

# Dynamics and Accounting of GHG Emissions in the World

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**Abstract.** The problem of climate change on the planet has been gradually forming since the middle of the 20th century. as the idea of a universal threat, to combat which humanity needs to unite and regulate the waste of resources. To do this, the problem of global climate change had to be introduced both into the political and economic agenda, and into the basic world system of values. Only then would climate rhetoric be able to influence political decisions and shape the way people live, as well as influence the global economy. But for this it is necessary to prove that humans are to blame for global climate change. The fact that nature is constantly changing, scientists knew until the middle of the 20th century. But it was believed that the reasons for this lie in the laws of long and short climatic cycles, and man has nothing to do with global changes. And this means that it is impossible to justify the reasons why the global community and individuals should change their behavior. That is, without substantiating the anthropogenic impact on global climate change, this topic cannot claim to be the central determinant of economic and political development.

## 1 Introduction

The global scientific community returned to the topic of the greenhouse effect in the middle of the 20th century. An important milestone is considered to be 1957, when the International Geophysical Year (a period of coordinated synchronized scientific research around the world) was held. As part of the research, data were obtained on an increase in the concentration of greenhouse gases in the Earth's atmosphere. Further studies of global climate change have intensified since the late 1980s, and they have increasingly emphasized the intensification of the anthropogenic factor as the cause of global warming. In 1985, the International Council for Science and the United Nations established an advisory group on greenhouse gases [1]. However, with this generalization, the IPCC can filter out any studies whose conclusions do not fit into the mainstream of climate science, which speaks of the detrimental effect of the anthropogenic factor on the global change in atmospheric temperature. The IPCC reports themselves are written in dry scientific language, and various organizations - public, environmental and UN agencies - further interpret the data of these reports [2]. It is significant that the Russian branch of the World Wildlife Fund openly writes in a review of one of the IPCC reports that the report is not

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intended for reading by a wide audience, and its theses should be perceived through the prism of such explanatory works as the text prepared by WWF. At the same time, IPCC reports continue to be an undeniable authoritative source among climatologists. The theses in them do not fundamentally change, because each next report is actually a development of the previous one, although estimates of the anthropogenic impact on climate are constantly being tightened.

The main greenhouse gas of the planet - water vapor - is not directly taken into account by the UNFCCC, but the IPCC reports noted that with warming, the content of water vapor in the atmosphere increases: with a temperature rise of 1 ° C, the atmosphere can contain approximately 7% more water vapor [3]. The obligation to annually provide information in the form of a national inventory according to the reporting format of the UNFCCC is only for the countries of Annex I of the UNFCCC, including Russia. As a result, the UNFCCC database on GHG emissions is characterized by incomplete information on developing countries. As part of the specification of the rules for the implementation of the Paris Agreement, it was decided that national inventories of GHG emissions and removals should be submitted by all countries - developed countries starting from 2022, and developing countries - from 2024. For least developed countries and small island developing countries, there is more flexibility in reporting [4-5]. The IPCC develops and updates for the UNFCCC the Guidelines for National GHG Inventories aimed at harmonizing the approaches of different countries (the last update was in 2019). Accounting involves not measurement, but calculation of GHG emissions and removals (using emission and removal factors), but a decision on measurement can be made at the national level. Countries may use their own methodologies if they are scientifically validated and approved by the UNFCCC [6]. The GHG inventory includes data related to LULUCF: forest management, planting of forests, deforestation, more progressive agriculture and land use, etc. Accounting under the UNFCCC is subject to increase or decrease in carbon stocks as a result of human activities (in managed forests or on managed lands) over a certain period. In 2003, the IPCC introduced the Good Practice Guidance for Land Use, Land-Use Change and Forestry [7]. Since LULUCF calculations and projections are subject to uncertainty, the UNFCCC records GHG emissions including and excluding LULUCF. According to the IEA, the uncertainty in estimating global emissions of carbon dioxide is 10%, methane - 25%, nitrous oxide - 30%, fluorine-containing gases - 20%. At the country level, the uncertainty in estimating carbon dioxide emissions is in the range of 5–10%, and for other GHGs in some cases it can exceed 100% (for example, nitrous oxide emissions from agriculture or methane emissions from fossil fuel extraction), so that existing national estimates should be considered as estimates of the order of magnitude. Traditionally, GHG emissions are calculated from production activities, but there are a growing number of studies that estimate GHG emissions from consumption, taking into account export and import flows. Such calculations are more complex and involve greater uncertainty.

