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SPECIAL SURVEY

COMPARISON OF THE ROAD TRAFFIC EMISSION CALCULATION METHODS IN RUSSIA AND IN FINLAND. ASSESING THE ENVIRONMENTAL LOAD OF THE CROSS-BOARDER TRAFFIC

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and the Republic of Finland

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1 INTRODUCTION

Atmospheric concentrations of greenhouse gases (GHGs) have reached their highest level in 800 thousand years and this increases the negative impacts of climate change. The importance of urgent measures to combat climate change is justified by the fact that over the past decades the world has seen an increase in average annual temperature on the planet due to an increase in GHG emissions, which causes an increase in the frequency, intensity and duration of natural disasters and leads to an increase in the scale of their negative exposure.

Air pollution is a major environmental health problem affecting everyone in developed and developing countries alike. The knowledge about the health effects on humans caused by the exposure to different pollutants in the air is continuously increasing due to the research studies, thus rising interest and awareness about the health aspect of pollutants in the air. It is possible to derive a quantitative relationship between the pollution levels and specific health outcomes (increased mortality or morbidity). This allows insights into the health improvements that could be expected if air pollution is reduced. Even relatively low concentrations of air pollutants have been related to a range of adverse health effects. Considerable reduction of exposure to air pollution can be achieved through lowering the concentrations of several of the most common air pollutants emitted during the combustion of fossil fuels. Such measures will also reduce GHGs and contribute to the mitigation of global warming. (WHO, 2016)

To control the global climate change and improve air quality, the priority is considered to be the transition to a green economy aimed at reducing GHG emissions, improving energy efficiency, rational use of natural resources, introducing low-carbon production and consumption models, and increasing environmental sustainability by reducing environmental pollution. As the climate or air quality issues do not obey the state borders, countries must solve these problematics together.

As of today, Russia and Finland have no unified legislation for environment protection. In Finland the European Union (EU) determines the limit values for the environmental legislation. In addition to the EU’s strong guidance, the member states of EU may have their own national legislation that give even stricter guidelines for environmental protection.

Finland and Russia have both signed the GHG Emissions Agreements: Kyoto and then the Paris Climate Agreement, adopted by the 21st session of the Parties to the United Nations (UN) Framework Convention on Climate Change (UN FCCC).These agreements set obligations for countries to reduce GHG emissions. By signing the Paris Agreement, the Russian Federation and the Republic of Finland indicated their commitment and assistance in achieving the long-term goal of the UN FCCC, aimed at reducing and stabilizing the concentration of GHGs in the atmosphere to a safe level for Earth's ecosystems.

The total global carbon dioxide emissions in 2017 reached 33.4 billion tons, which is 1.3% higher than in 2016. In terms of GHG emissions, Russia ranks fourth in the world after China, United States and India. Russia accounts for about 4.6% of global GHG emissions.

The total anthropogenic emission of GHGs in the Russian Federation in 1990 amounted to 3.77 billion tons of carbon dioxide equivalent units (CO_2 eq.), In 2016 it was around 2.6 billion tons of CO_2 eq. (excluding GHG absorption in land use, changes in land use and forestry). This value constitutes 70.8% of the cumulative GHG emissions in 1990. Considering emissions and absorptions related to land use, changes in land use and forestry, the cumulative emission in 2016 were 2.0 billion tons of CO_2 eq. (51.6% of the cumulative emissions in 1990).

EU regulations have established that since 2021 new cars should not emit more than 95 grams of carbon dioxide (CO_2) per kilometer (currently the average for the EU countries is 118.5 grams per kilometer). At the end of 2018, the European Parliament and the EU Commission agreed on CO_2 reduction requirements for new passenger cars and light commercial vehicles by an average of 15% by 2025 and by 35% by 2030.

In the Russian Federation there are a number of problems related to the regulation of GHG emissions from road transport, including regulatory and legislative nature.

The aim is to bring the methodological base for the road transport emission calculation method in the Russian Federation and Finland to a common standard. The common base will contribute to the development of integrated approaches in creation of an environmental monitoring system in the border territories of two neighboring states.

The present report contains comparison of basic and normative legislative acts and program documents, which determine the amount of GHG and other air emissions from vehicles using different types of fuel and energy. The second part of this survey contains comparison of approaches and methodologies to calculate GHG and other air emissions from vehicles in Russia and Finland as neighbor countries for the purpose of creating united principles towards preservation of environment and stable ecological development. The Conclusions contain the main findings and recommendations.

2 THE REQUIREMENTS OF ENVIRONMENTAL LEGISLATION CONCERNING ROAD TRAFFIC IN RUSSIA AND IN FINLAND

A report by the World Meteorological Organization on GHGs (Bonn, November 2017) states that atmospheric CO_2 concentration in 2016 reached its highest level in 800 thousand years, which increases the risks of negative climate change. Therefore, it is necessary to reduce GHG emissions into the atmosphere by 25% by 2020 compared with 1990.

The increase in the average annual temperature of the planet leads to many severe consequences like the melting of the glaciers, rising of the sea level and droughtin vulnerable regions of the world. The main reason for the increase of the average annual temperature on the planet is the strengthening of the greenhouse effect due to increasing of the GHGs in the atmosphere (primarily carbon dioxide and methane). The GHGs block infrared rays from escaping the atmosphere to space and thus they heat the Earth’s the atmosphere. Currently, approximately 80% of GHGs are generated because of burning fossil fuels (coal, oil, gas). Climate issues do not have state borders, therefore, countries must solve these problematics of climate change together.In September 2015, the UN General Assembly approved 17 Global Sustainable Development Goals (SDGs) and 169 accompanying tasks (UN General Assembly Resolution 70/1 “Transforming our world: the 2030 Agenda for Sustainable Development”), which countries of the world will use as a basis for the development of their programs and policies over the next 15 years. One of the 17 Sustainable Development Goals aims to take urgent action to combat climate change and its effects. Active discussion of climate cooperation at the international level and the implementation of specific interstate measures in this area resulted in the signing of the Paris Climate Agreement (December 2015) by the countries of UN. The goal of the Paris Climate Agreement, which will enter into force in 2020, is to intensify efforts to combat climate change, which includes restraining the global average temperature on the planet below 2 ° C and striving to limit the temperature increase to 1.5 ° C in comparison to pre-industrial times.

According to scientists, in the case of normal economic development without reducing GHG emissions by 2100, the global temperature on the planet may rise by about four or more degrees Celsius, which will lead to water shortages, an increase in the number and area of forest fires, an increase in the number of floods and droughts, as well as agricultural land reduction.

2.1 Environment Protection Laws in Russia

The most significant law in the environment protection in the Russian Federation is Federal Law from January 10, 2002 No. 7-FZ "On environment protection". The present Federal Law defines legal bases of the state policy in the environmental protection which aims to ensure well-balanced solution of social and economic tasks, preservation of favorable environment, biological diversity and natural resources for the purpose of satisfactiying the demands of present and future generations, as well as strengthening of law and order in the sphere of environmental protection and ensuring ecological safety.

The Federal Law regulates relations in the sphere of interaction between the society and the environment arising out of performance of economic and other activity, connected with environmental impact, within the limits of the Russian Federation, as well as on the continental shelf of the Russian Federation and in the exclusive economic area of the Russian Federation.

In accordance with Article 2, force of this law covers continental shelf of the Russian Federation and its exclusive economic area in full compliance with the norms of international law and federal laws; the action of this law is aimed at marine environment preservation.

The present document contains the main definitions in the sphere of ecology, environment, standardization and maintaining of environmental quality.

2.2 Environment Protection Laws in Finland

Environmental Protection Law (86/2000) regulates directives of the EU on integrated prevention and pollution control (IPPC) which obliges EU countries perform general control of emissions, made by various branches of industry.

Conditions (statements) in the environmental protection are joined in the Environment Protection law. It is a general law on prevention of pollution, which is applied to all kinds of activity, which cause or may cause harm to the environment.

Principles of the Environment Protection Law:

- Prevention or reduction of harmful impact (principle of prevention and minimization of harmful impact);
- Performance of due care and caution for prevention of environmental pollution (principles of care and caution);
- Use of the best available technique (BAT principle);
- Use of best practices for reducing environmental pollution (principle of environmentally best use);

The parties, participating in the events, connected with the risk of pollution, are obliged to prevent or minimize harmful impact (contaminator pays).

2.3 Environment Protection Laws – comparison summary

Contrary to Russian, Finnish law on environment protection guides to minimizes the damages and environmental harm , as well as of the minimum use of resources and use of advanced methods of prevention of environmental pollution. The environmental protection law is based on system of permissions. However, the Russian one guides primarily preservation of not yet disturbed territories when organizing specially protected natural territories, as well as preservation of objects of planetary heritage.

2.4 Air quality legislation in Russia

The principle law of the Russian Federation in air quality regulation is Federal Law from May 4, 199i8 No. 96-FZ "On atmospheric air protection".

Federal Law "On atmospheric air protection”, which sets the legal bases of atmospheric air protection and is aimed at realization of constitutional rights of citizens for favorable environment and for reliable information about its state.

State administration in the sphere of atmospheric air protection is based on the following principles:

- Priority of protection of human life and health, of present and future generations;
- Ensuring favorable ecological conditions for human life, labor and rest;
- Avoidance of the consequences of atmospheric air pollution, irreversible for the environment;
- Mandatory state regulation of emission of harmful (polluting) substances into the atmospheric air and of harmful physical impact on the air;
- Openness, fullness and reliability of information about atmospheric air state and on its pollution;
- Scientific substantiation, systematic mode and completeness of the approach towards atmospheric air and environmental protection on the whole;
- Mandatory observance of the requirements of the Russian Federation legislation in the sphere of atmospheric air protection and liability for breach of this legislation.

