uk).

[140] Bashmakov I. Readiness and Willingness of Population to Pay for Housing and Communal Services. *Voprosy Ekonomiki*. 2004;(4):136-150. (In Russ.) https://doi.org/10.32609/0042-8736-2004-4-136-150; Bashmakov I.A. and A. Myshak. "Minus 1" and Energy Costs Constants: Sectorial Implications. Journal of Energy. Volume 2018, Article ID 8962437, https://doi.org/10.1155/2018/8962437; European Commission, "Commission staff working paper. An energy policy for consumers," 2010.

Figure 6.5 Distribution of deciles by ECSs and by the share in coverage of full energy supply costs in 2022



Source: the author.

Social support helped bring the share of the energy poor in Russia to zero in 2022, if the ECS threshold is set at 10% of income, or to 1-2%, if this threshold is set at 7%. In Russia, three main schemes of providing social support to pay energy bills are financed from different levels of budgets (from federal to municipal):

- social support for individual categories of people and households. It is related to the status, not income;
- tariff subsidy – to cover the differences in tariffs (mainly for heat). The tariff is set below the full costs, and the gap is covered from municipal budgets. It is provided in municipalities with relatively low incomes, however, is not linked to the income of the energy users;
- subsidies for the poor to cover the gap between their housing, energy and other communal bills and the upper thresholds set at 10-22% of household income.[141]

Statistics do not provide data on the distribution of these support schemes by deciles. The first two schemes are not related to the income level, while the third scheme suggests that the support scales down as income grows and, starting from the sixth decile, it is down to zero.[142] As a result, the share of household expenses in covering full energy costs does grow with higher incomes, but even for the wealthiest decile it is not 100%. (Figure 6.5).

The average share of personal transport fuel costs in income in Russia is close to the upper limit of the range for many countries. It is regressive in Russia: for the first four deciles it is 3.6-3.8%, while for the tenth it is 2%. According to Rosstat, the share of personal transport costs in household expenses was up from 4.9% in 2012 to 7.4% in 2019. The share of fuel costs in

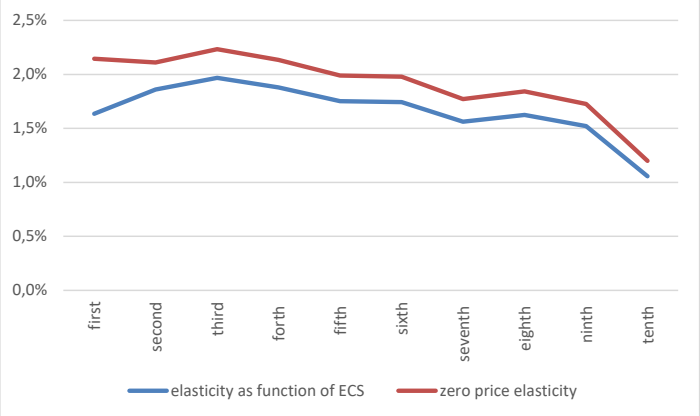
[141] In 58 regions of the Russian Federation. In other 24 regions, this share is 15–21%, in 3 less than 15%, and in Moscow 10%. In the UK, there are similar schemes to increase household solvency: the Winter Fuel Payment, the Warm Homes Discount and the Cold Weather Payment. Hinson S. and P. Bolton. Fuel poverty. The House of Commons Library, 24 March 2023 Fuel poverty in the UK - House of Commons Library (parliament.uk).

[142] This assumption was made based on the analysis of the distribution of the share of energy poor in the UK by deciles. Hinson S. and P. Bolton. Fuel poverty. The House of Commons Library 24 March 2023 Fuel poverty in the UK - House of Commons Library (parliament.uk).

incomes is lower: 2.9% in 2022. This share varies cyclically in many countries, generally staying in the narrow range of 2 to 3% of personal income before tax.[143]

Liquid fuel subsidies (damper) is equivalent to a negative carbon tax of (-100/tCO₂). It has a weak progressive effect (in terms of cost savings). In 2022, subsidies for motor liquid fuels (damper payments) amounted to 2.16 trillion rubles, or approximately 28 rubles/liter. If we assume that car mileage has no sensitivity to the price of fuel, it turns out that this measure is progressive (in terms of cost savings), since savings on the ECS in income, when moving from the first to the tenth decile, are down from 2.1% to 1.1% (Figure 6.6). However, if we assume that mileage depends on price with an elasticity coefficient ranging between -0.4 for the first decile and -0.2 for the tenth, the effect becomes nearly proportional for the first deciles and weakly progressive for the others, since the damper mechanism brings the cost 1.5-2% down for the first nine deciles and only 1.2% down for the tenth.

Figure 6.6 Liquid fuel damper-related reduction in the share of fuel costs in 2022



Source: the author.

Analysis of the impact of rising energy prices on the consumption inequality for 129 developed and developing countries, 1970–2013, shows that price growth brings the Gini index up, reduces the share of energy use for low-income deciles and increases it for high-income deciles.[144] Damper-related price reduction should have the opposite effect.

6.2.2 Distributional effects from low carbon measures in residential buildings

Below, the impact of low carbon measures is considered by components for which statistical data are available on housing and personal vehicles energy use or energy costs by deciles. For residential buildings, four sets of low carbon measures are considered:

- building codes with energy efficiency requirements for new and renovated buildings;
- subsidies for additional energy efficiency improvements in new and renovated buildings;
- subsidies for the installation of photovoltaic panels;
- carbon price mechanisms to encourage energy efficiency improvements in residential buildings.

[143] Bashmakov I.A. and A. Myshak. “Minus 1” and Energy Costs Constants: Sectorial Implications. Journal of Energy. Volume 2018, Article ID 8962437, https://doi.org/10.1155/2018/8962437.

[144] Bettarelli L., J. Estefania-Flores, D. Furceri, P. Loungani, P. Pizzuto. Energy inflation and consumption inequality. Energy Economics Volume 124, August 2023, 106823 Energy inflation and consumption inequality - ScienceDirect.

The first two sets differ in the role of subsidies in meeting the energy efficiency requirements. The level of subsidies determines the degree of participation in the programs and the degree of compliance with regulatory requirements. Allocation of subsidies and monitoring of results are key to better meet the energy efficiency requirements. Mandatory requirements assume full coverage and full compliance. In practice, this assumption is only valid if effective monitoring and verification procedures go along with penalties for non-compliance.