## 2 Research methodology

Since the beginning of the industrial revolution, anthropogenic GHG emissions have begun to rise and their sinks to fall due to intensive land use, which has changed the absorption properties of the earth's surface [8]. The increase in anthropogenic GHG emissions resulted in an increase in global GHG concentrations in the atmosphere and air temperature. According to WMO data, the global molar fraction of GHGs in the atmosphere in 2019 reached record levels [9]: carbon dioxide reached 410.5 ( $\pm 0.2$ ) parts per million, methane - 1877 ( $\pm 2$ ) parts per billion, nitrous oxide - 332, 0 ( $\pm 1$ ) parts per billion, which is 148%, 260% and 123% higher than pre-industrial levels, respectively. The average global temperature in January–October 2020 was about 1.2 ( $\pm 0.1$ )°C above pre-industrial levels (1850–1900). According to WMO preliminary data, 2020 will be one of the three warmest

years on record [10]. This finds expression in changing climatic conditions, the spread of adverse weather events and the increasing frequency of natural and man-made disasters. The growth of anthropogenic GHG emissions in the world is on an upward trend, despite the expected decline of 7% in 2020 as a result of the spread of coronavirus<sup>16</sup>. According to the Netherlands Environment Agency (PBL), global GHG emissions reached 52.4 billion tonnes of CO<sub>2</sub>-eq in 2019. (excluding LULUCF), which is 1.1% more than in 2018 (44% more than in 2000 and 59% more than in 1990). Taking into account LULUCF, GHG emissions in 2019 are estimated at 57.4 billion tons of CO<sub>2</sub>-eq. Although the PBL data are not reference data and may differ from national inventories (in particular, for Russia they exceed the national estimate), they offer the most complete temporal and country coverage of GHG emissions [11]. The largest GHG emitters in the world in absolute terms are China, the US, the EU-27, India, Russia and Japan. They accounted for 61.1% of total GHG emissions in 2019 (excluding LULUCF). Their combined share, according to PBL, has remained virtually unchanged since 1990 (62.4%), although GHG emissions in China and India increased by 3.5 and 2.6 times, respectively, while in Russia and the EU-27 they decreased by 16.4% and 22.3%. At the same time, according to the data of the national cadastre of Russia, in 2018 the decrease compared to 1990 was 30.3%. Other major GHG emitters include Brazil, Indonesia, Iran, Canada, Mexico, the Republic of Korea, Australia, Saudi Arabia, Turkey and South Africa.

### 3 Results and Discussions

The European Union is gearing up for another major overhaul of climate, energy, transport, building and forestry regulations to achieve a Green Deal for carbon neutrality by 2050. The previous EU target of reducing greenhouse gas emissions by 40% by 2030 compared to 1990 levels was approved by the European Council in 2014, and targets for the share of renewable energy in final energy consumption and for energy efficiency improvements were set by the “fourth energy package” in 2018 [12]. The Green Deal, announced in December 2019, outlined plans to make Europe the “first carbon-neutral continent” by 2050. In this regard, a number of subsequent documents, including the European Climate Law, set an interim goal of reducing emissions by up to 55% by 2030. Targets for renewable energy, energy efficiency and transport for the implementation of the Green Deal and the Climate Act are contained in the “Fit for 55” proposal package published in July 2021. The European Commission claims that its July legislative initiative is the most comprehensive of all that have been adopted in the field climate and energy. According to the European Commission, the chosen package of measures represents “a careful balance between pricing (emissions trading system, carbon tax), targets (directive on RES, energy efficiency, land and forest use), standards and support measures” [13]. The package includes both drafts of new regulatory legal acts and amendments to existing ones. Together they should create a regulatory framework for a comprehensive restructuring of the entire EU economy. The second part of the package will be presented by the European Commission in December 2021. It will include projects to revise the Energy Efficiency in Buildings Directive, the Third Gas Energy Package to regulate competitive decarbonized gas markets, and a project to reduce methane emissions in the energy sector [14].

The Climate and Energy Plan 2030 includes pan-European goals and targets for the period 2021-2030. Current key targets for 2030<sup>21</sup>: – reduction of greenhouse gas emissions by at least 40% (compared to 1990 levels); – Achievement of 32% share of renewable energy sources; – increase in energy efficiency by at least 32.5% [15]. The target of 40% greenhouse gas emissions is being met through the EU Emissions Trading Scheme, the Emission Sharing Efforts Regulation and the Land Use, Land-Use Change and Forestry Regulation [16]. Thus, all industries contribute to the achievement of the goal both by reducing emissions and by increasing absorption of gases. Trade provides the flexibility to

ensure that emissions are reduced where it costs the least. The high price of carbon also encourages investment in innovative low-carbon technologies.

## 4 Conclusions

The Paris Agreement is comprehensive, but countries shape their goals and commitments on their own - based on the principle of common but differentiated responsibilities (according to national circumstances) - and regularly review them towards increasing “ambition”. The Paris Agreement affirmed that developed countries “should continue to take the lead by setting economy-wide absolute emission reduction targets”, but the commitments of developing countries are very diverse. Of the 190 parties to the Paris Agreement, the majority (74 countries) have formulated their commitments to reduce GHG emissions in relation to the business-as-usual scenario (scenario targets); 61 parties, including Russia and the EU, have fixed absolute targets (as a percentage of the base year) and 8 more have indicated the target level of GHG emissions they are striving for; 25 countries declared only actions aimed at reducing GHG emissions, and another 13 - indirect goals that are not directly linked to GHG emissions; 9 countries focus on relative GHG emission reductions, typically per unit of GDP (relative targets). In addition, many countries, along with unconditional goals, have conditional goals that can be achieved when financial assistance is provided to them. The question of the wording of goals causes a lot of controversy in international climate negotiations - so far only an agreement has been reached that from 2031 a single time frame for the provision of NDCs will be in force for all countries. There are opinions that large developing countries are not interested in a clear system of comparison, as it will focus on the dependence of global GHG emissions on their national actions.

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