2.5 Air quality legislation in Finland

The main document, is the Environment Protection Law, which is applied to all kinds of activities, which may entail environmental pollution. Legislation in Finland on atmospheric air protection fully corresponds to the EU Directive on integrated prevention and pollution control.

Directive No. 96/62/EC for atmospheric air protection and quality management is usually mentioned as air quality master directive. It contains the main principles, as well as methods of air quality assessment and quality management in the EU member states. It contains the list of pollutants, for which air quality standards and objectives will be developed and specified in the legislation.

The provisions of this Directive were transferred into the national legislation on environmental protection, into Government regulation on air quality (711/2001) and later revised (79/2017) and into Government regulation on atmospheric air ozone (783/2003).

Directive 2001/81/EC of the European Parliament and the Council on National Emission Ceilings for certain pollutants (NEC Directive) set upper limits for each Member State for the total emissions in 2010 of the pollutants responsible for acidification, eutrophication and ground-level ozone pollution (sulfur [SO_2], nitrogen oxides [NO_x], volatile organic compounds [VOCs] and ammonia [NH_3]; see the graph on the cover page). Revision of this directive is underway, emission ceilings for 2020 will be set, and include particulate matter PM2.5 too.

In 2008 the Directive 2008/50/EC on ambient air quality and cleaner air for Europe merged most of existing air quality legislation into a single directive (except for the Directive 2004/107/EC relating to arsenic, cadmium, mercury, nickel and polycyclic aromatic hydrocarbons) with no change to existing air quality objectives. However, new air quality objectives for PM2.5 (fine particles) including the limit value and exposure related objectives – exposure concentration obligation and exposure reduction target – were included in this directive.

Other elements in this directive include:

- the possibility to discount natural sources of pollution when assessing compliance against limit values.
- the possibility for time extensions of three years (PM_{10}) or up to five years (NO_2, benzene) for complying with limit values, based on conditions and the assessment by the European Commission.
- sets the objectives (limit or target values) for SO_2, NO_2, PM10, PM2.5, ozone (O_3), lead, benzene, CO
- orders about additional VOC and fine particle chemical analyses (incl. OC/EC, sulphate etc.)
- defines the minimum number of measurement sites in each MS
- sets the EU rules for the assessment methods of air quality
- sets the quality requirements of measurements
- specifies the public information requirements.

2.6 Air quality legislation – comparison summary

In Russia, branch legislation is developed, and the law "On environment protection" has general declarative character. The basis of Finnish legislation is the law “On environment protection”, which describes various sides of environment-oriented relations, including air, and corresponds to the principal EU legislation. In addition to the EU legislation national legislation regulates the town and traffic planning. The national legislation is not as binding as the limit values from EU.

Directives on air quality estimation (in the given case all techniques, which may be applied) are described in other classes of legislative documents in Russia, both for measurement and for substances themselves. The basic law defines the direction of air quality policy and sets the general provisions for subjects and objects of the environmental management.

2.7 Agreement of Greenhouse Gas Emissions

The UN FCCC was adopted at the “Earth Summit” in Rio de Janeiro in 1992. It was signed by 180 countries and envisaged an agreement on common principles for the interaction of states to address climate change. Russia ratified the UN FCCC in 1994. This is the main regulatory document at the international level, which directs activities of states in the regulation of GHG emissions carried out by all sectors of the economy, including the transport sector.

The Kyoto Protocol is an international agreement, an additional document to the UN FCCC (1992), adopted in Kyoto (Japan) on December 11, 1997. The Kyoto Protocol for the first time defined the quantitative obligations of countries to reduce GHG emissions and proposed international economic mechanisms for managing emissions.

The Russian Federation ratified the Kyoto Protocol and as a result, Federal Law of November 4, 2004 No. 128-ФЗ “On Ratification of the Kyoto Protocol to the United Nations Framework Convention on Climate Change” was adopted.

To implement the provisions of the Kyoto Protocol in terms of verifying the fulfillment of obligations by states and introducing mechanisms for regulating the GHG emissions inventory of the Intergovernmental Panel on Climate Change (IPCC) in 2006, guidelines on national GHG inventories in all sectors were developed, including the transport sector. These principles are the basic document for developing of the existing national and sectorial methods for inventorying GHG emissions, including those in the transport industry.

A large international trading platform for emissions trading was created on the territory of the EU (European Union Emissions Trading System; EU ETS), which, in addition to EU countries, includes Norway, Iceland and Liechtenstein. Certain intergovernmental transactions for the sale of quotas under the Kyoto Protocol were concluded as part of bilateral agreements (for example, between Ukraine and Japan, Japan and Russia, Canada and Finland, etc.). While in 2005 on the European trading platform, the price of CO_2 allowance was between 20 and 25 euros per ton, after the economic crisis of 2008-2009, which led to a significant decline in the European economy and energy consumption, the price of CO_2 allowance fell to 5 euros per ton. As a result of the reduction in GHG emissions due to the economic downturn, an excess of unclaimed quotas has formed on the market. This situation led to the fact that the EU countries began recalling part of the quotas from the market (400 million tons in 2014, 300 million tons in 2015 and another 200 million tons by 2016), thereby reducing CO_2 trade. A decrease in global CO_2 emissions also led to Canada’s withdrawal from Kyoto Protocol in 2011, and later to withdrawal of Japan and Russia in 2012. Low CO_2 prices, combined with an excess of quotas, led to a decrease in the profitability of environmental projects.

Thus, the Kyoto Protocol was not able to form a global system for regulating emissions. One of the main obstacles was the reluctance of individual countries to commit themselves to reduce CO_2 emissions due to fears that this would negatively affect the pace of their economic development.

The creation of a single global emissions management system is currently facing the same challenges. This is due to the fact that the possibilities for reducing GHG emissions vary significantly across countries and depend on their economic structure, population, availability of financial resources and other factors.

A compromise in solving these problems was the conclusion of the Paris agreement on climate in December 2015, defining the goals and objectives of multilateral cooperation regarding climate change after 2020. The Paris Agreement will replace the Kyoto Protocol in the UN FCCC, which expires in 2020.

The strategic goal of the Paris Agreement is to keep the growth of the global average temperature on the planet within much below 2 degrees Celsius over pre-industrial indicators and make efforts to limit the temperature increase to 1.5 degrees Celsius in 2100 compared to pre-industrial times (circa 1750). The Paris Agreement provides for state obligations to quantitatively reduce GHG emissions, which each country independently determines to achieve the global temperature goal. The Paris Agreement entered into force on November 4, 2016. To date, 195 countries have signed this document and 179 countries have ratified it.

Each country that has signed the Paris Agreement must prepare, communicate and ensure compliance with nationally accepted commitments (“successive nationally determined contributions”) to reduce GHG emissions. The Paris Agreement includes a long-term plan to reduce GHG emissions and achieve a balance between GHGs resulting from human activities and their absorption by the seas and forests. The registry attached to the Paris Agreement contains a table reflecting countries' plans to reduce GHG emissions by 2030, which are not legally binding.

2.8 EU legislation for reducing greenhouse gas emissions

The substantive basis of the pan-European system of strategic management and planning is the economic development strategy “Europe 2020”, adopted by the EU in 2010. Its goal is to create conditions for sustainable development of the EU and inclusive growth. According to the definition of the World Bank, one can speak about inclusive growth: if sustainable development is ensured for a long-term perspective, all sectors of the economy and most of the labor resources of each country are involved in it.

The Europe 2020 strategy sets out five main objectives that cover the entire EU. These goals should be taken into account when determining the national values of each of the EU countries. One of the five main goals set in the Europe 2020 strategy relates to climate change and energy sustainability. This goal involves achieving sub-goals of energy and climate policy related policies (including a 30% reduction in environmental pollution). To achieve this goal, the following line of action has been put forward as a priority: “Expedient use of resources in Europe”, including:

- reasonable use of energy sources;
- transition to an economy with low consumption of hydrocarbons;

- increase of the use of renewable energy sources;
- modernization of the transport sector;
- reduction of the dependence of economic growth on the amount of resources consumed.

At the end of 2008, the European Parliament adopted the medium-term program “Climate and Energy Package 20/20/20 by 2020”, the main objectives of which are the following:

- reduction of GHG emissions in EU countries by 20% in 2020 compared to 1990;
- increasing the energy efficiency of the EU economy sectors by 20% in 2020 compared to 2005;
- increasing the share of renewable energy sources in the EU energy sector by 20% in 2020 compared to 2005.

The EU budget provides that in the period 2014-2020 about 20% of the funds will be directed towards mitigating the effects of climate change and adaptation measures.

The EU’s goal under the Paris Agreement is to reduce GHG emissions by 40% by 2030 from the 1990 level. By 2030, it is planned to increase the share of renewable energy in the EU’s energy mix and increase energy efficiency by 27%. In the longer term - until 2050 - the efforts of the EU countries are planned to reduce GHG emissions by 80-95% compared with 1990.

It is planned that over 70% reduction in potential CO_2 emissions from fossil fuel combustion in the EU can be achieved by increasing energy efficiency and introducing renewable energy sources. A significant contribution to the reduction of GHG emissions should be made by the further development of the EU ETS in the period 2013–2020, primarily through measures taken in the energy sector, as well as by extending the EU ETS to other sectors of the economy and air transportation.