The distributional effects of the first two measures were assessed using a specially developed model – DEFEND (*distributional effect of national decarbonization*). It includes a block of residential buildings and a block of road transport. Not all of the critical parameters of the model are backed by statistical data, so the distributional effects of measures for new residential buildings were assessed using a number of assumptions in addition to the statistical data:

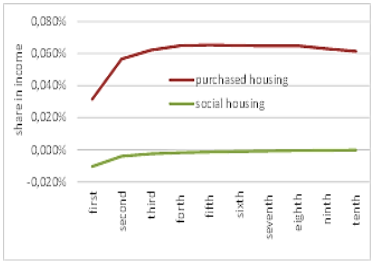
- The share of new housing purchase expenses in income by deciles is established based on its average value – 3.2% of income – adjusted by deciles by the expenses/income ratios for each decile to the average ratio. As a result, it stays at 1.2% for the first decile and at 4.1% for the tenth.
- The price of housing on the primary market differs by deciles. Its average 2022 value was 122.3 thousand rubles/m^2. For the first decile, it is taken equal to 89.9 thousand rubles/m^2 and escalates to 155.3 thousand rubles/m^2 for the tenth. This parameter is used to estimate the average annual purchase of residential space by different deciles.
- Part of the housing is provided in new buildings under various social programs and is financed from the budget and other external sources of funding. This amounts to approximately 5% of the newly built housing. It is assumed that when moving to higher deciles, this share decreases as the square of the ratio of the expenses/income ratio for each decile to average ratio across all deciles.
- Incremental capital costs of construction of a class A+ residential building (where energy use for space heating is 40% below the base level) are equal to 2,460 rubles/m^2, or 5% of the average construction costs of a new apartment building.
- Only part of the incremental capital costs are subsidized. If the share of subsidies is zero, the effect of introducing administrative energy efficiency requirements (building codes) for new buildings is assessed.

The DEFEND model estimates two effects:

1. Additional costs for purchasing energy-efficient housing;
2. Savings on one-year space heating costs for a class A+ building.

Introduction of administrative requirements to improve the energy efficiency of new buildings have, in general, a progressive effect for the first four deciles; then the effect becomes proportional and slightly declines for the tenth decile. The relatively small burden on the incomes of the first deciles is explained by the low share of expenses for housing purchase in their incomes. For deciles starting from the fourth, the additional pressure reaches 0.068%, or 0.065% – with an account of heat savings (Figure 6.7).

Figure 6.7 Distributional effects of mandatory energy efficiency requirements for new residential buildings



a) introduction of administrative requirements for energy efficiency of new buildings

b) 50% subsidies for incremental capital costs

c) 100% subsidies for incremental capital costs

Source: the author.

In order to compensate for the additional pressure, it is important to subsidize the incremental costs of improving energy efficiency and to develop programs to provide social housing to low-income families in new energy-efficient buildings. Where subsidies cover half of the incremental capital investments, the above conclusions are preserved, but the additional pressure is halved. Where subsidies are provided to cover full incremental capital costs, the effect is neutral—there is no additional pressure on any decile. If the assumptions about the level of incremental capital investments are modified, the conclusions about the nature of the effect do not change, yet the level of additional pressure is affected.

Providing social housing has a progressive effect (in terms of cost savings), since saving the same amount of heat more substantially reduces the burden on the poor households, even though their average housing space is smaller.

In Russia, there are no valid federal-level documents which specify energy efficiency targets following renovation of apartment buildings or targets for annual share of energy efficient renovation for apartment buildings. Monitoring of the volume or share of apartment buildings in which comprehensive (deep) energy-efficiency retrofits were accomplished was never established. According to the Federal Housing and Public Utilities Agency, with financial support provided in 2021, energy efficiency improvements were included in the renovations of 54 apartment buildings with 355 thousand m^2 total floor area. Incremental investment costs total to 203 million rubles, or 571 rubles/m^2 on average. The Federal Housing and Public Utilities Agency provided 80 million rubles in reimbursement for these costs (39%). Energy savings amounted to an average of 26%, or 32 million rubles annually. In addition to the projects of the Federal Housing and Communal Services Agency, other projects are in progress in some regions. But in general, according to CENEf-XXI, the share of apartment buildings with deep energy-efficiency retrofits is less than 0.2% of the total area of apartment buildings, which is 10 times below the 2% target.

The mechanism for co-financing energy-efficient renovations of apartment buildings in Russia was tested, debugged, has proved its efficiency, yet was abandoned after the meager budget of this program was exhausted. This is one of the most progressive mechanisms in the world. Funds were allocated on a competitive basis, and the amount of co-financing depended on the expected savings. A minimum target level of savings was set as at least 10% reduction of heat and electricity costs. The mechanism also encouraged higher savings: as soon as energy cost savings were up from 10 to 30%, the co-financing from the government increased from two to four times the annual energy cost savings with a 5 million rubles cap per 1 apartment building. This meant a 2-4 years reduction of the project payback period.

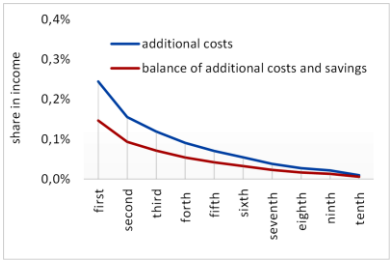
An option was considered to revive and scale up the mechanism described in the Decree No. 18 by the Government of the Russian Federation of January 17, 2017 (as amended on

December 21, 2020) "On approval of the Rules for the provision of financial support by the state corporation – Fund for Assistance to the Reform of Housing and Communal Services for major repairs of apartment buildings". The calculations were based on the actual distribution of per capita living space depending on the income (Figure 6.3). It is also assumed that:

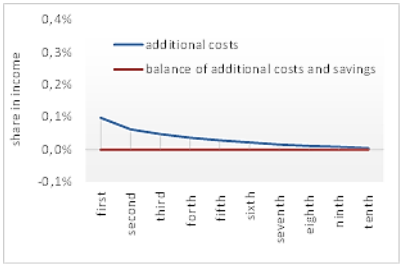
- on average, energy-efficiency renovations are accomplished in 2% of the apartment buildings floor area annually and deliver specific heat savings of 30%;
- the capital costs of such energy-efficiency package are on average 571 rubles/m^2;
- buildings with the highest specific energy consumption (from the right-hand side of the energy efficiency benchmarking curve) are the first candidates for energy-efficient retrofits;
- the distribution of the population with different income levels, living in buildings with different time in service is uneven: better-off people live in newer buildings. Therefore, it is assumed that the share of buildings selected for renovations for the lowest income decile is 50% above average (3% per year), and for the highest income group is 50% below average (1% per year).

