

OUTLOOK ON DEVELOPMENT OF ECOLOGICAL TRANSPORT SYSTEM IN A MEGALOPOLIS

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ABSTRACT

The article shows the dynamics of population growth in the largest cities in the world and the proportional growth in the number of vehicles, the effect of road transport emissions on health of urban population and environment, the maximum permissible levels of harmful substances emissions into the atmosphere, and the data on air pollution in the world megacities.

Cause-effect relations are considered and the damage, including economic, is estimated from pollution of atmospheric air. The programs of international organizations to reduce harmful emissions into the atmosphere are considered. Technical solutions are proposed to reduce the impact of road transport on the atmosphere of cities. The main measures and ways to reduce the environmental load in transport systems of large

cities of the world are formulated, in particular, the refusal of diesel buses and the transition to buses with electric motors.

Russian federal and regional programs to reduce the level of harmful substances in the atmosphere from road transport, as well as the main provisions of the new environmental strategy of the city of Moscow for the period until 2030, are considered and studied. Based on this strategy, the tasks of qualitative transformation of the city's transport system, reduction of anthropogenic CO₂ emissions and noise reduction have been defined. The results of tests of domestic and foreign models of electric buses on the routes of the capital are presented in the framework of implementation of the activities of the Government of Moscow aimed at developing and improving land urban passenger transport, reducing the congestion of the road network and improving the environmental situation.

Keywords: *environmental pollution, atmospheric air, road transport, electric bus, metropolis, charging station.*

Background. A characteristic feature of the modern world is the growth of cities and the number of their inhabitants. As population density increases, demand for transport services increases.

Transport plays a significant role in the economy and everyday life of people. The use of all modes of transport on all continents is increasing both in terms of the volume of goods transported and in the number of passengers. The passenger transport system becomes in many cases prevalent, the efficiency of the economy branches of the largest cities and the possibility of applying their urban and social and economic potential depend on its functioning and development. However, the transport system in addition to the positive effect also contains a negative impact. Megacities created giant transport hubs and related problems, including environmental ones.

According to various sources [see, for example, 1] at the moment, motor transport accounts for more than 50 % of all harmful emissions to the environment, which are considered to be the main source of atmospheric pollution, especially in large cities. And this is the global problem of the modern world. Half of the world's megacities suffers from air pollution, which is 2.5 times greater than WHO standards. In most cities there is a negative dynamics, air becomes dirtier, with more than 90 % of air pollution in them due to vehicle emissions.

More than 3.5 million people die prematurely every year because of air pollution¹. Between 2005 and 2010, the resulting mortality rates increased by 4 % worldwide, by 5 % in China and by 12 % in India. In the EU in 2010, more than 400 thousand people died prematurely for this reason, despite the tightening of European standards for emissions for vehicles. This fact confirms that technology alone cannot overcome the growth of environmental pollution.

Air pollution leads to social costs and significant economic costs. It is believed that such air pollution in

cities costs about 2 % of GDP in developed countries and 5 % in developing countries. In China, this cost is estimated at about 12 % of GDP, in Russia 8 %, and in India 7 % [see also 2]. According to the Global Commission on the Economy and Climate in Europe, the impact of air pollution from road transport costs about \$137 billion a year. This leads to direct expenses for medical care, to company expenses due to loss of working time.

The Organization for Economic Co-operation and Development (OECD) predicts that unless new strategies are adopted, urban air quality will continue to deteriorate globally and cause deaths due to environmental degradation throughout the world.

The United Nations Environment Program (UNEP) estimates that more than a billion people are exposed to polluted open air every year, and this is the biggest environmental hazard. Only 12 % of urban residents breathe air that meets the requirements of the World Health Organization.

Objective. The objective of the authors is to consider issues of development of ecological transport system in a megalopolis.

Methods. The authors use general scientific methods, comparative analysis, economic assessment, evaluation approach.

Results.

1. Solving environmental problems in the motor transport complex

An increase in the number of road transport, its concentration in large cities and near major transportation hubs, together with an increase in traffic and lower average traffic speeds, leads to a deterioration in the environmental situation. In some areas, total emissions from motor vehicles exceed emissions from stationary sources. In the conditions of hot sunny weather in megacities, there are cases of formation of tropospheric ozone (smog). This situation poses a serious danger for population living at highways, provokes emergence of specific diseases associated with ingestion of lead.

The transition to public transport is almost the only real solution to the problem of local emissions and the

¹ 12.6 million people or 23 % of all deaths in the world are associated with environmental pollution according to WHO. See, eg, http://www.who.int/quantifying_ghimpacts/publications/preventing-disease/en. Ed. note.

method of achieving environmental goals. Positive actions to promote alternatives for private transport are very important. There is also a need for comprehensive air quality management. Therefore, it is extremely necessary to control, monitor, analyze the situation, exchange data on the state of the air environment. This should include increased risk awareness, promotion and evaluation of results, as well as investments in more integrated public transport systems and sustainable development models. Such cities as Copenhagen and Bogota, for example, improved air quality, promoting «active transport» and giving priority to the target networks of urban public transport, pedestrian and cycling.