The most developed attempt to develop a “roadmap” of the transition of the EU countries to a low-carbon economy was the work of the ROADMAP 2050 Practical Guide to a Prosperous, Low-Carbon Europe, made in 2010 by the European Climate Fund with the involvement of a wide range of experts and based on the results of recent studies in areas.

In March 2011, the European Commission announced the official EU roadmap towards a competitive carbon-free economy. It identifies the stages of this path, assesses the need for in-vestment and analyzes the possibilities of certain sectors of the economy for the transition to low-carbon development. Taking into account the effects of the economic crisis, slowing economic growth and reducing energy consumption in the Climate Energy Package 20/20/20 by 2020 program, the following goal was adjusted: to reduce GHG emissions in EU countries by 25% (instead of 20%) in 2020 compared with 1990.

In order to further reduce CO_2 emissions from road transport in 2011, the European Commission adopted the “Transport Strategy”, according to which, since 2050, cars with gasoline and diesel engines should not remain in European cities. By 2050, it is planned to reduce CO_2 emissions by 54 to 67% compared with 1990. For this, it is planned to transfer cars from gasoline and diesel fuel to electric drive, gas motor fuel and biofuel.

2.9 Greenhouse gas emission prevention goals in Finland

The EU GHG reduction goals are reflected in Finland's national strategies and policy documents. Like other EU countries under the Paris Agreement, Finland has committed to reduce GHG emissions by 40% by 2030 from the 1990 level. Furthermore, in the new energy and climate strategy of Finland, the government set more ambitious targets to reduce GHG emissions by 60% by 2030 from the 1990 level. Finland plans to abandon coal fuel by 2030, reduce oil imports and increase the number of electric vehicles for reducing GHG emissions by 2050. By 2050, Finland plans to achieve a zero carbon balance.

2.10 Greenhouse gas emission prevention goals The Russian Federation

Currently, a whole range of measures is being implemented in the Russian Federation aimed at reducing GHG emissions. In accordance with the order of the Government of the Russian Federation dated May 15, 2017 No. 930-r, the federal executive bodies annually submit to Roshydromet of the official statistical information on the processes and activities that result in anthropogenic emissions from sources and absorption by sinks of GHGs, as well as information on methods for their collection and processing.

Documents aimed at reducing GHG emissions and adaptation to adverse climate changes have been developed and are being prepared, including:

- The Action Plan for the implementation of the State Policy in the field of environmental development of the Russian Federation for the period until 2030, approved by order of the Government of the Russian Federation of December 18, 2012 No. 2423-r;

- The Comprehensive Plan for the implementation of the Climate Doctrine of the Russian Federation for the period until 2020, approved by order of the Government of the Russian Federation of April 25, 2011 No. 730-r;

- Preparing of the draft decree of the Government of the Russian Federation "On approval of the National Action Plan for adaptation to adverse climate changes".

After a comprehensive analysis of the socio-economic consequences, the Ministry of Natural Resources of Russia prepared and submitted to the Government of the Russian Federation proposals justifying the expediency of ratifying the Paris Climate Agreement. It is planned that the decision to ratify the Paris Climate Agreement will be made at the end of 2019 by the beginning of the 25th session of the Conference of the Parties to the UN FCCC. The aim of Russia in the framework of the Paris Agreement is to reduce GHG emissions by 2030 to 70–75% of the 1990 level, subject to the maximum possible absorption capacity of forests.

In recent years, the Russian Federation has developed and adopted a number of documents defining the main activities in the field of reducing GHG emissions in connection with the ongoing climate change. The main ones include the following:

- Environmental Doctrine of the Russian Federation;
- Climate Doctrine of the Russian Federation;
- The order of the Government of the Russian Federation on the approval of the Integrated Implementation Plan of the Climate Doctrine for the period up to 2020;
- Basics of state policy in the field of environmental development of Russia for the period up to 2030;
- National Security Strategy of the Russian Federation;
- Presidential Decree "On the reduction of GHG emissions";
- The order of the Government of the Russian Federation on the approval of the Plan for measures to ensure the reduction of GHG emissions by 2020;
- The order of the Government of the Russian Federation on the approval of the concept of forming a system for monitoring, reporting and verifying GHG emissions in the Russian Federation;
- The order of the Ministry of Natural Resources approving the Methodological Recommendations for conduction of voluntary inventory of GHG emissions in the constituent entities of the Russian Federation.

Decree of the Government of the Russian Federation of November 3, 2016 No. 2344-r on approval of the Plan of implementation of a set of measures to improve state regulation of GHG emissions and preparation for ratification of the Paris Agreement adopted on December 12, 2015 by the 21st session of the Conference of the Parties to the United Nations Framework Convention Nations on climate change.

In the Russian Federation, the concept of creating a system for monitoring, reporting and verifying GHG emissions has been adopted, according to which enterprises must submit emission inventory data from 2016, and regions should take into account and forecast GHG emissions over the long term, as well as implement programs to reduce them. For the organization of activities in the field of reducing GHG emissions, special organizations were created:

- Interagency Working Group on issues related to climate change and sustainable development under the Administration of the President of the Russian Federation;
- Interdepartmental Working Group on Economic Aspects of Environmental Protection and Regulation of GHG Emissions under the Ministry of Economic Development of the Russian Federation.

The measures of the Implementation Plan for a set of measures to improve state regulation of GHG emissions and prepare for ratification of the Paris Agreement provide for the following main areas of activity in the field of reducing GHG emissions:

- preparation of a draft decree of the President of the Russian Federation on the approval of the goal of limiting GHG emissions by 2030;
- preparation of a draft federal law on state regulation of GHG emissions;
- development of the project “Long-term development strategies with a low level of greenhouse gas emissions until 2050”;
- development of a model of state regulation of GHG emissions in the Russian Federation;
- development of a draft national plan for adaptation to adverse climate change.

Currently, the only long-term planning document for the development of the transport complex of the Russian Federation, which aims to reduce emissions of GHGs and other pollutants for the transport complex, called the Transport Strategy of the Russian Federation on the period up to 2030 (as amended on May 12, 2018). In particular, in the framework of achieving the goal of “Reducing the negative impact of the transport system on the environment” it is planned for road transport:

1) To achieve a reduction in CO_2 emissions by 25% per one given ton-kilometer (tkm),
2) To achieve a reduction in emissions of pollutants into the atmosphere by 45% per one given tkm.

The Table 1 provides information on the level of achievement of indicator values in 2017 for the goal of “Reducing the negative impact of the transport system on the environment” as part of the Transport Strategy of the Russian Federation for the period up to 2030 in terms of road transport (in percentage basic development of the industry).

Table 1. Information on the level of achievement of indicator values in 2017 for the goal of “Reducing the negative impact of the transport system on the environment” as part of the Transport Strategy of the Russian Federation for the period up to 2030 (in % of the base case)

Cipher	Indicator	Year 2017
6.1.1	CO_2 emissions per tkm by mode of transport (relative to the level of 2011): road transport	97,96 %
6.2.1	The amount of emissions of pollutants to the atmosphere per a given tkm by type of transport (relative to the level of 2011): road transport	91,27 %

3 COMPARISON OF THE ROAD TRAFFIC EMISSION CALCULATIONS METHODS IN RUSSIA AND IN FINLAND

Currently in Russian Federation, it is not possible to reliably estimate the concentration harmful pollutant emissions from the transport sector due to the absence of legally approved methods and mechanisms for obtaining statistical source data necessary for calculating the amount of GHG emissions and other pollutants from objects and technologies in charge of transport organizations carrying out economic and other activities, as well as from those in the ownership of individuals.

Meanwhile, the literature provides calculated quantitative estimates of emissions of GHGs and other pollutants by the transport in general and its separate types using certain sets of source data. Thus, the results of an assessment of the volume (inventory) and dynamics of GHG emissions by transport are presented in the National Report on the inventory of anthropogenic emissions from sources and absorptions of GHGs not controlled by the Montreal Protocol. According to the structure of this document, in 2016 (the last reporting year according to 2018 data), the share of transport in the total amount of GHG emissions resulting from fuel combustion is 17.7% (Table 2).

Table 2. Greenhouse gas emissions from fuel combustion by source category (Gt CO_2 equivalent) in Russian Federation

Year	1990	1995	2000	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Total	2,29	1,45	1,31	1,35	1,4	1,39	1,44	1,35	1,41	1,46	1,47	1,41	1,42	1,43	1,41
Energy industry	1,17	0,91	0,84	0,86	0,89	0,88	0,9	0,84	0,88	0,89	0,91	0,85	0,85	0,82	0,81
Industrial production	0,21	0,09	0,1	0,11	0,11	0,11	0,12	0,12	0,13	0,13	0,14	0,14	0,15	0,15	0,17
Transport	0,32	0,21	0,17	0,21	0,21	0,22	0,23	0,21	0,23	0,24	0,24	0,25	0,25	0,27	0,25
Other sectors of the economy	0,27	0,2	0,18	0,14	0,14	0,14	0,14	0,14	0,13	0,14	0,12	0,14	0,14	0,15	0,16
Others (incl. military fuel use etc.)	0,32	0,04	0,01	0,03	0,04	0,04	0,05	0,04	0,04	0,04	0,05	0,03	0,03	0,03	0,02

Source: [1]

The given above estimates of GHG emissions from motor vehicle combustion have been estimated for national civil aviation, road transport, rail transport, water transport not involved in international transportation, and also pipeline transport.

