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Climate Policies of G20 and New Threats for Russian Energy and Transportation Complex

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ABSTRACT

The aim of this study is tracking the goals of national climate policies and real trends in the carbon intensity of the economies of the G20 countries. A comparative content analysis of the Intended Nationally Determined Contributions (INDC) of the G20 countries was performed. The trends of mean were built for the carbon intensity indicator of G20 countries in the period 1991-2014. The countries, which already passed the peak of the carbon intensity of the economy, were identified. The constructed models of time series of carbon intensity can be used to forecast the future dynamics of the carbon intensity of the G20 countries and to estimate the changes in the world's hydrocarbons demand. The issues of global energy security from the perspective of energy resources exporters were discussed.

Keywords: Climate Strategies, G20, Carbon Intensity, Global Energy Security, Energy Transition
JEL Classifications: O33, Q42, Q47, Q48

1. INTRODUCTION

Nowadays the climate change problems are in the center of attention of both politicians and the world business community (Yeganeh et al., 2020) An active discussion about the need for urgent measures to reduce greenhouse gas (GHG) emissions and the essence of these measures goes beyond climatology and ecology, since the main emitters of greenhouse gases are such powerful sectors of the world economy as energy, construction and transport (Hasan et al., 2020; Alves et al., 2020: Lomborg, 2020). The transition to low-carbon technologies in these sectors of the economy is associated not only with huge investments, but also with changes in the existing infrastructure, consumer behavior of millions of people (Revinova et al., 2020), and most importantly, with the degradation of some traditional markets and the formation of completely new markets with other major players (Lomborg, 2020; Ratner et al., 2020). Therefore, the introduction of low-carbon technologies is still a field of competitive war between the largest energy corporations and, as a result, between the countries to which these corporations belong de jure.

Russia traditionally belongs to countries with highly developed energy, but low energy efficiency of the economy (Makarov and Mitrova, 2018; Iosifov and Ratner, 2018). Of the entire range of low-carbon energy technologies, only nuclear and hydropower technologies are highly developed in Russia (Proskuryakova and Ermolenko, 2019). Of the low-carbon transport technologies in the Russian Federation, railway transport is the most developed, however, in recent decades it has significantly lagged behind modern technical and service standards. Russian vehicle manufacturers (especially when their products are used in international markets) often face high competition in terms of environmental friendliness and fuel efficiency and lose in the competition (Ratner and Zaretskaya, 2018). This situation most clearly manifests in aircraft construction and air transportation (Yilmaz and Atmanli, 2017; Ratner et al., 2019; Csereklyei and Stern, 2020). However, other transport sectors are also affected by the overall trend to reduce carbon intensity and improve energy efficiency (Ershov et al., 2016; Karpov, 2019; Titova and Ratner, 2019; Matraeva et al., 2019; Ratner et al., 2020).

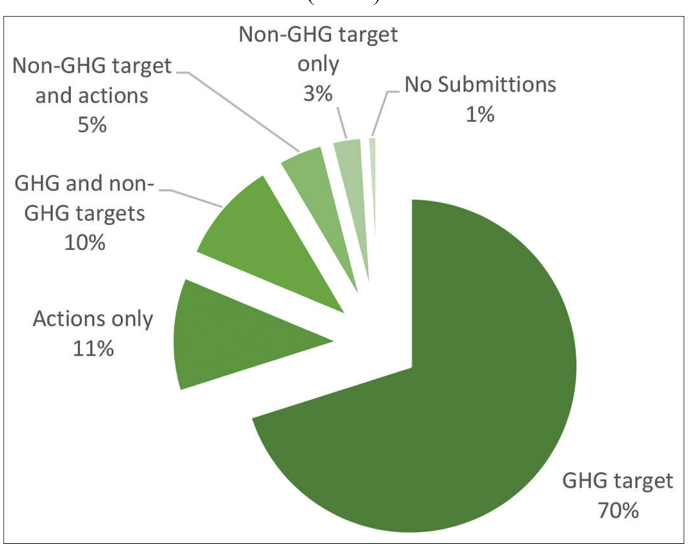
For Russia, as one of the world's main exporters of energy resources (oil, natural gas, coal), a decrease in energy consumption in the countries consuming Russian energy products can also pose a significant threat for national economy (Paltsev, 2014; Orlov, 2017; Talipova et al., 2019).

In December 2015, following the 21st conference of the Framework Convention on Climate Change (FCCC) in Paris, a climate agreement was adopted. Officially, this agreement was called the Paris Agreement under the UNFCCC (the United Nations Framework Convention on Climate Change). The agreement was supported by about 200 countries participating in the convention. This agreement is structured as a composite document that includes both the legal obligations of the UN protocol and separately adopted decisions of the convention.