Two levels of subsidies to cover the incremental costs of energy-efficient retrofits are considered: 60% and 100% (Figure 6.8). In some programs, subsidies can exceed 100% to obtain additional benefits from energy efficiency: for example, Italy implements the Ecobonus and Superbonus programs, which guarantee 50 to 110% tax deductions from the costs of energy efficiency retrofits or from the installation costs of renewable energy sources in buildings. 110% tax deductions are provided for insulating houses with materials that meet the specified requirements and for improving the efficiency of space heating to A-class level in accordance with EU rules.[145]

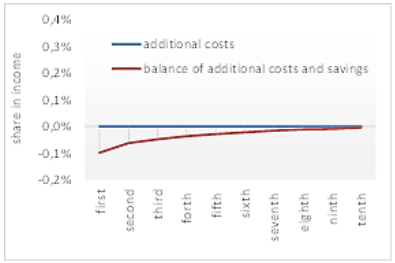
Figure 6.8 Distributional effects of mandatory energy efficiency requirements for residential buildings renovations



a) introduction of administrative requirements to increase energy efficiency after building renovation



b) subsidies to cover 60% of costs of energy efficiency retrofits as part of building renovation



c) subsidies to cover 100% of costs of energy efficiency retrofits as part of building renovation

Source: the author.

The introduction of administrative requirements to improve the energy efficiency of buildings through renovations has a regressive effect (Figure 6.8a). It is slightly mitigated by savings on heating bills, but it takes 2.5 years before the additional costs pay back from savings.

Full subsidies for the incremental costs of energy efficiency retrofits result in a proportional effect in terms of costs and a progressive effect with an account of the resulting energy savings (Figure 6.8c). Cost savings are smaller for higher-income deciles.

[145] Ecobonus 2022: detrazione 50 65 110% risparmio energetico: guida (studiomadera.it). Under this program, more than 122 thousand applications were approved, and 21 billion euros were provided in the form of tax deductions. Italy's Superbonus 110% extended in 2022 — idealista; Italy's superbonus 110% scheme prompts surge of green home renovations | Italy | The Guardian;Microsoft Word - GREEN Home_GP Superbonus IT-KE_IWO (green-home.org).

60% subsidies to cover the incremental costs produce the neutral effect balanced by costs and additional annual energy savings (Figure 6.7b). Depending on the payback period requirements, it is possible to determine the share of subsidies required to achieve a neutral effect.

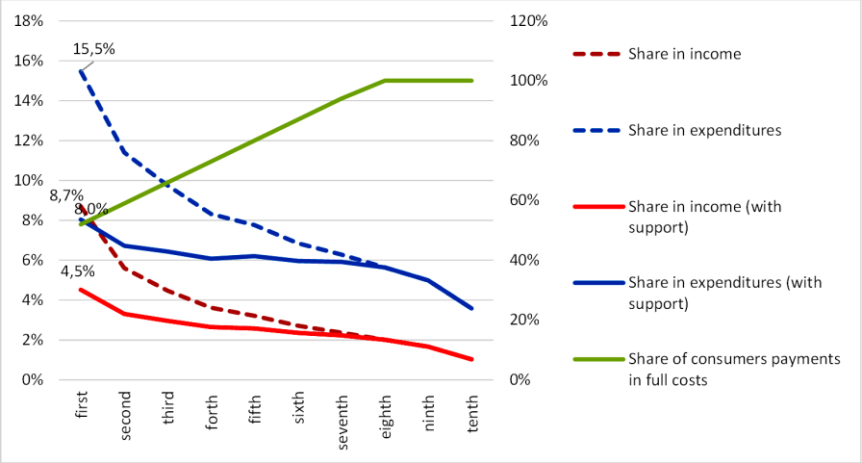
The DEFEND model was used to assess the distributional effects from the introduction of carbon price mechanisms. It was run with the following assumptions:

- Energy consumption is broken down by space heating, hot water supply, and other needs. For each of these, the fuel mix includes: coal, liquid fuel, natural gas, other solid fuels, electricity, and district heat. Specific energy consumption and the prospective fuel mix are borrowed from the *4D* scenario.[146] They are assumed to be equal for all deciles.
- Average Russian energy prices for residential consumers are used. On the 2060 horizon, they are growing 1% faster, than the consumer price index.
- In the main version of the calculations, the carbon price is introduced in 2031 at 3 USD/tCO_2. It then grows annually by 3 USD/tCO_2 to reach 108 USD/tCO_2 in 2060. Calculations are in rubles. The exchange rate is 127 rubles/USD in 2030 and 132 rubles/dollar in 2060. It is an outcome in the RUS-DVA model runs (see Chapter 2).
- In the main version of the calculations, the current energy subsidies for the housing sector remain: social support for individual categories of people, compensation of the difference in tariffs, and subsidies for the poor.
- In the future, the personal income evolves in line with GDP in accordance with the *4D* scenario. The elasticity of the share of household total expenditures relative to income is -0.25 (coefficient estimated for 2022).
- Average per capita living space grows in accordance with the *4D* scenario, and the values by deciles are distributed in accordance with the decile to average ratios observed in 2022.
- Specific GHG emissions from power and district heat production are set in the *4D* scenario.[147]

The transition to carbon neutrality and bringing the carbon price to 108 \$/tCO_2 in 2060 while maintaining the current social support schemes and pursuing a pro-active low carbon policy, will reduce the share of residential energy bills in income from the average 3.4% in 2022 to 2.8% in 2060, and for the first decile from 6.8% to 5.7% respectively (Figures 6.9 and 6.5). This is mainly the result of energy efficiency improvements and increased volumes of on-site renewable power generation.

[146] Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, 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.
[147] Ibid.

Figure 6.9 Deciles distribution by housing ECS in incomes and expenditures and by the share in covering the full energy supply costs in 2060

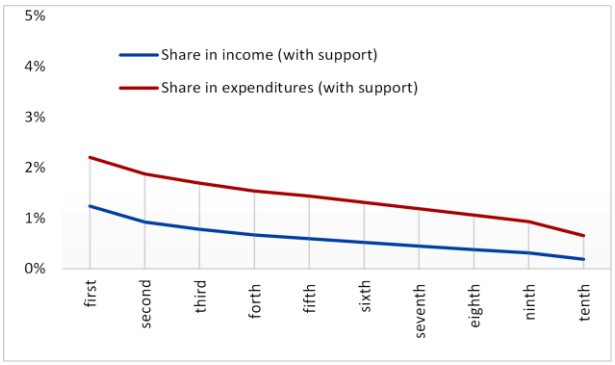


Source: the author.