Based on the analysis of the data presented in the National Report on the inventory of GHG emissions, there are different dynamics of changes in gross GHG emissions by different modes of transport. While for railway, water transport and civil aviation there were practically no significant changes in gross GHG emissions during the period 1990–2016, a completely different picture is observed for road transport - there was a significant reduction in GHG emissions in 1990–1999 compared to 1990 year (40%), and then a constant increase to 165.09 million tons of CO_2 eq. (2013), i.e. 7% more than in 1990 (154.86 million tons of CO_2 eq.).

If pipeline transport is not taken into account, the share of road transport in total transport emissions of GHGs (2015) is 89.32%, civil aviation - 6.14%, rail transport - 3.85%, water transport - 0.69 %. That way GHG emissions by road transport exceed emissions from other types of transport by more than an order of magnitude.

It should be noted that the methods of GHG inventory used in the preparation of the National Inventory of anthropogenic emissions from sources and absorption of GHGs are characterized by a two-year delay in reporting (this year's report reflects the GHG emissions and removals for the year preceding the previous one), which does not meet the goals and objectives of climate policy at the present stage.

The main disadvantage of this approach is that it provides aggregated estimates of GHG emissions by gas type and source category, but does not contain data on GHG emissions by specific organizations, which is necessary for developing and implementing effective public policies and measures to reduce GHG emissions; gases, including for setting targets for reducing GHG emissions by economy sector.

Therefore, it is necessary to conduct an inventory of GHGs at the national, regional and enterprise levels. Moreover, the results of the inventory performed at each of these levels should be comparable.

Calculations of gross emissions of GHGs at the regional level are currently performed by individual regions and companies in a voluntary order. To do this, they use the Methodological Recommendations for conducting a voluntary inventory of GHG emissions in the constituent entities of the Russian Federation [2]. However, these guidelines set out methods for estimating GHG emissions only for those categories of emission sources (activities) that will make the largest contribution to the cumulative emission for most constituent entities of the Russian Federation.

The methodological approaches to estimating GHG emissions by transport at the international level are based on the requirements of the guidelines and guidelines of the IPCC [3-5].

Key categories of emission sources in accordance with the IPCC guidelines can be determined by two methods: the Level 1 method and the Level 2 method. The Level 1 method assumes that the key categories include the emission source categories that contribute the most to the total amount of GHG emissions or in the trend of total emissions relative to the base year. The Level 2 method is similar to the Level 1 method, but regional calculations of emission factors based on real carbon content in fuel are used for calculations.

When implementing this method, emissions from all sources of fuel combustion can be calculated based on the amount of fuel burned (known from national and regional energy statistics) and average emission factors. Thus, in the National Report for each year from 1990 to 2016, CO_2 emissions from the combustion of primary and secondary fuels were estimated. The estimates were based on national fuel balance data prepared by the Rosstat.

To apply Level 1 for each source category and fuel type, data on the amount of fuel burned and the values of recommended GHG emission factors are needed. Therefore, for automobile gasoline, the emission factor (t CO_2 / t) is 3.02, for diesel fuel, it is 3.15, and for liquefied gases, it is 2.9.

To convert source data into total energy units (TJ), such IPCC conversion factors as the International Energy Agency (IEA) coefficients are used to convert to tons of oil equivalent, as well as national conversion factors to tons of standard fuel. GHG emissions are expressed in mass units (Gg = 1000 tons). Cumulative emissions of various GHGs, for example, cumulative regional emissions, are expressed in Gg of CO_2 equivalent.

It should be noted that the IPCC methodology is officially intended only for national inventories, however, as experience shows, it can successfully be applied to inventories at the level of individual regions and enterprises. The main thing to follow is the principle of providing information and calculating emissions and sinks, as well as documentary evidence used in the inventory data. Attempts to adapt the IPCC methodology to estimating emissions and sinks of individual sources led to the creation of a number of methodological guidelines applied at the level of individual companies, regions and states. The main objective, as a rule, is connected to the need to obtain management information for the development of specific decisions, the justification of various practical measures aimed at reducing the impact on climate.

The principles laid down in the method of transport emissions TREMOD [6] (**Figure 1**), which is designed to estimate emissions of pollutants during the movement of vehicles, trains, ships and airplanes in Germany for the period 1960–2030, are widely spread.

Road mileage emissions for the most part come from measuring programs TU Graz, EM-PA and “TÜV Nord”. In the 2006 version, for the category of “road transport”, the vehicle emissions that meet the EURO-2 and EURO-3 standards were taken into account; a database for heavy duty vehicles and motorcycles has been introduced; parks and mileage data were updated up to 2004. Later versions of this methodology take into account emissions of ATSs of all environmental classes. The effect on emissions of low-sulfur fuels as well as bio-fuels for diesel engines is taken into account.

Baseline data: the number of vehicles in the flow, mileage, transport work in the carriage of passengers (person km) and goods (tkm). Primary energy consumption (MJ) and final consumption of gasoline and diesel fuel, aviation gasoline and kerosene (t), as well as electricity (kWh) from the public grid are calculated.

Emissions of the following substances are estimated: hydrocarbons (total and differentially methane and non-methane, as well as by individual components: benzene, toluene and xylene); nitrogen dioxide (NO_2), CO and particulate matter for diesel engines; fuel dependent components: carbon dioxide and sulfur dioxide; uncontrolled components of exhaust gas: ammonia (NH_3), nitrous oxide (N_2O) of nitrogen.

A number of foreign and domestic methods are based on the same principles, including methodological guidelines and guidelines for quantifying GHG emissions by organizations engaged in business and other activities in the Russian Federation, developed and approved by the Russian Ministry of Natural Resources [7]. In accordance with these guidelines, organizations can use: a calculation method based on activity data and emission factors; calculation method based on the material and raw material balance; calculation method based on periodic measurements of GHG emissions; method of continuous monitoring of GHG emissions.

It is also necessary to take into account the existing international documents on accounting for GHG emissions at the organization level, including international standards in this area, in particular the ISO / TR 14069: 2013 standard "Quantifying and reporting on GHG emissions at the organization level. Guidelines for the application of ISO 14064-1" [8].

Thus, in world of practice, methods based on data on their activities, emission coefficients, raw material balance, and in some cases based on data from continuous monitoring of GHG emissions, are used to quantify emissions of GHGs and other pollutants from mobile and stationary sources of transport.

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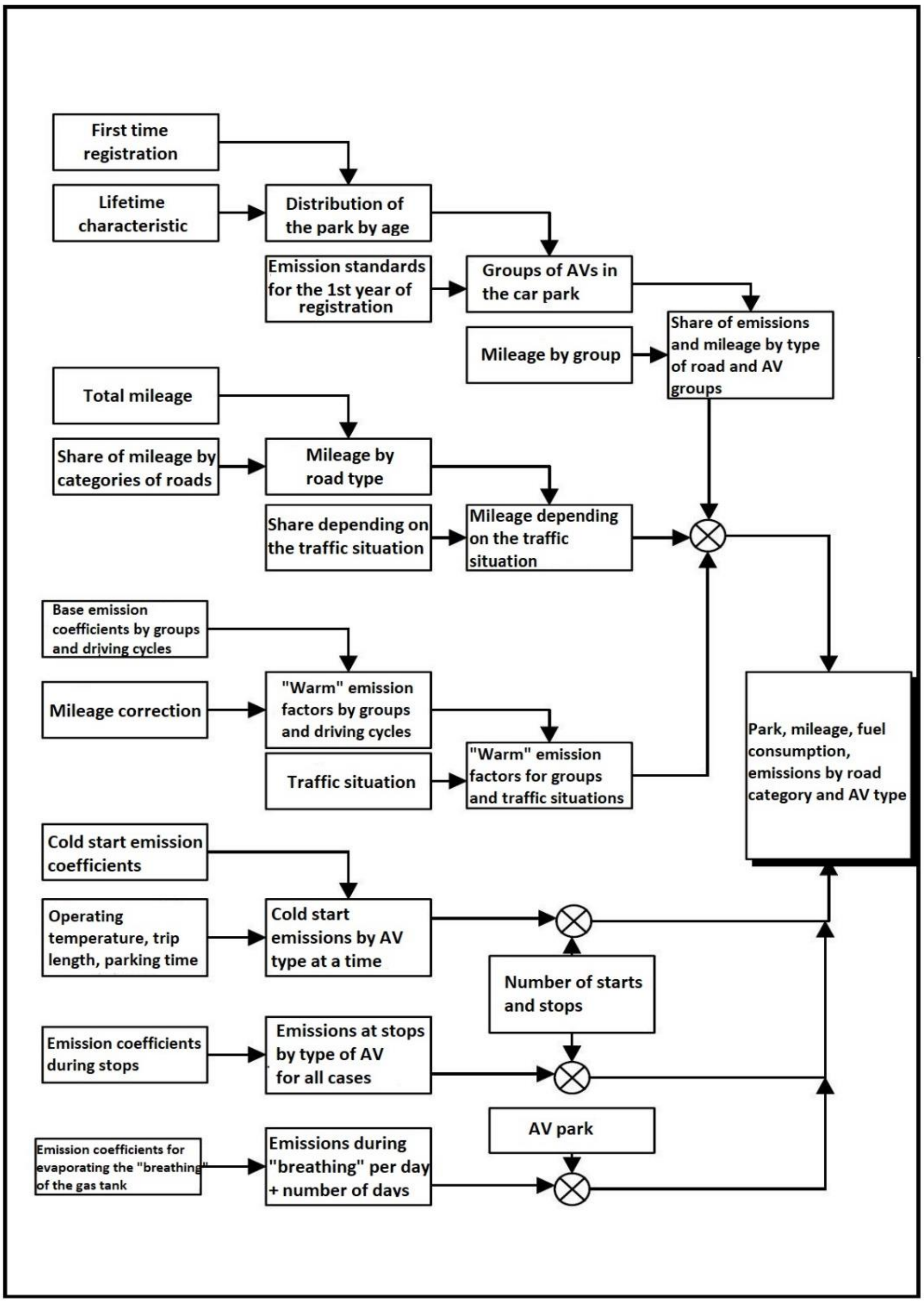

Figure 1. Scheme for calculating emissions for passenger cars using TREMOD

It should be noted that the methodology for estimating emissions of pollutants from transport, adopted in different countries, is approximately the same. The calculation of these emissions may be based on fuel consumption or on the results of studies on the characteristics of the use of vehicles of different types. In the second case, specific mileage emissions of GHGs are used. Below is an overview of the main methodological approaches used to estimate GHG emissions from road transport.