The countries participating in this agreement, taking into account the fact of global climate change, intend to follow the path of sustainable development. The purpose of this agreement is "to prevent the global average annual temperature increase on the planet from exceeding 2°C from the pre-industrial level and to do everything possible to keep warming within 1.5°C." To achieve this global goal, each country undertakes a certain set of activities and quantitative obligations in the form of a declared nationally determined contribution (INDC). In contrast to the binding "top-down" approach adopted in the Kyoto Protocol, which stipulates censure and even punishment of countries that fail to meet the task of reducing GHG emissions, the Paris Agreement is based on "bottom-up" principle and voluntary commitments (Falkner, 2016; Bäckstrand et al., 2017; Tobin et al., 2018; Jernnäs and Linnér, 2019; Vrontisi et al., 2020).

At the moment, according to the World Resource Institute, the majority of countries that have signed the Paris Agreement undertake certain obligations to reduce greenhouse gas (GHG) emissions (Figure 1). An even larger group of countries (over 11%) does not define specific targets for reducing GHG emissions,

Figure 1: Distribution of countries participating in the Paris climate agreement by type of declared nationally determined contributions (INDC)



Source: http://cait.wri.org/indc/#/

but declares its own action plan, consisting of certain measures to reduce GHG emissions. In addition to targets for reducing GHG emissions, countries can define other targets in their national climate commitments. For example, these can be goals for the conservation of biodiversity, the preservation of ecosystems in certain areas, or for the restoration of forests. The share of such countries in the total number of countries participating in the Paris Agreement is currently just over 10% (Figure 1).

The aim of this study is tracking the goals of national climate policies and real trends in the carbon intensity of the economies of the G20 countries. The rest of the paper is organized as follows: Section 2 describes the methodology and data of research; the main results of the study are presented and discussed in the Section 3. The Section 4 concludes the study by highlighting basic policy applications of obtained results, describing the limitation and future directions of the study.

2. METHODOLOGY AND DATA

The research was performed in two stages. At the first stage, a comparative content analysis of the Intended Nationally Determined Contributions (INDC) of the G20 countries was implemented; the goals of G20 climate policies and the main declared strategic measures to achieve these goals were identified. The information base for this stage of the study was formed by the official documents of the UN (Framework Convention on Climate Change, Paris Agreement on Climate, Intended Nationally Determined Contributions [INDC]).

At the second stage of the study, a time series for the carbon intensity (total annual GHG emissions per capita) of the economies of all G20 countries were built for the period from 1991 to 2014. The information base for the second stage of the study was the data of the World Bank (https://data.worldbank.org). In this source the data for 2014 is the latest, so, unfortunately, we could not find newer data on the studied indicator. The choice of indicator for the study of the dynamic of carbon intensity is not traditional, since in many studies the ratio of GHG emissions to GDP is used as an indicator of carbon intensity (Yang and Su, 2019; Hoang et al., 2018; Bhattacharya et al., 2020; Xiao et al., 2020; Rodriguez et al., 2020). However, it takes into account the energy intensity and, as a consequence, the carbon intensity, not only of the manufacturing sector, but also of the energy supply sector for the population, therefore, it seems more objective (Ratner and Ratner, 2017). Comparing different countries according to this indicator, we can talk not only about energy intensity, and, as a consequence, carbon intensity of their economies, but also include in consideration such a concept as "energy poverty" (Betto et al., 2020; Lin and Wang, 2020).

For each time series, the trend of mean with the highest quality of approximation was chosen. When constructing trends, we were especially interested in the question of how much they correspond to the Kuznets ecological curve. Are there any G20 countries that have passed the peak of their carbon intensity? Are there any countries that are approaching this peak? These questions were considered as the main research hypotheses.

3. RESULTS AND DISCUSSION

3.1. Main Objectives of Intended Nationally Determined Contributions of G20

The analysis of the texts of Intended nationally determined contributions of the G20 countries allows us to highlight some quantified goals for reducing GHG emissions. This goals and the types of obligations of the countries are summarized in Table 1.

As one can see, most of G20 countries have set the goal of reducing the level of greenhouse gas emissions by a certain percentage of the level of a certain base year. The largest reductions are projected in Brazil and the European Union, the smallest in Turkey. The variation in emission reduction values is explained by the fact that each country has different climatic conditions and the ability to achieve highlighted goals without harming its economy by they own, without UN assistance. The freedom to choose goals and strategies for achieving the declared goal of the agreement comes from the voluntary nature of Paris agreement. Thus, countries are not only free to choose to participate in this event or not, but they themselves set goals and methods of their achievement.