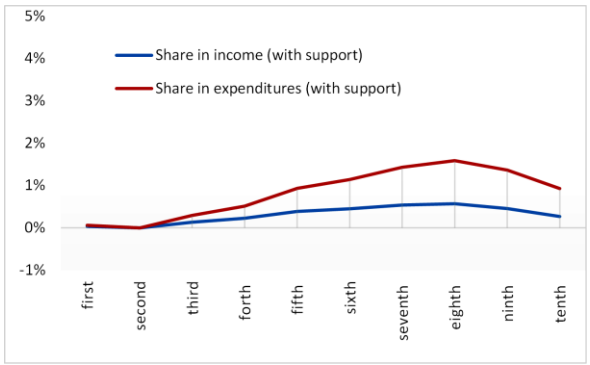
The effect of carbon pricing is regressive. It can be made neutral or progressive by changing the social support mechanisms without increasing the amount of such support. With the above assumptions, the introduction of a USD108/t CO_2 carbon price in 2060 will increase the ECS in income for the first decile by 1.2%, and for the tenth only by 0.2% (Figure 6.10a). This result is valid if the existing schemes of providing social support to households to pay their energy bills is unchanged.

There are a variety of social support mechanisms that can be tuned to follow the *worst first* principle. Under the existing scheme, benefits and subsidies to cover the tariff gap are provided regardless of the income level. An alternative scheme, which includes higher subsidies for the first deciles and the elimination of support for the last three deciles (Figure 6.10b) ensures a neutral effect of carbon pricing for the first two deciles and a weak progressive effect for the rest (Figure 6.10b).

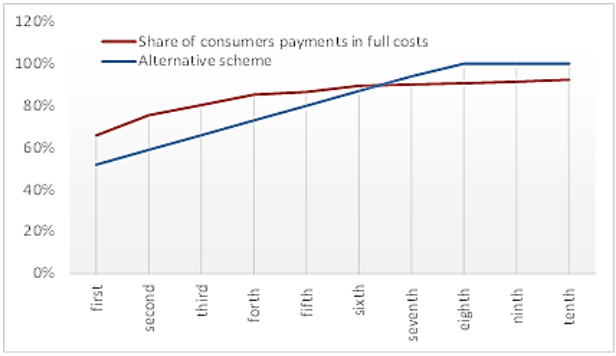
Figure 6.10 Deciles distribution of driven by carbon price increments in housing ECSs



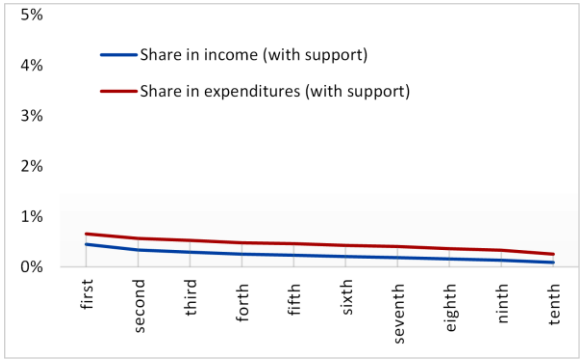
a) change in ECS from introduction of USD108/tCO_2 carbon price in 2060



b) change in ECS from introduction of 108 USD/tCO_2 carbon price in 2060 and from change in social support scheme



c) change in social support scheme



d) change in ECS from introduction of 10 USD/tCO_2 carbon price in 2030

Source: the author.

***Decarbonization first*. The negative effect of introducing a carbon price can be limited or fully offset through proactive energy efficiency policies and promoting both grid- and distributed "green" generation of power and heat**. With USD 10/tCO_2 carbon price, progress to this end will give a weak regressive effect in 2030. By changing social support schemes (Figure 6.10d) this effect could be neutral or weakly progressive.

Providing subsidies for the installation of on-site PVs equally for all deciles will reduce the burden, but will not change the regressive nature of the effect. The scheme in which the share of subsidies goes down as the income grows, will result in a neutral effect. The demand from the residential sector for photovoltaic (PV) on-site power microgeneration is gradually growing due to the significant cost reduction and increased localization of production. The law enshrines the right of households to supply part of their self-generation to the common grid, but at wholesale prices – which is a weak incentive. Subsidies for the purchase of PV equipment from Russian manufacturers with confirmed localization are being discussed.[148] Meanwhile, in other countries this is rapidly developing.[149] In the United States, solar panels were installed in more than 3 million residential buildings by 2022.[150] In order to assess the effects of providing subsidies for the installation of PV panels, the following assumptions were made:

- with no subsidies, annually 0.1% of individual buildings where the first-decile families live are equipped with solar panels. This share increases linearly and reaches 0.7% for the tenth decile. These shares depend on the share of subsidies. When subsidies are provided to cover the full costs, they grow to 0.4 and 1% respectively;
- the average reduction in the public grid electricity consumption per household is 2,295 kWh per year per 1 kW of PV installed. All self-generated electricity is used for the household's own needs;
- the average cost of purchasing a turnkeyPV panel is 30 thousand rubles/kW.

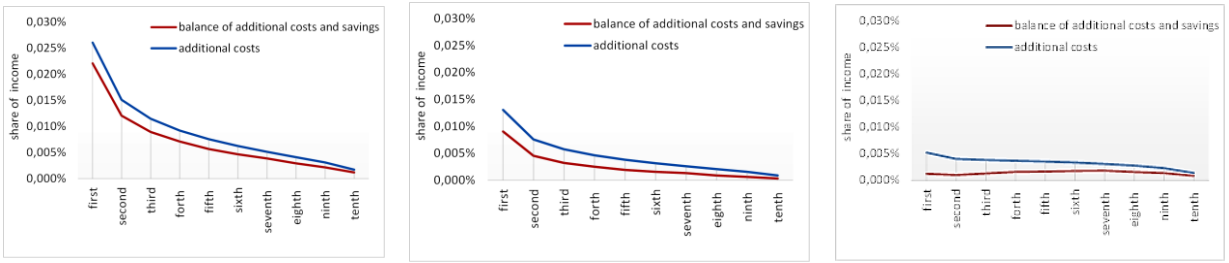
Three subsidy options have been considered: no subsidies; 50% subsidies; and a scheme with a decreasing share of subsidy as the income grows with 40% on average (Figure 6.11). The first two options have a regressive effect, whereas the last one is almost neutral, with an account of reduced grid electricity bills.

[148] https://iz.ru/1238221/valerii-voronov/podobrat-luch-v-rf-mogut-poiavitsia-subsidii-na-solnechnye-batarei-dlia-grazhdan.

[149] Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, O. Lebedev, A. Lunin, A. Myshak. 2023. Low-carbon technologies in Russia. Current status and perspectives. https://cenef-xxi.ru/articles/nizkouglerodnye-tehnologii-v-rossii.-nyneshnij-status-i-perspektivy.