Eleven major cities in the world, including London, New York, Los Angeles, Beijing, Madrid, Copenhagen, Cape Town, are gradually moving towards a total refusal to purchase diesel buses by 2020 [3].

In a number of European countries, the tram is the main type of passenger transport when moving around the metropolis.

The Paris RATP has declared a strategy of total refusal to purchase diesel transport in the region. In 2025, 80 % of the park will be electric buses.

The public transport operator in Montreal (Canada) STM proclaimed by 2025 the intention to purchase only electric buses.

All rolling stock in Oslo and Arkeshus (Norway) by 2020 will consist only of vehicles moving on the basis of renewable energy sources.

In Darmstadt (Germany), the goal is to completely switch to «zero-emission» transport by 2025.

Madrid and Mexico City announced a program, under which until 2025 in these cities there will be no single diesel bus.

In our country, the problem of air pollution is solved at the federal and regional levels. The orders of the President of Russia on the results of the meeting of the State Council Presidium on passenger transport contain the requirements to pay special attention to the renewal of the park for the innovative nature of the decisions made and the inclusion of environmental safety requirements in them [4].

Decree of the Government of the Russian Federation of April 15, 2014 No. 326 approved the state program «Environmental Protection» for 2012–2020 [5]. Subprogram 1 «Environmental quality management», together with numerous activities, contains an indicator on emissions from road transport.

Certain indicators of the state program are to be established and monitored at the level of each constituent entity of the Russian Federation. However, for example, for Moscow, there are no indicators related to emissions from road transport. At the same time, the resolution of the Government of Moscow dated July 10, 2014 No. 394-PP approved «The main provisions of the new environmental policy of the city of Moscow for the period until 2030» [10].

Key objectives and principles of the new environmental policy include tasks related to qualitative transformations of the transport system aimed at reducing anthropogenic CO₂ emissions, and reducing noise. At the same time it was planned [10]:

- to invest in public transport;
- to carry out transfer of the bus fleet with diesel engines to electric motors;
- to encourage the renewal of the fleet by vehicles of a higher ecological class;
- to increase the role of cycling transport.

Consolidation of forces and resources is carried out in the field of environmental protection, nature

management and environmental security in the metropolis. The participation of citizens, organizations of all types and forms of ownership in addressing environmental issues, the use of vehicles in dense housing and ongoing renovation is being realized.

The following is required:

- Formation of the ecological culture of the capital's population, integration of environmental education, including education, into all relevant city programs and events.

- Support for all initiatives that promote progressive development scenarios.

- Raising awareness of organizations in the field of environmental legislation and environmental management, teaching them how to manage organizations in accordance with environmental requirements.

Implementation of the new environmental policy includes:

1. Development and implementation of the Environmental Strategy of Moscow for the period until 2030.

2. Reforming the city's management system in the sphere of environmental protection, nature management and environmental safety, aimed at maximizing the involvement of the public, scientific specialists and experts, commerce representatives in making environmentally important decisions. Creation for their implementation of effective intersectoral and branch-wise collegial bodies, rational distribution of powers between executive bodies of power of all levels, exclusion of redundant and overlapping functions.

3. Creation of economic mechanisms aimed at stimulating environmental protection and ensuring environmental safety, rational use of non-renewable natural resources, encouraging organizations that carry out rehabilitation of ecologically disadvantaged and contaminated areas. Stimulation of investment attraction to reduce the harmful impact of vehicles on the environment, production of environmentally friendly products, introduction of resource-saving technologies.

4. Improvement of the normative legal and methodological base, including in the area of introduction of environmental indicators in assessing the effectiveness of state programs of the city, creating standards for «green building», a system of regional measures for social reward and economic incentives for citizens, organizations of all forms of ownership participating in formation and implementation of environmental strategy.

5. Scientific provision of nature protection activities, scientifically based selection of priorities and implemented environmental solutions.

2. Introduction of electric buses into the urban transport system

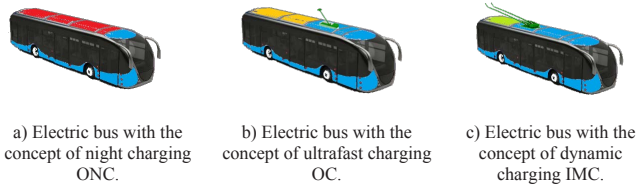
Creation of a reliable, environmentally friendly and safe transport system remains an indispensable task in shaping the development strategy for the largest cities, including Moscow. Metropolitan environmental strategy, highlighting this task in a relatively close perspective, could not but take into account the obvious. Each type of public passenger transport has its advantages and disadvantages, but the key advantage of electric transport is just high ecological cleanliness.

As a result of the analysis of the international and domestic approach to solving environmental problems, we can confidently conclude that the transition from bus diesel transport to electric buses is of primary ecological importance.

SUE Mosgortrans has become the main testing ground in the Russian Federation and has consistently



Pic. 1. Classification of the types of electric buses.



tested various models of electric buses on the routes of the capital. On the site of the branch «Central» in Filevsky bus-trolleybus park, periodic tests were conducted on KamAZ electric buses and Finnish Linkker model.