Content analysis of the texts of Intended nationally determined contributions also allows to highlight the strategic measures that the country intends to carry out in certain sectors of the economy to achieve the declared goals to reduce GHG emissions. Table 2 summarizes the content of energy and transport activities in individual G20 countries that have explicitly included them in their Intended nationally determined contributions.

It should be noted, that although the texts of Intended Nationally Determined Contributions are intended to reflect the global goals of countries in the field of energy and transport, they do not clearly describe all the implemented or planned measures that have an impact on GHG emissions. For example, many of the G20 countries currently have quantified targets for phasing out internal combustion vehicles and moving towards green mobility. For example, at the beginning of 2020, the UK set a goal to completely ban sales of cars with gasoline and diesel engines by 2035, and their operation by 2050 (https://www.gov.uk/government/news/pm-launches-un-climate -summit-in-the-uk). The cessation of the use of cars with internal combustion engines within 10-30 years has been announced by about 10 countries of the world, including such large G20 countries as India and the China.

Nevertheless, when analyzing the specific goals of the G20 countries in the field of transport energy, it is easy to see that none of the countries with clear strategies for improving energy efficiency in transport is a neighboring country for Russia or a country with significantly intersecting passenger and transport flows. Therefore, for now, the risk that the climatic standards introduced by these countries will have a negative impact on Russian carriers can be assessed as minimal. On the other hand, taking into account the identified restrictions can be useful when developing export measures for promoting the products of Russian vehicle manufacturers to international markets.

Table 1: Climate goals of the G20 countries in the framework of Intended nationally determined contributions

Country	Target	Type of obligation
Argentina	Net emissions of carbon dioxide should not exceed 483 million tons by 2030	goal is a threshold for the entire economy
Australia	To reduce greenhouse gas emissions by 28%, compared with 2005 emissions by 2030	Target value of GHG emissions versus base year's value
Brazil	To reduce greenhouse gas emissions by 37%, compared to 2005 emissions by 2025	Target value of GHG emissions versus base year's value
China	To reduce carbon dioxide emissions per unit of GDP by 60-65% from the 2005 level by 2030; to achieve the peaking of carbon dioxide emissions around 2030 and making best efforts to peak early	Target value on carbon intensity versus base year's value
Canada	To reduce greenhouse gas emissions by 30%, compared with the level of emissions in 2005 by 2030	Target value of GHG emissions versus base year's value
European Union	To reduce greenhouse gas emissions by 40%, compared with the level of emissions in 1990 by 2030	Target value of GHG emissions versus base year's value
Indonesia	To reduce overall emissions by 26% in the commercial sector by 2020	Target value of GHG emissions versus base year's value
India	To reduce emissions by 37% of business as usual (BAU) by 2030	Target value of GHG emissions versus extrapolation of current development (business as usual scenario)
Japan	To reduce greenhouse gas emissions by 26%, compared to 2013 by 2030	Target value of GHG emissions versus base year's value
Mexico	To reduce greenhouse gas emissions by 25% by 2030	Target value of GHG emissions versus base year's value
Russia	To achieve a level of anthropogenic emissions equal to 75% of emissions in 1990 by 2030	Target value of GHG emissions versus base year's value
Saudi Arabia	To reduce CO2 emissions to 130 million tons by 2030	Goal is a threshold for the entire economy
South Korea	To reduce emissions by 37% of BAU levels by 2030	Target value of GHG emissions versus extrapolation of current development (business as usual scenario)
South Africa	To keep emissions by 2025 and 2030 in a range between 398 and 614 MtCO2eq	Trajectory target
Turkey	To reduce greenhouse gas emissions by 21% by 2030	Target value of GHG emissions versus base year's value
USA	To reduce the level of greenhouse gas emissions by 28% compared to the level of emissions in 2005 by 2025 with a further decrease in this indicator by another 28%	Target value of GHG emissions versus base year's value

Source: Authoring

With regard to the energy sector, Turkey and China are one of the main strategic markets for Russian gas; therefore, the policies of these countries in the field of energy efficiency and decarbonization of energy supply may pose certain risks for Russia as an energy exporter.

Thus, as a result of the analysis of the goals of the national climate policy declared within the framework of the Paris Agreement, a circle of countries was selected for further more detailed study and monitoring of the planned measures to improve the energy efficiency of the entire economy and the transport sector in particular. Such monitoring is the direction of further research of the authors.