There is a fairly wide range of techniques and computer programs that can be used to estimate GHG emissions and other pollutants from motor vehicles (Table 3). Some of these techniques are complex and integrate blocks designed to solve various problems of transport planning and monitoring the situation.

Table 3. *International and domestic methodologies and computer programs used to estimate emissions of GHGs and other pollutants by motor vehicles*

№	Title	Purpose of a technique or computer model
1	IPCC 2006 [3]	A three-level method for estimating GHG emissions from transport. Is described in Chapter 3, Mobile Fuel Combustion, Vol. 2, Energy, of the Guidelines for National Inventory of Panic Gases.
2	CORINAIR (EMEP/EEA) [9]	A three-level methodology for inventorying GHG emissions and other pollutants from motor vehicles, including from road transport. Developed by UNECE.
3	Estimated instruction (methodology) for inventory of pollutant emissions from motor vehicles in the largest cities [10]	It is intended for the inventory of emissions of pollutants into the atmospheric air by motor vehicles when driving along the road network of the largest cities (with a population of over 1 million people). It can be used for planning the development of transport infrastructure of the largest cities. Applies to cars and trucks, as well as buses running on gasoline, diesel fuel, liquefied petroleum gas and compressed (compressed) natural gas. Developed by JSC "NIIAT".
4	COPERT IV [11]	The program COPERT 4 (Computer Program to calculate Emissions from Road Transport), developed for Microsoft Windows, is a European methodological tool for determining the amount of emissions generated by road transport
5	GEF TEEMP [12]	Transportation Emissions Evaluation Model for Projects (TEEMP). Model for estimating the reduction of GHG emissions due to the implementation of the Global Environment Facility projects in the transport industry
6	ForFITS [13]	For Future Inland Transport Systems (ForFITS) was developed by the United Nations Economic Commission for Europe (UNECE) and is a software tool designed to perform two main tasks: estimating CO_2 emissions from transport; an assessment of policies to reduce CO_2 emissions from transport
7	VISUM [14]	VISUM. An integrated transport planning model with an environmental unit that calculates emissions of NO_x, CO, SO_2 and HC. Additional emissions of other pollutants may be made in the model if the delivery of the VISUM software package includes the PTV HBEFA Data Package
8	HBEFA [15]	Handbook Emission Factors for Road Transport. The model is used in several European countries and in China to calculate emissions of GHGs and other pollutants by road transport. The pollutant emission coefficients used in HBEFA are input data for many other models.
9	COPERT Micro [16]	COPERT Micro determines the amount of emissions generated by road transport on an urban scale. The program allows you to estimate emissions in a single street or road, and throughout the city.
10	COPERT Street Level [17]	A new tool, at the last stage of development and improvement, for estimating emissions in relation to specific city streets using information on the speed and density of flow.

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11	AimSun [18]	AIMSUN (Advanced Interactive Microscopic Simulator for Urban and Non-urban Networks) is a micro-simulator of the topology of the road network and transport demand, designed to solve dynamic transport and organizational tasks and includes an emission assessment unit.
12	TREMOVE [19]	An imitation model for transport simulation for strategic cost-benefit analysis of a wide range of policy instruments and measures in 31 countries and 8 maritime regions in 1995–2030.
13	TREMOD [6]	Designed to simulate the traffic of motorized vehicles, trains, ships and aircraft in Germany in the years 1960-2030. Used along with other models as a basis for policy development.
14	SCENES [20]	It is the basis of the main traffic flow model TREMOVE. Includes 4 scenarios for the development of transport until 2020 and the base year 1995. The purpose of the model is a forecast of transport activity in European countries and some others. The result is estimates of freight and passenger turnover in 2020.
15	IVE [21]	International Vehicle Emissions. The model is a tool for estimating GHG emissions from road transport in cities
16	MOVES [22]	Developed by U.S. Environmental Protection Agency for estimating emissions from motorized vehicles. In particular, it is used to assess the effectiveness of policies in individual states. As input data requires complete information about the mileage of transport in a detailed breakdown
17	EMFAC [23]	Emissions Factors Model. The main purpose of the model is to evaluate the policies proposed for implementation in California, in the context of reducing air pollution. The program complex allows to calculate emissions of GHGs and other pollutants by road transport, but the results obtained do not have an official status.
18	GLOBEMI [24]	Globale Modellbildung für Emissions. The model is used in Austria to calculate countrywide emissions of pollutants by road transport.

In addition, such methods and databases as EMME III [25], EUROSTAT [26], CEFIC [27], PDP [28], PHEM [29], TRANSCAO [30], TRANUS [31], etc. are actively used abroad for the inventory of pollutant emissions from road transport.

The methodology for estimating emissions of pollutants from motor vehicles adopted in different countries (IPCC, EMEP, NIIAT, CORINAIR, MOBILE, IVE, etc.) is approximately the same. The calculation of these emissions can be based on fuel consumption (a simplified approach) or on the results of research (or modeling) of the characteristics of transport flows and the use of vehicles. In the second case, specific (mileage) emissions of pollutants and data on annual mileage of vehicles are used, and other factors are taken into account. Consider this methodology in more detail on the example of the IPCC methodology.

In this methodology, the category “Automobile (road) transportation” includes all types of vehicles, such as: cars, light trucks and heavy trucks, buses, as well as motorcycles (including mopeds, scooters and motorcycles with a sidecar). These vehicles operate on various types of liquid and gaseous fuels.

Emissions from road transport can be estimated using two independent sets of source data: fuel consumption data or distance traveled by the vehicle. In general, the first approach (by fuel consumption — of all motor vehicles (AVs) or divided into their classes) is suitable for estimating CO_2 emissions, and the second (by distance) is suitable for estimating CH_4 and N_2O emissions.

If both data sets are available, it is important to check their comparability, otherwise the estimates of different gases may be inconsistent. It is also necessary to check the fuel balance if all calculations of emissions from motor transport are based on the annual mileage data of the considered groups of vehicles.

When estimating CO_2 emissions from fuel combustion by road transport, there are two levels of calculations. The Level 1 method is based on the amount and type of fuel burned and recommended average CO_2 emission factors:

$$E_{CO2} = \sum_a (AD_a \cdot EF_a) \, , \qquad (1)$$

where E_{CO2} stands for CO_2 emissions, kg; a – type of fuel (for example, gasoline, diesel fuel, natural gas, liquefied petroleum gas, etc.); AD_a –a fuel consumption data, TJ; EF_a – emission coefficient for fuel type a, kg/TJ. The CO_2 emission coefficient is calculated by carbon content multiplied by 44/12. The recommended CO_2 emission coefficient is calculated based on the total carbon content in the fuel, including emissions in the form of CO_2, CH_4, CO, volatile non-methane organic compounds (NNOS) and particulate matter.

The Level 2 method is similar to the Level 1 method and is calculated using Formula 1.1, but regional values of emission coefficients based on real carbon content in the fuel consumed in the region during the year are used for calculation.

According to the IPCC methodology, an additional assessment is made of GHG emissions from the use of urea-based additives for diesel AVs of environmental class 5 and above.

Depending on the availability of a source data set, three alternative approaches are used to estimate emissions CH_4 and N_2O:

Level 1 - calculation by the amount of fuel burned without classifying cars - uses fuel consumption data and emission factors for types of motor fuel and can be used if it is impossible to estimate fuel consumption by vehicle categories;

Level 2 - calculation based on the amount of fuel burned by car class - uses the emission factors that are normalized to the unit of fuel burned, specific for each category of AVs;

Level 3 - calculation of the distance traveled with the division into classes of vehicles - requires detailed data to obtain emission coefficients based on the activity of the AVs for sub-categories of vehicles and can use model calculations. Vehicle subcategories are based on vehicle types, their age and emission control technology.

It is much more difficult to estimate the amount of fuel consumed, calculated on the basis of specific fuel consumption per unit of mileage for various categories of vehicles without sufficient data on the fleet structure by categories of AVs, than to estimate the average annual mileage. Therefore, if CH_4 and N_2O emissions are key source categories, it

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seems most appropriate to use a Level 3 method for conducting a regional inventory of road transport emissions and emission coefficients, respectively, adjusted to mileage (kg / km).

The formula for the Level 1 method for estimating CH_4 and N_2O emissions from road vehicles is the same as for estimating CO_2 emissions, but with its emission coefficients (EF_a) CH_4 or N_2O (kg / TJ). For a Level 2 calculation, the formula for estimating CH_4 and N_2O emissions from road vehicles is:

$$E = \sum_{a,b,c}(AD_{a,b,c} \cdot EF_{a,b,c}) , \quad (2)$$

where E stands for CH_4 or N_2O emissions, kg; a - type of fuel (for example, diesel fuel, gasoline, natural gas or liquefied petroleum gas); b - type of vehicle; c - emission control technology (uncontrolled, neutralizer, etc.); AD – fuel consumed, TJ; EF - CH_4 or N_2O emission coefficient, kg/TJ.