[150] Barbose G., N. Darghouth, E. O'Shaughnessy, and S. Forrester. Tracking the Sun. Pricing and Design Trends for Distributed Photovoltaic Systems in the United States. 2023 Edition. Lawrence Berkeley National Laboratory. September 2023. trackingthesun.lbl.gov.

Figure 6.11 Distributional effects of on-site PV installations



a) no subsidies b) 50% subsidies c) scheme with a decreasing share of subsidies with 40% avarege

Source: the author.

6.2.3 Distributional effects of personal vehicles decarbonization

The first barrier to assessing the distributional effects is the inconsistency of data on the car ownership. According to the traffic police, there were 328 personal cars per 1,000 people in 2022 on average. Rosstat's data on the number of cars per 100 households by deciles range between 42 and 92, with the average of 64 cars per 100 households. Given the average size of a household 2.2 people,[151] this would result in 291 cars/1,000 people. The transition from ownership per 100 households to ownership per 1,000 people requires estimation of the average size of household by deciles. Rosstat does not provide such data. The DEFEND model used UK data as a proxy for ratios of decile values to the mean.[152]

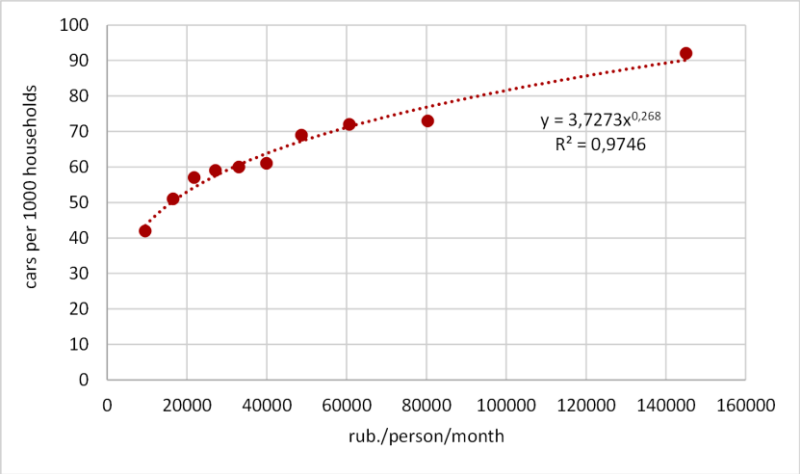
The second obstacle is the uncertainty of perspective trends in the passenger cars ownership by deciles. Calculations based on the *4D* scenario using the TRANS-GHG model (see Chapter 2) show, that low carbon transition in transport causes the passenger cars ownership decline from 328 cars/1,000 people in 2022 to 254 in 2030 and further down to 160 in 2060, or to 56 and 35 cars per 100 households respectively. Both figures are below the 2022 values. Figure 6.12 shows that as income grows, the cars ownership per 100 households scales up with an elasticity of 0.27. However, from the seventh to the ninth decile the car ownership is practically saturated. Rosstat has significantly increased the estimate for the tenth decile: from 77 cars per 100 households in 2021 to 92 in 2022 (Figure 6.13). When using the first number, practical saturation was observed for the tenth decile too. In the EU, the Gini index for energy use in transport is 0.47.[153]

[151] According to the 2002 All-Russian Population Census, it was 2.7 in 2002; according to the 2010 All-Russian Population Census it was 2.6; according to the 2015 Microcensus it was 2.4. Center for Macroeconomic Analysis and Short-Term Forecasting, Thesis 7. Demographic Policy: Staged Gap between Policy and Processes. TTF7.pdf (forecast.ru). Extrapolation of this trend gives 2.2 people in 2022. According to a limited sample of the Central Bank, it turns out 2.5 people (All-Russian household survey on consumer finances (5th wave). Technical report. Central Bank of the Russian Federation, 2023. method_t.pdf (cbr.ru). The use of such assessment leads to an even greater discrepancy in estimates of the car ownership.

[152] Percentage of households by size, composition and age in each gross income decile group: Table A49 - Office for National Statistics (ons.gov.uk).

[153] Büchs M., N. Cass, C. Mullen, K. Lucas and D/ Ivanova. Emissions savings from equitable energy demand reduction. Nature energy. Published online: 17 July 2023. https://doi.org/10.1038/s41560-023-01283-y.

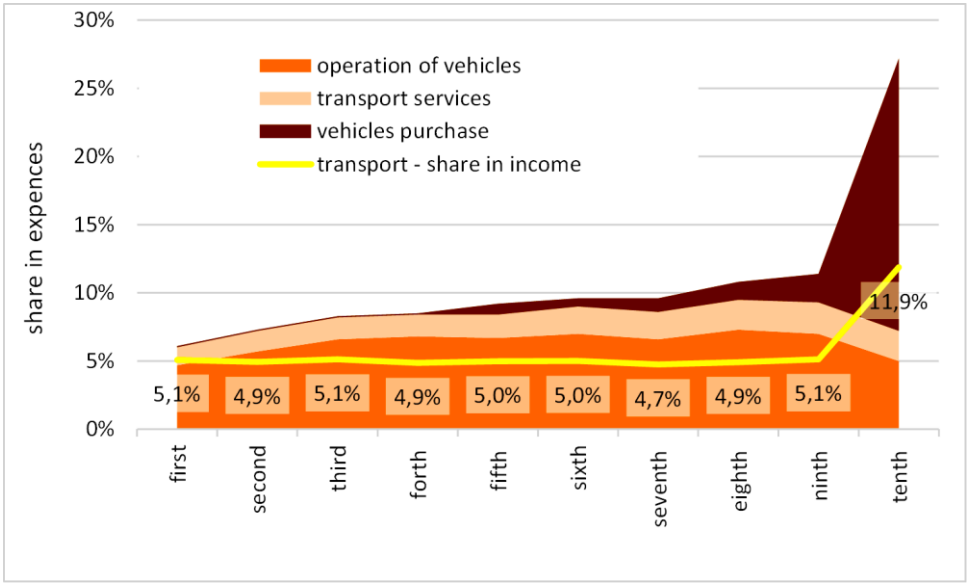
Figure 6.12 Car ownership as a function of income. 2022



Source: author based on Rosstat's data.

The share of transport expenses in total expenditures is progressive for all components for the first nine deciles. For the tenth decile, the share of costs related to the purchase of vehicles is steeply up, while the share of vehicles operation costs is down. The share of vehicles operation costs follows the ∩ law with a strongly extended apex. The share of transport expenditures in income is almost neutral for the first nine deciles and is steeply up for the tenth decile.