3.2. Analysis of the Main Trends in the Carbon Intensity of the Economies of the G20 Countries

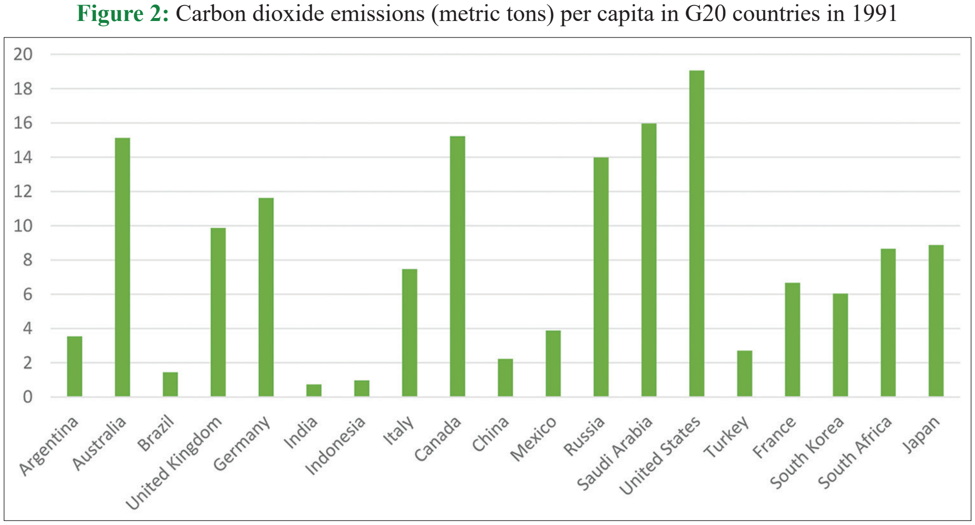
Figures 2 and 3 show the results of a comparison of the G20 countries in terms of the carbon intensity of the national economy in 1991 (the beginning of the study period) and in 2014 (the latest available statistics).

Table 2: Measures GHG emissions reduction in G20 countries in the energy and transportation sectors

Country	Measures in energy sector	Measures in transportation sector
Australia	-	Researching opportunities to improve the efficiency of light and heavy vehicles
Argentina	A wider introduction of renewable energy, a transition to biofuels	Improving rail infrastructure and introducing technologies and services that contribute to the modernization and efficiency of the rail transport system.
China	To expand the use of natural gas: by 2020, achieving more than 10% share of natural gas consumption in the primary energy consumption and making efforts to reach 30 billion cubic meters of coal-bed methane production; To achieve the installed capacity of wind power reaching 200 gigawatts, the installed capacity of solar power reaching around 100 gigawatts and the utilization of thermal energy reaching 50 million tons coal equivalent by 2020	To promote the share of public transport in motorized travel in big-and-medium-sized cities reaching 30% by 2020 To improve the quality of gasoline and to promote new types of alternative fuels
Canada	Complete rejection of coal as a source of energy	Standards for the content of biofuels in the fuel mixture Fuel consumption standards for heavy duty vehicles after model year 2018
India	Transition to energy efficient lighting, introduction of mechanisms to stimulate energy efficient technologies in industry, introduction of energy efficiency standards for buildings	Introduction of new standards for corporate average fuel consumption for vehicles (in 2017 and 2022)
Saudi Arabia	-	Development of the public transport system in urban areas (mainly metro)
South Africa	As part of a Renewable Energy Independent Power Producer Procurement Programme (REI4P) has approved 79 renewable energy IPP projects, total 5,243 MW, another 6,300 MW are under consideration.	To invest US$513 billion from 2010 until 2050 in development of electric vehicles; to invest US$488 billion by 2030 in hybrid electric vehicles To achieve a share of hybrid electric vehicles 20% by 2030
Turkey	Stimulus for the introduction of energy efficient technologies as part of the national energy efficiency strategy	-

Source: Authoring

Figure 2: Carbon dioxide emissions (metric tons) per capita in G20 countries in 1991