The type of vehicle must comply with one of the categories of road transport; it is also desirable to further divide each category by age, emission control technology, and fuel by sulfur content. The breakdown of the fleet by age allows determining the ecological classes of the AV, depending on the year of manufacture and the country - manufacturer of the AV (for Levels 2 and 3).

The fundamental difference of the Level 3 method is that the calculation is based on the engine warming up, operating conditions (roads, climate, etc.). The formula for estimating CH_4 and N_2O emissions by the Level 3 method from road vehicles is:

$$E = \sum_{a,b,c,d}\left(AD_{a,b,c,d} \cdot EF_{a,b,c,d}\right) + \sum_{a,b,c,d} C_{a,b,c,d} , \quad (3)$$

where E stands for CH_4 or N_2O emissions, kg; a - type of fuel (for example, diesel fuel, gasoline, natural gas or liquefied petroleum gas); b - type of vehicle; c - emission control technology (uncontrolled, neutralizer, etc.); d – operating conditions (for example, urban or rural roads, climate, and other environmental characteristics); $AD_{a,b,c,d}$ – distance traveled, km;

$EF_{a,b,c,d}$ –CH_4 or N_2O emission coefficients, kg/km; $C_{a,b,c,d}$ – emissions at start-up and warm-up of the engine (cold start), kg.

In the absence of data of the required detail for the calculation of Levels 2 and 3, the IPCC Guidelines allow the use of emission models or transport models that calculate emissions from vehicles of various environmental classes and abatement technologies, as well as the distances traveled by each type of vehicle.

A more detailed modeling for estimating emissions from road vehicles using the Level 3 methodology is available if the model EMEP/EEA (COPERT) [17] is used.

When performing GHG inventories, one should choose the recommended emission factors by type of fuel used (Level 1) or coefficients by vehicle category, taking into account the specific conditions of the subject of the Russian Federation or Russia as a whole (Levels 2 and 3). The choice of coefficients depends on the level of calculation used and the availability of the necessary input data.

As stated above, the IPCC methodology directly refers to such models as COPERT (based on EMEP / EEA) of the European Environment Protection Agency, MOVES or MOBILE of the US Environmental Protection Agency (US EPA). Emission models can help maintain consistency and transparency, since calculation procedures can be embedded into the software used.

Thus, the COPERT program is a methodological tool for determining the amount of GHG emissions (CO_2, CH_4, N_2O), pollutants generated by road transport (CO, NO_x, VOC, PM, NH_3, SO_2, NMVOC, etc.), while also keeping records of motor fuel consumption. The development of COPERT is coordinated by the European Environment Protection Agency (EEA), as part of the activities of the European Center for Air Pollution and Climate Change Mitigation. COPERT is used to prepare an official inventory of automobile emissions in 28 EU member states.

Figure 2 shows a flowchart for estimating emissions of pollutants and other pollutants using the COPERT program, and Table 4 presents algorithms for estimating gross emissions from an AV fleet and the necessary initial data.

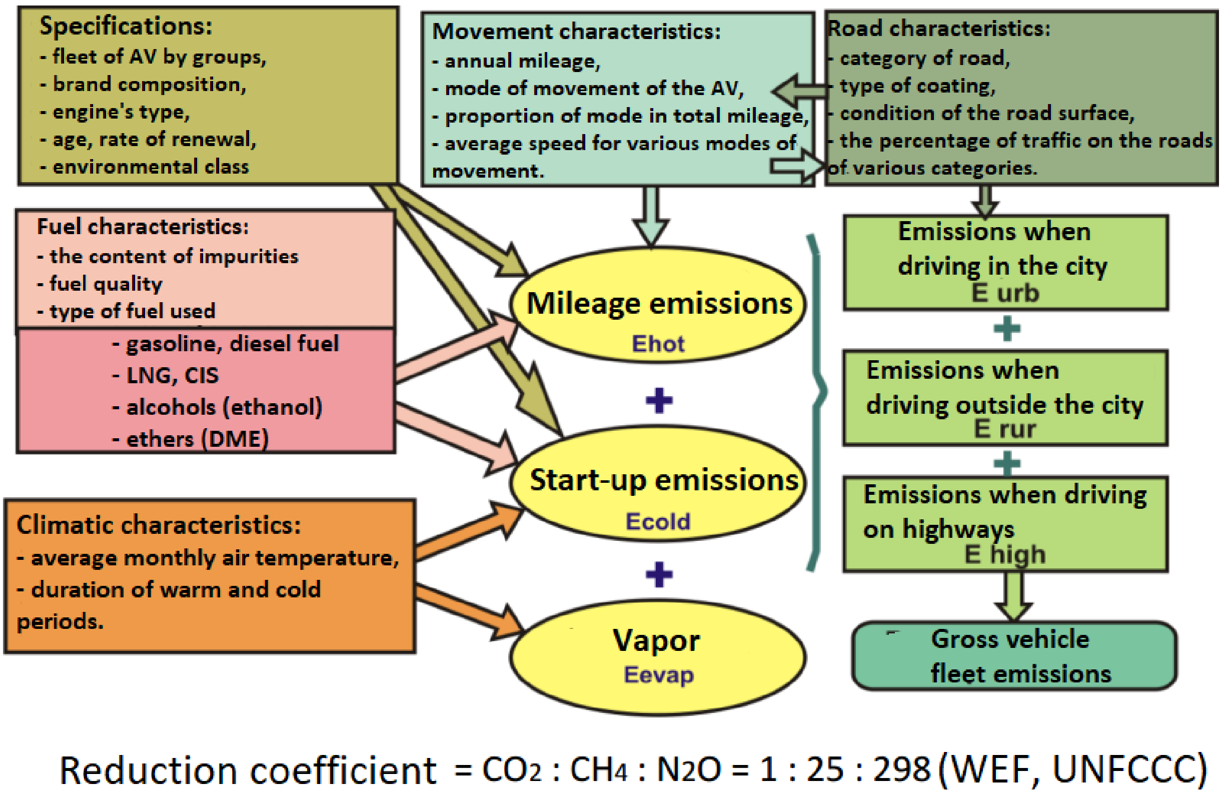

Figure 2. Block diagram of COPERT pollutant emission estimate

Table 4. Algorithms for estimating gross emissions of GHGs and other pollutants by the ATC park under the COPERT program

Algorithm Name	**Initial data**
Algorithm A - for fuel combustion	- Total annual mileage of AVs; - the share of mileage according to driving conditions (urban, rural and highway); - average speeds of AVs by driving modes (urban, rural and highway); - emission coefficients (EC) depending on speed. - *Cold start emissions* are calculated based on: - the length of the average ride of the vehicle; - average monthly temperature; - temperature and length of the ride depending on the cold start correction factor. - *Fuel fumes* are calculated based on: - fuel volatility (RVP); - average monthly temperature, fluctuations in average monthly temperature; - - EC depending on temperature.
Algorithm B	- Annual mileage of AVs; - the share of mileage according to driving conditions (urban, rural and highway); - average speeds of AVs by driving modes (urban, rural and highway); - emission coefficients (EC) depending on speed. - For diesel passenger cars, additional cold start emissions for CO, NOx and NMVOC, as well as additional fuel consumption
Algorithm C	- Total annual mileage of AVs; - the share of mileage according to driving conditions (urban, rural and highway); - emission coefficients (EC) depending on speed. - For gasoline and light diesel ATSs, additional emissions of CO, NOx and NMVOC during cold start, as well as additional fuel consumption, are obtained using this algorithm
Algorithm D	- Full annual fuel consumption by individual categories of vehicles and / or full annual runs for each category of AV; - EC, depending on fuel consumption and / or mileage. - For two-wheeled AVs, the evaporation volatilities are determined using algorithm A

In addition to the above mentioned methods for the assessment of gross emissions of GHGs and other pollutants by road in the Russian Federation other methods, developed mainly by NIIAT, and are widely used.

These techniques are based on the well-known approach (Levels 1, 2 of the IPCC) to estimate the volume of consumption of motor fuel and the intensity of use of AVs, which in general can be represented by the expression:

$$M_i = 10^{-6} \sum_{k=1}^{h} (m_{ik} N_k L_k), \tag{4}$$

where Mi stands for mass emission of i-th pollutant, т; h – the number of considered types of cars; mik – specific mileage emission of the i-th pollutant by the k-type car, g / km; Nk – the to-tal number of cars of the k-th type; Lk – total mileage of k-type cars, km.

In the case of calculations for individual sections of street-road networks, the linear section of the street (road) with a certain traffic intensity and relatively homogeneous traffic conditions is considered as a source of emission (in this case, Lk = L means the length of such a segment, and Nk - k-th type traffic intensity on this section). The combination of such sites determines the road network with traffic flows, which ultimately allows us to go to fairly accurate estimates of gross emissions.

When estimating emissions from motor transport in certain territories, one should additionally take into account emissions associated with the start-up and heating of motor vehicles at their parking places, as well as emissions of pollutants resulting from the evaporation of fuel. Given these components, formula (1.4) can be represented as:

$$M_i = 10^{-6} \left[\sum_{k=1}^{h} (m_{ik} N_k L_k) + \sum_{k=1}^{h} \left(P_{ik}(t) \cdot T_k(t) \right) + \sum_{k=1}^{h} Q_{ik} \right], \tag{5}$$

where Pi(t) — specific emission of the i-th pollutant when starting and warming up the engine of a car of the k-th type (depending on the ambient temperature), g / min; Tk(t) — average time of start-up and warm-up of an engine of a k-th vehicle (depending on temperature), min.; Qik — emissions of the i-th pollutant in the k-th type vehicle fuel vapor.