In August 2017, the Chinese electric bus Yutong was replaced by LiAZ-6274 electric bus on route M2. This model will run through the streets of Moscow during 2018. As representatives of the concern-manufacturer said, the model is not afraid of severe Russian weather conditions. It is ready to operate smoothly in different temperature modes, as well as during ice, snow and rain. The electric bus is adapted to the climate from minus 30 to plus 35 degrees. During the tests, drivers and repair personnel of SUE Mosgortrans will constantly keep an on-board log, which will record all the performance of the electric bus: data on mileage, charge level, power consumption, charge time, faults and their elimination. Representatives of the manufacturing plant, members of the working group, in turn, on the basis of this information will formulate a technical task for the first full-scale serial electric bus for the city.

At the end of 2017, SUE Mosgortrans published a draft of its terms of reference (TOR) for Moscow electric bus. The creation of the project was preceded by scientific and technical councils with participation of experts, manufacturers of rolling stock and components. According to the terms of reference [11–13], a tender was announced for supply of 300 buses on electric traction under the life cycle contract. Together with electric buses it is provided for supply of charging

stations capable of charging batteries in the shortest possible time. Electric-charging stations will be located at the terminal stations, TIH and directly at the operating enterprises. On urban routes, they should appear already in 2018. An obligatory condition of the contract is localization of production of the fleet on the territory of the Russian Federation.

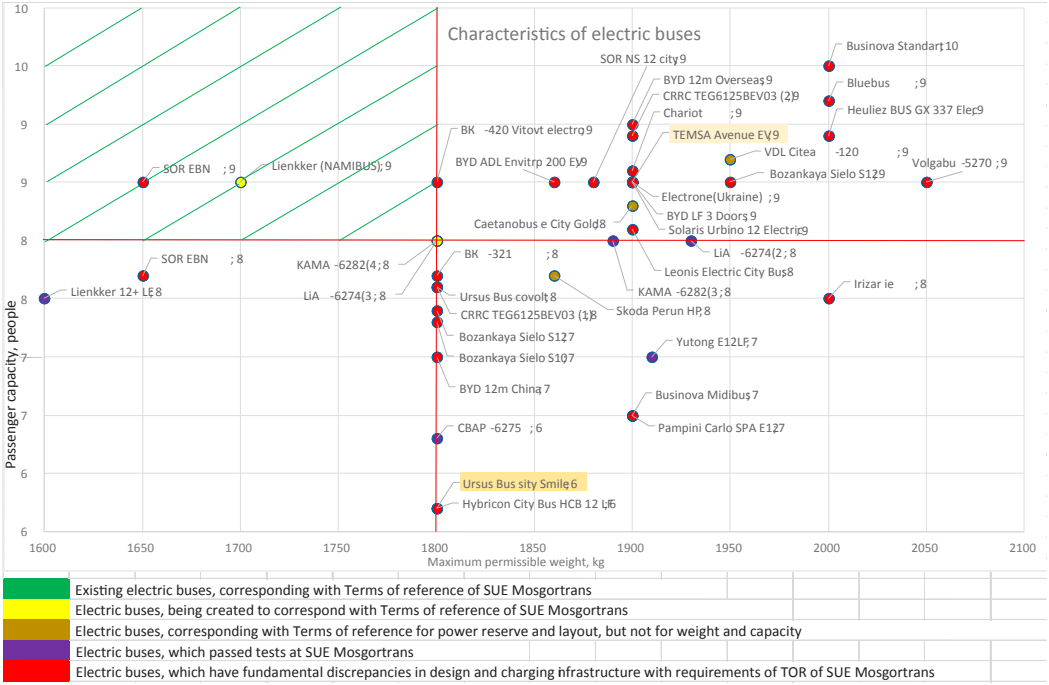
The electric bus is a relatively new type of rolling stock, which requires a balanced and objective justification of the choice of various options for technical, technological and other aspects of solving such a global task.

Classification of the types of electric buses and their conceptual differences [14, 15]:

- a) Electric bus with the concept of night charging ONC.
- b) Electric bus with the concept of ultrafast charging OC.
- c) Electric bus with the concept of dynamic charging IMC.

Pic. 1 shows three types of electric buses.

The existing types of electric buses differ in cost, battery capacity, charging time, power consumption, etc. But the conceptual difference is in the way of obtaining electricity. The electric bus with the ONC concept is charged at night at a slow pistol charging station (socket) located in the park. The electric bus with the OC concept is charged on the route from ultra-fast charging stations, which are located at checkpoints and intermediate points. Technical solutions for charging:



Pic. 2. Characteristics of the relationship between passenger capacity and maximum technical weight of existing electric buses.

can meet the growing demand for transportation, ensuring the mobility of the system on which the city can base its sustainable development. And undoubtedly, the transition to cleaner modes of transport from the ecological point of view is a global imperative. The idea of moving, like Moscow, from diesel buses to electric buses will positively affect the ecological situation in cities.

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