Source: Authoring

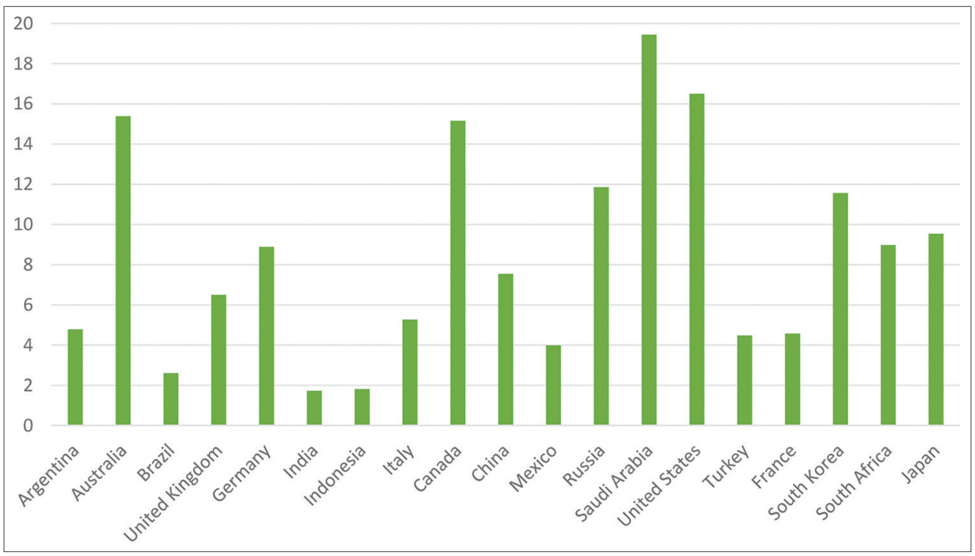
As one can see from the analysis of the graphs presented in Figures 2 and 3, the set of top-5 countries with the highest carbon intensity remained almost the same. As in 1991, in 2014 it includes Saudi Arabia, the United States, Canada, Australia and Russia. South Korea shows very close to Russian indicators in 2014. The group of countries with the lowest CO2 emissions per capita continues to be India, Indonesia and Brazil. However, China left this group of countries; its CO2 emissions per capita almost reached the level of Germany (Figure 3).

Table 3 shows the trends in the dynamics of CO2 emissions per capita, built for each country separately using least square technic. When selecting a type of the trend, preference was given to trends with the highest level of approximation and, at the same time, the simplest.

As one can see from the analysis of the trend equations presented in Table 3, the following countries increased their CO2 emissions per capita: Argentina, Brazil, China, Mexico, Turkey and South Korea. Moreover, of all the listed countries, China showed the strongest growth of the carbon intensity per capita, which is exponential (Figure 4). The smallest increase in CO2 emissions per capita has occurred in Mexico.

Some countries, for example, Indonesia, also showed an increase in CO2 emissions per capita during the study period, but this growth was not smooth and had some fluctuations. It can be associated with both changes in government policy in the energy sector, and with some other factors requiring more detailed study (Figure 5). However, a simpler linear trend also gives a good quality of

Figure 3: Carbon dioxide emissions (metric tons) per capita in G20 countries in 2014



Source: Authoring

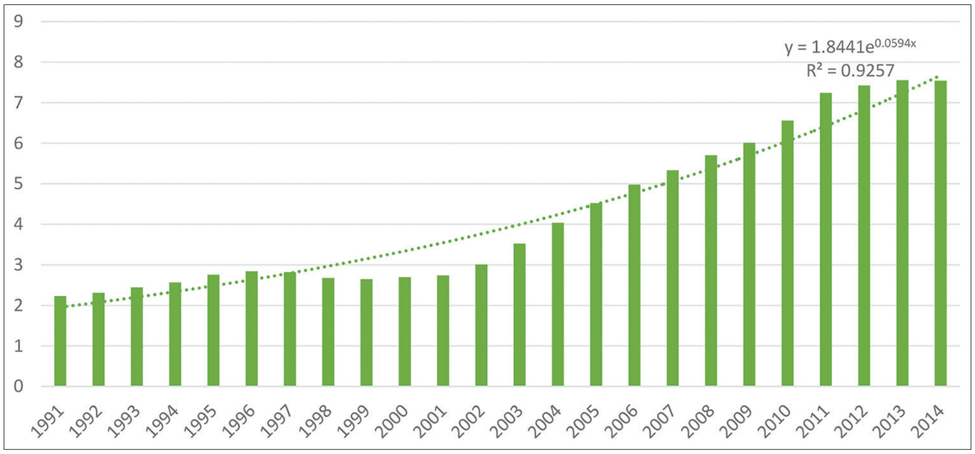
Table 3: Types of trends for the dynamics of CO_2 emissions per capita in the G20 countries for the period 1991-2014