Figure 6.13 The share of transport costs in total expenditures and incomes. 2022



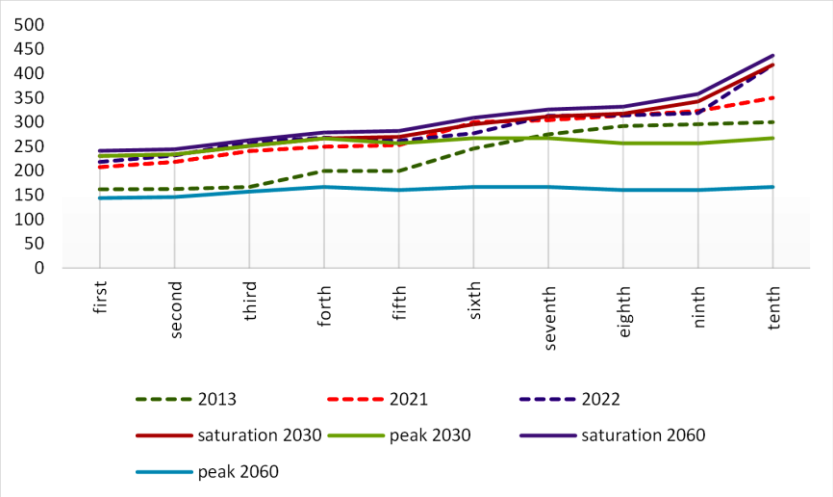
Source: the author based on Rosstat's data.

The third obstacle is the disagreement between the theoretical models of peak and saturation in car ownership. According to the peak theory, per capita personal vehicle mileage peaks as the income rises and then steadily declines. According to the market saturation model, car usage should plateau and remain on that level as the income grows. The peak theory is based on the decline in private car use as observed in many countries (Australia, Belgium, France, Germany, Iceland, Japan, New Zealand, Sweden, UK, USA) and in many cities. In many countries, the supply of all passenger cars in 2010-2021 grew slower than by 1% per year, and in Argentina,

Australia, Belgium, Great Britain, Sweden and Switzerland the growth rates were less than 0.5% per year.[154] The growth was mainly driven by taxis, car sharing and company cars. In a number of countries, stabilization of car ownership has almost been achieved at levels varying between 366 (Argentina) and 579 (Australia) cars per 1,000 people. If we assume that the share of personal cars is 90%, then by recalculating per 100 households we get 82 and 120 cars.

In the 4D scenario, decarbonization in transport relies on a significant change in the intensity and structure of personal mobility in accordance with the peak model (Figure 6.14). In France, saturation of personal passenger cars occurred in 1999-2000 for all quartiles, but at different levels, and then the ownership rate began to decline. The data are presented for 4 quartiles. The second and third quartiles reached the level of the fourth, and then the dynamics for all three almost coincided: the ownership rates declined. The first quartile reached saturation at a level 10-15% lower, than the other three, and froze.[155] In France, car ownership in cities with more than 100 thousand people peaked in 2008 (64% of households), and in 2015 this figure was already 7% below the peak value.[156] In Russia, 67% of the population live in such cities. In the DEFEND model, the ownership rate slightly grows for the first deciles, whereas for the other deciles it goes down. By 2060, it will decline substantially for all deciles.

Figure 6.14 Car ownership per 1,000 people as a function of income for car ownership peak and saturation models



Source: author.

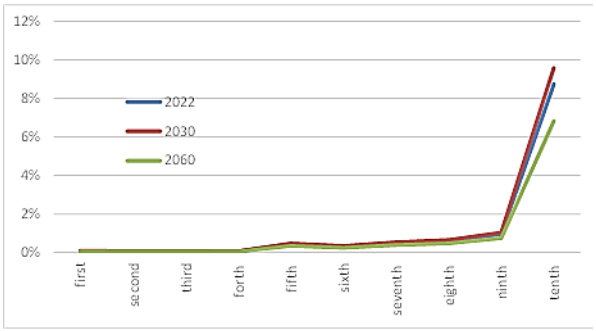
An important argument in favor of choosing the peak model for Russia is the inability of Russian consumers in all deciles to significantly increase their car ownership given the very slow expected growth of their incomes and the already sharp rise in car prices in 2022-2023. The average cost allocated to purchase a car was 96 rubles per person per year for the first decile, 1,716 rubles/person for the fifth, and 159,937 rubles/person for the tenth. According to Autostat, at the end of 2022, the weighted average price of a new passenger car in Russia amounted to 2.38 million rubles,[157] and according to Rosstat, in September 2023 the average price of a new domestic car was above 1 million rubles, and of a new imported car 2.3 million rubles. Even for the tenth decile it will take at least 6 years to increase the ownership rate by 1 car/1,000 people (14 years for the imported cars), and for the first nine deciles this is merely economically

[154] Indicators (oecd.org).
[155] Roger Collet, Elise Boucq, Jean-Loup Madre, Laurent Hivert. Long term dynamics of inequalities between French households concerning automobile. 12th World Conference on Transport Research, Jul 2010, Lisbonne, Portugal. 17p. hal-00615156.
[156] France | Motor Vehicle Ownership per Household | CEIC (ceicdata.com).
[157] https://www.autostat.ru/news/53894

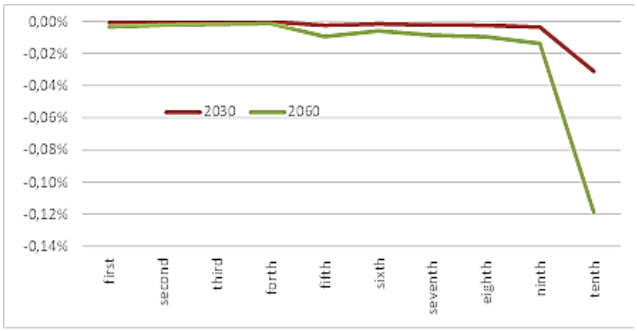
prohibitive. In Russia, the demand elasticity coefficient of new cars is -1...-1.6. There may be some increase and redistribution of ownership rates across deciles due to the purchase of second-hand cars, but it is unlikely to be significant. As the existing fleet wears out, the car ownership rate will go down.

Subsidies for purchasing electric vehicles up to the ninth decile inclusive will have a weak progressive effect (in terms of cost savings), which will be steeply up for the tenth decile, yet not above 0.12% of income, against the background of the 7-10% basic share of income used to purchase cars in 2060. The share of vehicle purchase costs (mainly cars, but also two-wheelers, trucks, and motor boats) in the incomes of the first nine deciles is small and only slightly changes over time (Figure 6.15). By 2060, the effect will be noticeable only for the tenth decile: this share will decrease, as electric vehicles will become cheaper and the sales volume will grow.