The most reliable is the "Settlement Instruction (Methodology) on Inventory of Emissions of Polluting Substances from Motor Vehicles in the Territories of Major Cities (Moscow as an Example)" [32], which is intended for inventory of emissions of pollutants into the atmospheric air by motor vehicles. when driving on the road network of the largest cities (with a population of over 1 million people), as well as highways, and it is recommended for use by the Research Institute "Atmosphere" from 2015 to calculate, standardize and control Emissions of pollutants into the ambient air. The advantages of this technique are:

- a large list of calculated pollutants, including GHGs (CO2, N2O, hydro-carbons in terms of methane) etc. (SO2, NOx PM, Pb, NMVOC, NH3);
- accounting for emissions of pollutants not only during the movement of road transport, but also during engine start-up and warm-up. Also in this method, emissions of pollutants are calculated when the fuel evaporates.

The methodology for calculating emissions from motor transport in large cities is almost completely harmonized with the European EMEP / CORINAIR methodology. However, it has the following differences:

- more differentiated classification of urban traffic conditions;

- large differentiation of certain categories of AVs;
- accounting of emissions of pollutants for motor vehicles of Russian production of environmental classes pre-EURO, Euro-1 and Euro-2.

Unlike the CORINAIR methodology, where emission estimates are carried out for three characteristic traffic conditions (along city streets, country roads and highways), the NIIAT method considers five levels of mileage emission gradation according to the traffic conditions given in Table 5.

The NIIAT method includes three calculation blocks (see Figure 3):

- calculation of gross emissions from the movement of AVs (the so-called hot emissions);
- calculation of gross emissions during start-up and warm-up of the engine (cold emissions);
- calculation of gross emissions from fuel evaporation.

The calculation model (method) for determining emissions of GHGs and other pollutants from road transport includes six blocks of input (initial) data, three blocks of reference data and four calculation modules. A block has also been introduced that allows taking into account the impact on quality emissions of the used fuel.

Table 5. Classification of elements of the road network

I.P	Main roads of regulated traffic and main streets of citywide value of regulated traffic, main streets of city value of continuous traffic and main roads of high-speed traffic, as well as mainline streets of regional significance during peak load at speed of communication $V_c \leq 15$ km/h
I.I-P	Main roads of regulated traffic and main streets of citywide value of regulated traffic during the inter-peak period at the speed of communication $V_c > 15$ km/h
II	Main streets of district value in the inter-peak period at the speed of communication $V_c > 15$ km/h, streets and local roads
III	Main streets of citywide value of continuous traffic at $V_c > 15$ km/h
IV	Highway speed roads at $V_c > 15$ km/h

To obtain correction coefficients for the run-out emissions of NMVOC and nonnormable pollutants for cars with gasoline engines, the equations derived from the European Emissions, Fuels and Engine Technologies (EPEFE) [33] and quality indicators of Russian gasoline of various environmental classes were used. In preparing the input (initial) data for the calculations, the following information is necessary:

1) data on the road network and traffic conditions in the settlement;
2) data of the field survey of selected sections of the road network;
3) data on the climatic characteristics of the settlement.

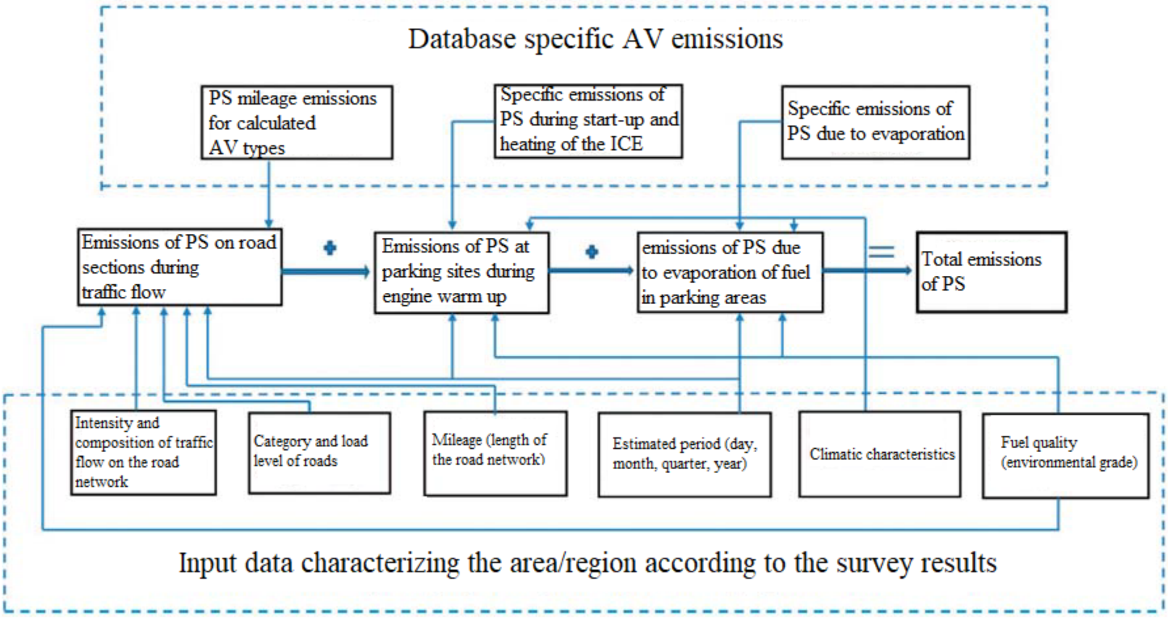

Figure 3. A flowchart of the calculated model for estimating emissions of pollutants by the method of NIIAT [10]

Reference data for the computational model (methodology) for determining emissions of pollutants include three blocks:

- 1st block: “Mileage emissions of pollutants for each type and subtype of vehicles”.
- 2nd block: "Specific emissions of pollutants during start-up and warm-up of motor vehicles".
- 3rd block: "Specific emissions of pollutants during evaporation of fuel."

The number of types and subtypes of vehicles is determined based on the analysis of the structure of the vehicle fleet, which passed the state technical inspection and registered in the territory of the settlement (traffic police data).

Meanwhile, for the purposes of inventory and the development of measures to reduce GHG emissions from transport in large cities and megalopolises, it is no longer enough to use the methodology for estimating emissions only by road transport. It is necessary to assess emissions of pollutants and other types of urban transport (electric transport, rail transport, etc.). Such estimates can be obtained using the GEF methodology, as well as “Guide-lines for transport organizations transporting automobile and city electrified transport (trams, trolleybuses) for conducting GHG emission inventories”, which were developed in the UNDP / GEF Project in 2016 [34] for transport organizations that carry out transportation on regular routes by public transport (buses, trams, trolley buses) and are intended for emissions inventory GHGs in the territory of municipalities.

Depending on the availability of data, the inventory of GHG emissions in these guidelines is carried out according to the IPCC methodology at three levels for categories of elements:

- Level 1 - if there is only total data on the consumption of different types of fuel and energy resources;
- Level 2 – if data on the consumption of different types of fuel and energy resources for different classes of vehicles is available;
- Level 3 – if data on the consumption of fuel and energy resources and their mileage by vehicle class is available.

In all the mentioned above methods, the volume and structure of fuel consumption by road can be determined in the following ways:

- based on actual data for organizations and the population operating motor vehicles (for organizations it is still possible, and for the population - only in the case of separate accounting for the supply of fuel to the population or in case all personal vehicles are equipped with fuel consumption sensors and collecting information from them, or annual mileage and specific fuel consumption recorded in the VL of each vehicle);
- according to average statistical data for organizations and the population that use vehicles (that is, based on polls of owners and expert assessments).

Collecting and analyzing actual and / or average statistical data on the consumption and structure of fuel consumption by motor vehicles can be carried out by specialized organizations:

- license data for each type, subtype and model of vehicles;
- according to the established standards of fuel consumption for each type and subtype of vehicles.

Reference data determines the specific emissions of pollutants during the combustion of 1 kg of different types of fuel. The consumption of each type of fuel for each established type and subtype of vehicles for the billing period based on specific fuel consumption data for specific car brands can be obtained by calculation using average annual mileage, provided that unit costs are adjusted for average speeds and take into account other parameters affecting the mileage of fuel.

3.1 Emissions from the road traffic

The vehicle engines burn the fuel and change the fuel's chemical energy into movement. Since the burning process of fossil fuels is not perfect, the exhaust gas is composed of many harmful substances. The composition of the combustion products, adjusted for a particular type of hydrocarbon fuel, has the following form:

- nitrogen 74-78%;

- oxygen 0.5-18%;
- water (steam) - 0.5-5.5%;
- GHGs, including:
  - carbon dioxide (CO_2) - up to 16%;
  - carbon monoxide (CO) - up to 5%;
  - nitrogen oxides - up to 0.8%;
  - hydrocarbons (primarily methane - CH_4) - up to 3%;
- sulfur dioxide (SO_2) - up to 0.02%;
- aldehydes - up to 0.2%;
- particulate matter (carbon black) - up to 1.0%;
- benzpyrene - less than 0.00001%.

In addition, in the case of leaded gasoline, a certain amount of various lead compounds may be contained in the exhaust gases.