Country	Trend's equation	The quality of approximation
Argentina	$y=0.0564x+3.3462$	$R^2 = 0.7357$
Australia	$y=-0.0141x^2+0.4253x+14.342$	$R^2=0.7434$
Brazil	$y=0.0397x+1.3915$	$R^2=0.8303$
Canada	$y=-0.0176x^2+0.4252x+14.538$	$R^2=0.8703$
China	$y=1.8441e^{0.0594x}$	$R^2=0.9257$
France	$y=-0.0552x+6.5054$	$R^2=0.6398$
Germany	$y=-0.0975x+11.226$	$R^2=0.9066$
India	$y=0.6908e^{0.0348x}$	$R^2=0.9529$
Indonesia	$y=-6E-05x^4+0.0029x^3-0.0439x^2+0.2572x+0.7097$	$R^2=0.8479$
Italy	$y=-0.0137x^2+0.2871x+6.575$	$R^2=0.8555$
Japan	$y=5E-05x^4-0.0021x^3+0.0228x^2+0.0043x+8.92$	$R^2=0.438$
Mexico	$y=0.0211x+3.8218$	$R^2=0.4401$
Russia	$y=-0.0021x^3+0.0974x^2-1.2794x+15.546$	$R^2=0.8756$
Saudi Arabia	$y=-0.0037x^3+0.1694x^2-1.9519x+19.629$	$R^2=0.7073$
South Korea	$y=0.2161x+6.7762$	$R^2=0.8999$
South Africa	$y=-1E-04x^4+0.0043x^3-0.0555x^2+0.28x+7.9811$	$R^2=0.5159$
Turkey	$y=0.0783x+2.5243$	$R^2=0.9122$
United Kingdom	$y=-0.1175x+10.144$	$R^2=0.8192$
United States	$y=-0.0171x^2+0.2975x+18.536$	$R^2=0.9234$

approximation ($R^2 > 0.76$), so Indonesia can also be ranked among the group of countries with increasing CO2 emissions per capita.

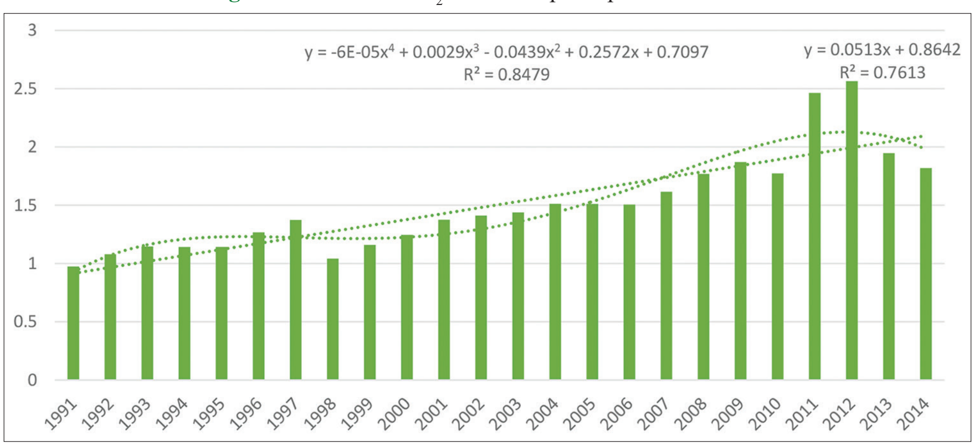
On the contrary, the more economically and technically developed countries in the G20 group decreased the carbon intensity of their economies during the study period. These are countries such as Great Britain and Germany, where the CO2 per capita indicator monotonically decreased along a linear trend throughout the entire period from 1991 to 2014. Countries such as Australia, Italy, Canada and the United States have passed the peak of their economies' carbon intensity during the study period, and CO2 emissions per capita began to decline along a parabola (Figures 6-8). This type of dynamics is most clearly seen on the graph for Canada (Figure 8).