Figure 6.15 Effects from subsidies to purchase electric vehicles by deciles



a) change in the share of expenses to purchase passenger cars in income (excl. subsidies for electric vehicles)



b) change in the share of expenses to purchase passenger cars, incl. subsidies for electric vehicles

Source: author.

The distribution effects of providing subsidies to purchase electric vehicles were assessed using the DEFEND model with the following assumptions:

- the subsidy is assumed to be 200,000 rubles per car. This is more, than the subsidy for converting a car to compressed gas (50,000 thousand rubles).[158] The subsidy amount does not change, as the prices of cars with different power trains grow. Therefore, the share of the subsidy in the car price goes down, as cars become more expensive;
- real prices of gasoline and diesel vehicles are set at the 2022 levels and are adjusted for inflation. The real price of electric cars is assumed to be 2.4 times higher in 2022, than of gasoline cars, but it is 34% down in 2030 and 70% down in 2060. Average car price growth outpaces the consumer price index, similarly to how it was in 2000-2022;
- based on Rosstat's data and the data from the Russian car market, the dependence of the average purchased car price on the deciles' income was formed. The mean car price for the tenth decile is 3 times the mean for the first decile;[159]

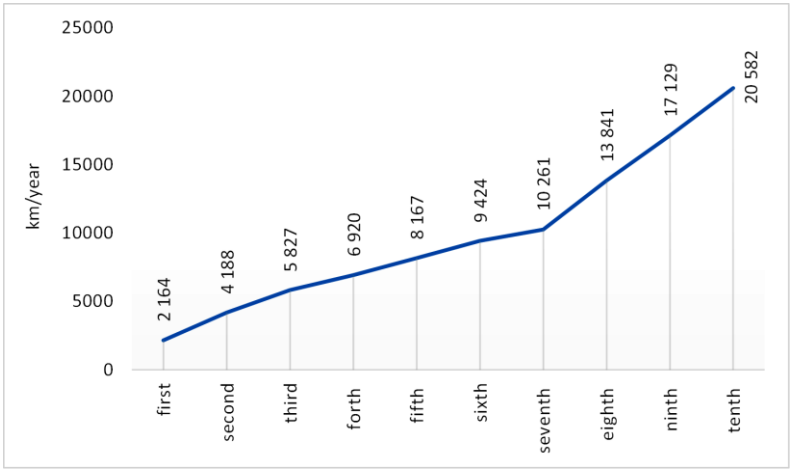
[158] According to the Government Decree of the Russian Federation No. 1427 of August 17, 2022, the subsidy amount equals 48% of the cost of converting a gasoline car to methane. Subsidies for converting gasoline cars to methane will double (elitegas.ru). The average cost of refurbishment is 75-95 thousand rubles, and the subsidy is 50-60 thousand rubles. Subsidies programme for compressed gas equipment installation. Specific features and the size of subsidies for compressed gas equipment installation (omvlgbo.ru).

[159] With an average configuration, the price gap between the cheapest of the 25 best-selling models on the market (Lada Niva) and the most expensive model (Toyota RAV4) was 5-fold.

- the share of expenses to purchase a car for each decile was determined based on Rosstat's 2019 data;
- the structure of purchased new cars by power train is estimated using the TRANS-GHG model depending on the car ownership cost.

One important factor in assessing the distributional effects of the introduction of carbon price on motor fuels is the multiple difference in average annual vehicle mileage across deciles: for the tenth decile, it is almost an order of magnitude higher, than for the first decile (Figure 6.16). The Russian statistics do not provide average vehicle mileage either for the country as a whole or by deciles. These data were estimated based on the share of vehicle operating costs in consumer expenditures, assuming that fuel purchase accounts for 90% of these expenditures. The calculation also used data on the structure of the private car fleet by power train and the corresponding fuel prices. For gasoline, a slight quality adjustment for deciles was made. The multiple difference in mileage can be attributed to a variety of reasons. Less well-off households tend to own cars with longer service life and poorer technical condition. Average mileage per year of a car that has been in service for 15 years is almost twice lower, than of a new car.[160] People commute long distances only if they have higher salaries, than could be offered by the nearby options. Many wealthy people live in the suburbs, because they have higher requirements in terms of personal space and privacy, and therefore are less inclined to use public transport, despite the time lost in traffic jams.

Figure 6.16 Distribution of average annual car mileage across deciles



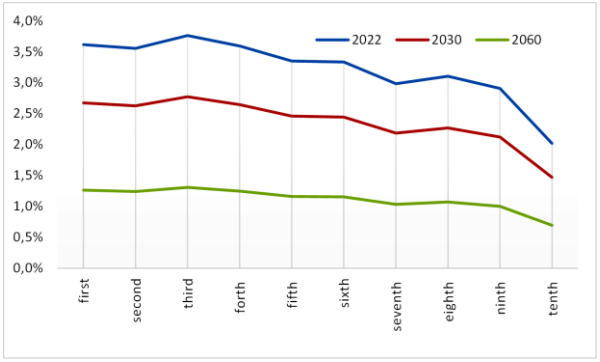
Source: author.

The first deciles benefit more from the implementation of the concept of peaking the cars ownership and their gradual electrification, which is necessary for the decarbonization of personal road transport. These measures reduce the share of personal fuel expenditures for all deciles (Figure 6.17). The average ECS drops from 2.9% in 2022 to 2.1% in 2030 and to 1.2% in 2060. This decrease is associated with a reduction in the car ownership for the upper deciles (Figure 6.11) and practical stabilization for the lower deciles due to the high (nearly prohibitive for the lower deciles) car prices, and later with the growing share of electric vehicles, the prices of which are expected to be substantially lower in 2060, than for liquid fuel-driven cars, and the costs of ownership will converge around 2030. The effect of ECS reduction may be partially offset by an increase in the share of expenditures to purchase passenger cars. For example, in the USA, a 1% change in the share of fuel expenditures incurred a 0.3-0.4% change in the share of car purchase

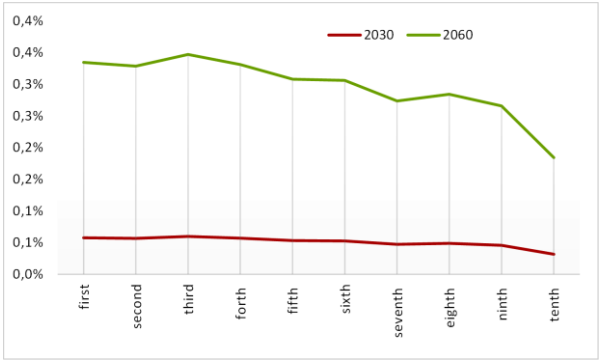
[160] Methodology for estimating the residual value of vehicles with an account of their technical condition. R-03112194-0376-98. Methodology for estimating the residual value of vehicles with an account of their technical condition. R-03112194-0376-98 — Edition of 10.12.1998 — Kontur.Normativ (kontur.ru).

expenses (with the opposite sign).[161] In Russia, part of this effect will be offset by an increase in the share of spending on public transport and taxis.