In the current practice of inventory, carbon dioxide (CO_2), carbon monoxide (CO), methane (CH_4), nitrogen oxides (NO and NO_2), nitrous oxide (N_2O), and also solid particles are primarily subject to inventory. In addition to contributing to the formation of total GHGs, carbon monoxide, methane, and nitrogen oxides are toxic substances representing the greatest danger to the human body.

The most significant emission components from road traffic from the air quality point of view are particulate matter (PM) and nitrogen oxides (NOx) because of their large amount in the exhaust gas and the health effects they cause even in diluted concentrations. The emissions from the road traffic are being emitted from relative low emission height near breathing level and, depending on the meteorological conditions, they may cause bad air quality situation.

The current concentration of GHG components in the atmosphere results from the emission and removal processes. Gases and aerosols are emitted into the atmosphere due to human activities or are formed from precursors emitted into the atmosphere. These emissions are offset by chemical and physical removal processes. With the exception of carbon dioxide (CO_2), these processes annually remove a certain proportion of each gas from the atmosphere, and the reciprocal of this removal rate gives an average gas lifetime. In some cases, the removal rate may vary depending on the concentration of gas or other properties of the atmosphere (for example, temperature or background chemical conditions).

The long-lived GHGs - CO_2, methane (CH_4), nitrous oxide (N_2O), which are chemically stable and persist in the atmosphere from ten years to several centuries, dominate in the radiation impact on the climate system. Therefore, their emissions have a long-term effect on climate. They are mixed in the atmosphere much faster than they are removed, and their global concentrations can be accurately estimated based on data from several places.

It should be noted that the process of generating GHGs and their release into the atmosphere has a significant impact on the proportion of ozone (O_3) - one of the most important GHGs in the atmosphere. In the lowest part of the atmosphere, in troposphere, human influence on ozone occurs mainly through changes in precursor gases, which lead to the formation of ozone. In next layer of atmosphere above troposphere in the stratosphere, human influence mainly occurs through changes in the ozone removal rate due to ozone-depleting substances.

It is also necessary to note a certain effect of dispersed particles on the atmosphere. Dispersed particles can affect the climate in two ways: directly, by scattering or absorbing radiation, and indirectly, acting as condensation nuclei around which clouds form, or by changing the optical properties and life expectancy of the clouds. Dispersed particles larger than 0.1 μm can reflect or scatter sunlight, changing the optical characteristics of the atmosphere, and deposited on the surface of the cryosphere, thereby participating in the change in the total albedo of the earth's surface. The concept of "black carbon" refers to any dispersed particles, which are formed in the combustion process and have good light absorbing properties. The main component of such particles is soot (or elemental carbon). Along with other aerosol particles, soot is washed away from the atmosphere several thousand kilometers from the source of pollution, therefore its thermal effect is relatively short-lived. The term of life usually does not exceed one week. Soot particles are important impurities that contribute to the heating of the atmosphere, due to their ability to absorb light energy. Most of the techniques presented in section 3 allow an inventory of all the main above-mentioned products of combustion of hydrocarbon fuels. At the same time, part of the methodologies, for example, IPCC 2006, GEF TEEMP or ForFITS were initially formed in order to allow inventory of GHG emissions and the impact of various spheres of economic activity on climate change. The lack of accounting for emissions of dispersed particles, sulfur dioxide, water vapor, and volatile organic compounds in these methods is primarily due to the lack of a generally accepted position among international and Russian scientists and experts on the impact of these substances on climate change.

4 CONCLUSIONS

At present, both in Finland and in the Russia, a regulatory and legislative framework has been formed that defines the basis of state policy regarding the control of the environmental burden from economic activity.

Legislation for industry is developed in the Russian Federation and the law “On Environmental Protection” is of a general declarative nature. The Finnish legislation is based on the Law on Environmental Protection, which describes the various aspects of environmental relations, including air, and complies with the higher legislation of the EU.

Unlike the Russian one, the Finnish law on environmental protection involves the use of the principles of minimizing harm and environmental damage, the least use of resources, as well as the use of advanced methods to prevent environmental pollution. The Law on Environmental Protection is based on an integrated system of environmental permits.

Regarding the directives for assessing air quality, it should be noted that in the Russian Federation all the applied methods are described in other classes of legislative documents. The basic law defines only the direction of the policy on air quality itself and determines the general provisions of objects and subjects of this type of environmental management.

Based on the analysis of the existing legislation of Russia and Finland, several fundamental differences between the existing legislative systems should be noted:

- The finnish environmental legislation currently in force is subordinate to the rules of the EU. In addittion to the European legislations national guidelines are given in air quality setting. The national guidelines concerning air quality are not as binding as the european level limits but they give guidelines for town and traffic planning.;

- those areas of legislation that are of priority importance in both states are more developed;

- significant impact on the system of legislative and by-laws;

- geographical, climatic and socio-economic characteristics have a significant impact on the formation of regulatory mechanisms in both countries, which, in turn, has a significant impact on the system of legislative and by-laws.

Finland ratified the Paris Agreement along with the rest of the EU Member States. Finland, like other EU countries, under the Paris Agreement, has committed to reduce GHG emissions by 40% by 2030 from the 1990 level. In the new energy and climate strategy of Finland, the government has set more ambitious targets for reducing GHG emissions 60% by 2030 from the 1990 level. By 2050, Finland plans to achieve a zero carbon balance.

It is planned that the Russian Federation will decide on the ratification of the Paris Climate Agreement at the end of 2019. The goal of Russia in the framework of the Paris

Agreement is to reduce GHG emissions by 2030 to 70–75% of the 1990 level, subject to the maximum possible absorption capacity of forests.

Ratification of the Paris Agreement will contribute to the formation of effective mechanisms for energy conservation and energy efficiency in the transport industry of the Russian Federation.

Ratification of the Paris Agreement will also contribute to solving the tasks formulated in Decree of the President of the Russian Federation dated May 7, 2018 No. 204 “On National Goals and Strategic Tasks of the Development of the Russian Federation for the Period until 2024” with respect to the federal project “Clean Air”, aimed at reduction of air pollution by harmful emissions from vehicles. The implementation of a set of measures to reduce GHG emissions by all modes of transport by switching to the use of alternative fuels, switching freight and passenger transportation to less energy-intensive modes of transport, developing multimodality and other measures will contribute to improving the quality of life and reducing the incidence of population in cities.

Upon ratification of the Paris Agreement, the Russian Federation will be able to participate in the formation of mechanisms for regulating GHG emissions taking into account national interests.

Currently, the Russian Federation has not resolved the number of problems associated with the regulation of GHG emissions from road transport. In particular, Russia does not have approved methods for inventorying and calculating GHG emissions from road transport in the regions and along highways. In Russia, there are no regulatory requirements for specific CO_2 emissions of new cars, eco-labeling of vehicles to identify their energy efficiency, an effective system for monitoring the technical condition and fuel economy of cars of individual owners.

Bringing the regulatory framework to some common standard will contribute to the development of not only environmental, but also economic dialogue with the development of various sectors of the economy. The application of existing regulatory aspects for estimating GHG emissions and other harmful substances into the atmosphere from vehicles used in Finland and the EU is important, especially in the case of the border location of territories, as in the case of: St. Petersburg and the Leningrad Region on the one hand and Finland - with another

Among the priority tasks is the development of an industry methodology for determining GHG emissions by stationary and mobile sources in the Russian Federation. Using this technique, GHG emissions along highways with significant lengths should be calculated.

EU countries, including Finland, have considerable experience in the development and use of methodological documents that determine the calculation of GHG emissions from road traffic.

The analysis showed that it is advisable to use the three-level EMEP / EEA (previously called EMEP / CORINAIR) methodology developed by the UNECE as a basic methodology for calculating emissions of GHGs and other harmful substances from road transport. This technique is widely used in Finland, it allows the calculation of so-called "run-through" emissions, which is most suitable for an inventory of emissions in the gravity zone of the E-18 highway.

The methodology is tested for the European road E-18 on the section from St. Petersburg to Helsinki during the project CBC Green InterTraffic.

The aim of the CBC Green InterTraffic project is to provide a common methodological base to calculate the road traffic emissions in the Russian Federation and Finland. The common approach would contribute to the development a common environmental monitoring system in the border territories of two neighboring states and the adoption of coordinated measures to improve the environmental friendliness of the road European route E-18 on a section from St. Petersburg to Helsinki.

It is assumed that potential users of this methodology for determining the volume of GHG emissions and other air emissions from road transport can be roughly classified as follows:

- executive authorities;
- scientific organizations;
- road organizations and trucking companies.

The executive authorities or their subordinate organizations can use the methodology for inventorying pollutant emissions at the national or regional level for the following tasks:

- to assess the degree of fulfillment of national commitments or the achievement of target indicators in the composition of strategic or programmatic documents for the development of the transport industry related to the reduction of harmful emissions into the atmosphere;

- to assess the environmental effects in the framework of determining the socio-economic efficiency of the implementation of measures for the development of the transport complex of the state;

- to prepare and evaluate the effectiveness of a set of measures aimed at reducing emissions of air polluting substances by motor vehicles;

- to form a sectorial monitoring system and a statistical accounting system of emissions of air polluting substances by motor vehicles.

Scientific organizations can use the methodology in question to assess the potential effectiveness of initiatives proposed as part of research or development activities related to improving the design of AVs, road infrastructure, motor fuels and other elements of the transport complex that influence the emission of air pollutants from motor vehicles.

In their turn, organizations operating a AVs can, if necessary, use the methodology in question to estimate the amount of emissions of air polluting substances from their own AV fleet or emissions within a particular territory in which it is operated. Such a need may arise when assessing the impact of pollutant emissions on the health of employees or the production process.

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