Figure 4: Dynamics of changes in CO_2 emissions per capita in China



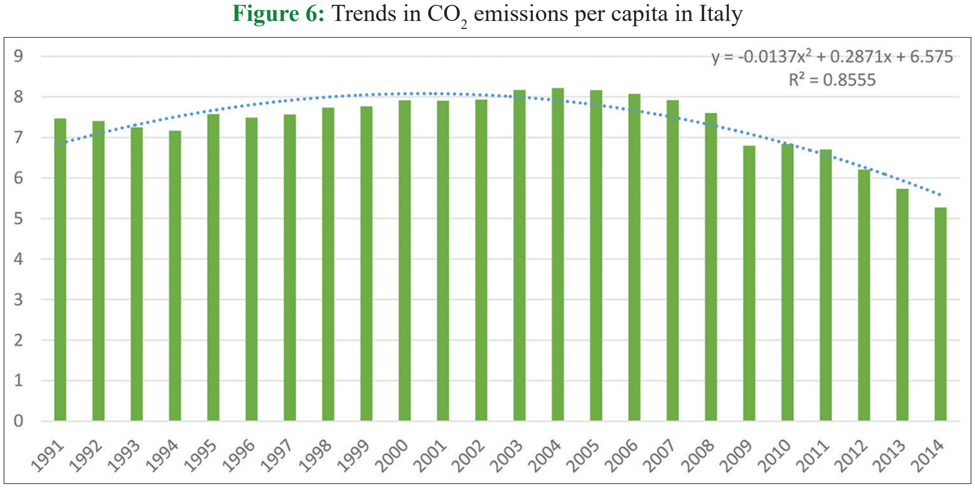
Source: Authoring

Figure 5: Trends in CO_2 emissions per capita in Indonesia



Source: Authoring

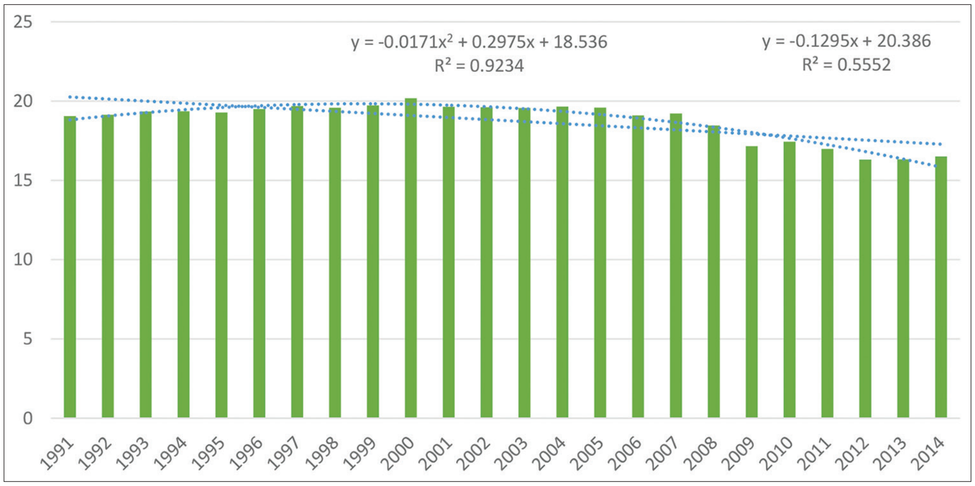
Figure 6: Trends in CO_2 emissions per capita in Italy



Source: Authoring

In Russia, as in some other G20 countries, the dynamics of the carbon intensity of the economy is more complex (Figure 9). Per capita CO2 emissions are decreasing in some periods and increasing in others.

