Assessment of the level of development of electric transport

D E Morkovkin¹, P V Stroev¹, A A Gibadullin², D V Troshin¹, S V Makar¹ and M I Sadriddinov³

¹Financial University under the Government of the Russian Federation, 49, Leningradsky avenue, Moscow, 125993, Russia
²State University of Management, 99, Ryazan Avenue, Moscow, 109542, Russia
³Tajik State Finance and Economics University, 64/14, Nakhimova Street, Dushanbe, 734067, Republic of Tajikistan

E-mail: 11117899@mail.ru

Abstract. It is substantiated in the work that in recent years, the transition to new technologies, including in the transport sector, has reduced the environmental burden on the environment and can reduce the use of energy resources. As part of the study, an assessment was made of the level of development of electric transport. The work-analyzed indicators reflecting the level of development of public electric transport, because of which it was concluded that until 2016, the development of public electric transport was observed, but today its reduction is observed. The study found that the number of cities using electric transport is insignificant, but reduced. The analyzed volume of electric energy consumption by urban transport remains an uneven trend. The study proposed a model for ensuring the development of electric transport in Russia, because of which stages were, identified that aimed at achieving the research goal.

1. Introduction

In recent decades, trends related to the need for efficient use of fuel and energy resources, the development of energy-saving technologies, a decrease in the dependence of production on various hydrocarbons and the transition to innovative technologies have been updated [1-3]. Such trends are updated at a time when society is thinking about the need for the rational use of natural resources and the preservation of the environment for future generations [4]. Environmental protection requirements are imposed on almost all types of activities, including the transport industry. The transport industry of Russia developed based on using various types of resources that were available to humankind, at first horses were used as a driving force, and then they began to switch to engines that worked on fuel, as well as on electricity [5]. Many types of transport are developed in Russia, including railway, automobile, aviation, pipeline, sea and other types of transport that are used in modern times [6-8].

In modern times, more and more states are abandoning the use of vehicles running on fuel resources, and there is a gradual refusal to use such resources as gasoline, coal, fuel oil, etc. In this regard, transport complexes are switching to electric transport, since the use of electric energy practically does not produce emissions of pollutants into the air [9]. In the Russia Federation, although such a large-scale restructuring of the transport industry is not observed, at the same time, such cities as trams, trolleybuses and the subway that operate exclusively on electric energy are developed in Russian cities, while rail transportation is mainly carried out by electric traction engines [10-11].
Thus, it is relevant to analyze the level of development of electric transport in the Russian Federation, since the transport industry was created back in the Soviet period and uniform requirements for the development of territories were applied. Moreover, it seems advisable to consider how public electric transport is developing today, which carries tens of millions of passengers every day. In addition, we consider it necessary to propose mechanisms for the development of electric transport in Russia, which today is receiving a new round of development at the global level.

2. Materials and methods

The purpose of this study was to assess the level of development of electric transport in Russia. As part of the goal, the following tasks were formed:

- Assess the level of development of electric transport;
- To propose a model for ensuring the development of electric transport in Russia.

The study was based on the use of statistical data published in open sources, as well as on general scientific methods and approaches that allowed revealing the goal of the study.

3. Results

The first public transport that ran inside the cities is considered to be a tram; in Russia, it began to function almost simultaneously with the commissioning of the first power plants. Power stations provided electrical power to separate administrative buildings, illuminated the streets and supplied electricity to electric vehicles, which were just starting to run on city streets. From this period in Russia began to create new modes of transport that, due to the consumption of electric energy, could function and transport people. After several decades, a trolleybus and subway, which apply to electric transport, will appear in Russia. Despite the fact that such modes of transport were invented about 80-100 years ago, they remain the main transport system of cities and regions that provide millions of people daily [12-13].

Consider the volume of changes in the means of communication of electric transport in Russia (figure 1) [14].

![Figure 1](image)

**Figure 1.** The operational length of the public transport lines, thousands of kilometers.

From the presented figure it can be seen that the tram tracks and trolleybus lines actively developed until 2016, and then there is an insignificant drop. Metro tracks are constantly evolving and today reach 600 kilometers. It should be noted that the cost of building tram tracks and trolleybus lines is ten times
lower than, for example, subway tracks. At the same time, passenger traffic in the subway per kilometer of tracks is almost ten times more than on tram and trolleybus routes.

Further, it is advisable to consider the number of cities with urban electric transport (figure 2) [14].

![Figure 2](image-url)  
**Figure 2.** The number of cities with urban electric transport, units.

The figure shows that the development of electric transport does not occur, for example, since 2005 in Russia there are only 7 subways, and the number of cities with tram and trolleybus routes is reduced, despite the fact that Russia was connected to this period new territories.

We will present data that reflect the volumes of electricity consumed by different modes of transport (figure 3) [14].

![Figure 3](image-url)  
**Figure 3.** Electricity consumption by different types of urban transport, billion kW * h.

From the presented figure, it is clear that the situation with electricity consumption is variable, but, in general, there is no dynamics to reduce the consumption of electric energy by public urban transport.

Thus, it can be seen from the analysis that electric urban transport is not developing, which requires state and city structures to ensure the transition to new technologies, including using electric energy [15-19].
4. Discussion
In recent decades, in the world, as well as in certain regions of Russia, they began to use a new type of transport - the electric bus. This type of transport can be attributed to electric transport, which runs on batteries and can travel on any route. According to researchers, the development of electric transport in Russia is a necessary reality for the Russian economy and society, as it reduces the use of fuel and energy resources and reduces emissions of pollutants into the air [20-24].

However, the analysis showed that electric transport is not developing in Russia. In this regard, we believe it is necessary to propose a model for ensuring the development of electric transport in Russia (figure 4) [25-30].

![Figure 4. Model for ensuring the development of electric transport in Russia.](image)

The implementation of the presented model must be based on the following steps:

- Assessment of passenger traffic and the level of development of public transport;
- Analysis of the possibility of using various modes of transport in order to ensure passenger traffic;
- Assessing the environmental benefits of using electric vehicles;
- Formation of a system for the development of the transport complex in selected cities and territories;
- Designing a system for the development of electric vehicles taking into account modern technologies;
- Implementation of the design system for the operation of electric transport in individual agglomerations.

5. Conclusion
Thus, as part of the study, it was revealed that in Russia electric transport began to develop from the end of the XIX century, during this period the first electric tram was launched. Further, electric transport continued to develop, so, in 1933 and 1935 trolleybus routes and the subway were launched. However, in recent years, the use of trolleybus and tram tracks has been declining, and the subway tracks have been increasing. In addition, the number of cities with tram and trolleybus routes is reduced, and the
metro is located in only seven cities of Russia, the volume of electricity consumption by urban public transport is uneven. Because electric transport is recognized as the most environmentally friendly and efficient transport, the study proposed a model that ensures the development of electric transport in Russia.

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