Figure 6.17 Effects of reduced car ownership and fleet electrification and the introduction of a carbon price



a) evolution of ECS with an account of reduction in car ownership and passenger car fleet electrification



b) change in ECS due to introduction of 10 USD/tCO_2 carbon price in 2030 and 108 USD/tCO_2 in 2060

Source: the author.

Introducing a carbon price for motor fuels has a weak regressive effect. On average, with a 10 $/$tCO_2$ price in 2030, the ECS in income will be 0.05% up, and with a 108 $/$tCO_2$ price in 2060 the ECS will be 0.3% up. Both estimates are noticeably lower, than the gains from the decarbonization of personal road vehicles with a decrease in the personal car ownership. These effects were assessed using the DEFEND and TRANS-GHG models with the following assumptions:

- personal car ownership peaks and then decreases according to the pattern shown in Figure 6.12;
- fuel and electricity prices increase annually by inflation plus one percent plus the carbon price make-up component. Specific GHG emissions from power generation are borrowed from the 4D scenario;[162]
- specific fuel consumption decreases, as the fleet rotates and powertrain structure evolves according to the estimates obtained in the 4D scenario using the TRANS-GHG model;
- the structure of the vehicle fleet by power train evolves according to the 4D scenario.

The maximum increase in the share of public transport costs in income driven by the introduction of a carbon price does not exceed 0.05%. As private mobility declines the share of income spent on public transport will escalate. The degree of such escalation was not if the focus of this study. In 2012-2021, the share of expenses on public transport (for all types of transport) was down from 3% to 1.9% of total expenses. In 2022, it was back to 3%. In relation to income it amounted to 1.7% in 2022. The ECS for public transport, depending on the type of transport, is 17-29%. The introduction of a carbon price at 10 USD/tCO_2 in 2030 and 108 USD/tCO_2 in 2060 will bring the price of liquid fuels 10% up and the price of electricity 6% up. As a result, only a limited increase in public transport expenditures can be expected. An investigation of the welfare effects of transport decarbonization policy portfolios (bus rapid transit network; fuel tax; 'fuel efficiency' policy assuming mandatory use of low emission vehicles)

[161] Bashmakov I.A. and A. Myshak. "Minus 1" and Energy Costs Constants: Sectorial Implications. Journal of Energy. Volume 2018, Article ID 8962437, https://doi.org/10.1155/2018/8962437.

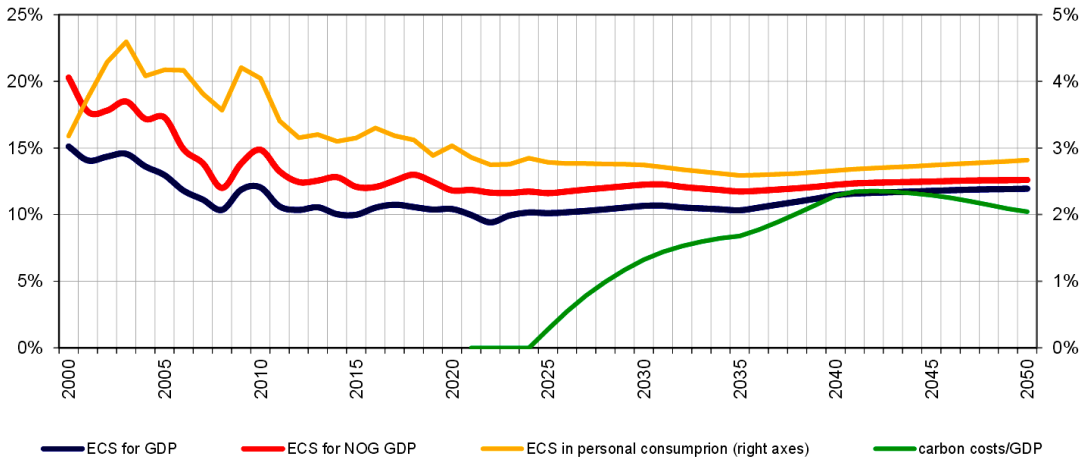
[162] Bashmakov I., V. Bashmakov, K. Borisov, M. Dzedzichek, A. Lunin, I. Govor. 2022. Russia's carbon neutrality: pathways to 2060. CENEf-XXI. https://cenef-xxi.ru/articles/russia's-carbon-neutrality:-pathways-to-2060.

across 120 cities to 2035 shows that these three policies have positive welfare effects (including for human health) ranging between 0.3 and 0.6%. Additional costs are estimated at 0.1% for bus rapid transit network; -0.1 for fuel tax; and 0.4 for fuel efficiency. Only a restrictive land-use regulations policy promoting urban density has welfare effects was estimated negative.[163]

6.2.4 Energy affordability in the low carbon scenario

Even if in the 4D scenario a 3 USD/tCO₂ carbon price is introduced in 2031 and steadily grows to 108 USD/tCO₂ in 2060, the affordability of energy remains unchanged, and the energy cost share in GDP, in the NOGGDP, and in personal income will not exceed the levels observed in 2000-2022 (Figure 6.18). Carbon price revenues peak at 8.5 trillion rubles in 2047, and their share in GDP will be 2.4% in 2042. Since a fiscally neutral introduction of a carbon price is assumed, there will be no additional pressure on business.

Figure 6.18 Energy costs shares in 4D scenario



Source: the author.

Energy affordability (the share of energy costs in GDP, NOGGDP or household income) will remain near or below the thresholds and ranges recorded in 2000-2022. It will be slightly above the thresholds in market economies dominated by the service sector, but similar to, or lower than, the values observed in economies, such as South Korea, that specialize in the export of fuels or energy-intensive materials.[164]

[163] Liotta C., V. Viguié & F. Creutzig. Environmental and welfare gains via urban transport policy portfolios across 120 cities. Nature Sustainability | Volume 6 | September 2023 | 1067–1076.

[164] Bashmakov, I., M. Grubb, P. Drummond, R. Lowe, A. Myshak, and B. Hinder. 'Minus 1' and Energy Costs Constants: Empirical Evidence, Theory and Policy Implications. Available at SSRN: https://ssrn.com/abstract=4401851 or http://dx.doi.org/10.2139/ssrn.4401851