Figure 7: Trends in CO_2 emissions per capita in USA



Source: Authoring

Figure 8: Trends in CO_2 emissions per capita in Canada

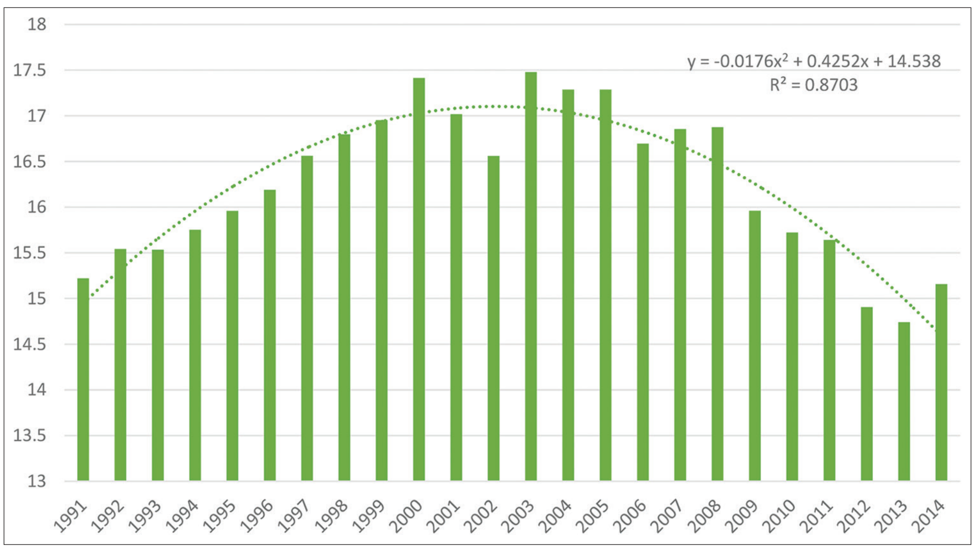


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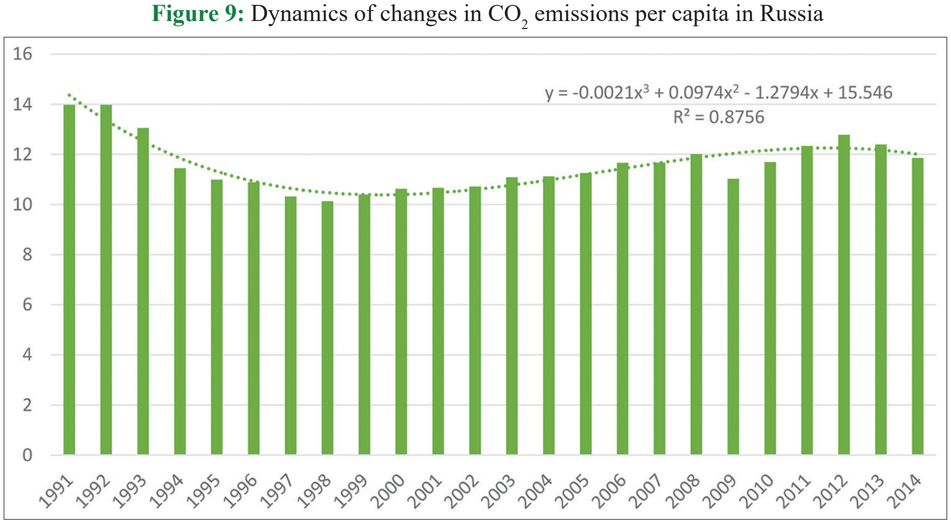
Figure 9: Dynamics of changes in CO_2 emissions per capita in Russia



Source: Authoring

This dynamic is also typical for Saudi Arabia, which in 2014 became the country with the highest CO2 emissions per capita. South Africa and Japan demonstrate the dynamics of carbon intensity described by a polynomial of the fourth degree, but the quality of approximation of the time series is not high enough. This fact suggests the presence of a seasonal component in the time series.

The constructed models (Table 3) can be used to forecast the dynamics of the carbon intensity of the G20 countries, as well as to select countries and the time for a more detailed study of the factors influencing the change in the dynamics of carbon intensity.

4. CONCLUSIONS

The G20 countries are by far the largest consumers of hydrocarbon resources in the world and, as a consequence, the largest emitters of anthropogenic greenhouse gases. Therefore, the study of the energy transition, which is taking place in these countries, can provide new knowledge in several areas of social and economic sciences. On one hand, by studying the dynamics of greenhouse gas emissions in these countries, it is possible to track those countries that have already passed the peak of the carbon intensity of the economy and recognize the government measures of these countries as the most effective in terms of reducing the anthropogenic impact on climate. The most effective strategic measures can become the standard of modern management in the context of the energy transition. For example, based on the results of this study, it is possible to point out Canada and Italy as the countries with the most effective energy transition management and, then, study in more detail the Canadian experience in the development of renewable and low-carbon energy (Bataille and Melton, 2017; Maiorano, 2019), and the Italian experience in development of biofuels and smart grids (Malinauskaite et al., 2019; Ratner and Nizhegorodtsev, 2018).

On the other hand, by studying the strategies of the G20 countries in the field of reducing the carbon intensity of economies, one can assess the potential for reducing global demand for hydrocarbons, as well as changes in the structure of demand (for example, abandoning some hydrocarbon energy resources in favor of others). This helps not only to predict the feasibility of achieving the goals of the Paris Agreement, but also prepares countries - exporters of hydrocarbons for the necessary changes in their economies. Given the dependence of a number of G20 countries on the export of hydrocarbons, the studies, which identify the risks of changing demand for these energy sources, make a certain positive contribution to promoting the idea of a new global energy security. In recent decades, the term "energy security" has usually been understood as such a system of economic relations between countries that ensures uninterrupted supply of energy resources and, thus, reflects the interests of energy consumers (Zhang et al., 2017; Rodríguez-Fernández et al., 2020). However, the interests of energy suppliers must also be taken into account to ensure the sustainable development of these countries in the social and economic spheres.

The main limitation of the study is the lack of analysis of the dynamics of carbon intensity in the G20 countries in the period 2015-2020, i.e. after the signing of the Paris Agreement. Such an analysis could show how successful different measures for reduction carbon intensity were in different countries, and provide more plausible models for predicting carbon intensity dynamics. Elimination of these limitations is the subject of further research by the authors.

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