Reducing the energy costs of urban households when using electric bikes and electric scooters to provide urban mobility

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Abstract. The study analyzed the reduction in energy consumption of urban households when using electric bikes and electric scooters to provide urban mobility. An analysis was made of reducing the average energy consumption of urban households when switching to the use of electric bikes and electric scooters to ensure urban mobility, depending on operating temperature conditions (0-10C^0, 11-20C^0, 21-30C^0). The data obtained reflect the degree of reduction in average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility, depending on the temperature operating conditions. These studies can be used in conducting research aimed at optimizing the energy consumption of urban residents to ensure urban mobility based on the use of electric bikes and electric scooters in modern cities.

1 Introduction

Conducting research aimed at optimizing the energy consumption of urban households while ensuring urban mobility based on the use of electric bikes and electric scooters is an urgent scientific task for modern megacities.

Reducing the energy costs of urban households is possible by optimizing existing expenses. Energy costs for urban mobility can be reduced based on the selection of the optimal means of transportation for various conditions, including seasonality, weather and temperature conditions, etc.

Analysis of the reduction in average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility, depending on temperature operating conditions, can be divided into three levels:

- 0-10C^0;
- 11-20C^0;
- 21-30C^0.

These temperature regimes are typical for modern megacities in different seasons.

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2 Materials and Methods

This study is aimed at analyzing the reduction in average energy consumption of urban households when switching to the use of electric bikes and electric scooters to ensure urban mobility. An analysis was made of reducing the average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility under different operating temperature conditions (Table 1). The reduction in energy costs when using electric bikes and electric scooters was compared with the use of a mid-range electric vehicle.

Table 1. Different operating temperature conditions for electric bikes and electric scooters to ensure urban mobility.

Temperature operating conditions for electric bikes and electric scooters	**C^0**
Temperature conditions No. 1	0-10C^0
Temperature conditions No. 2	11-20C^0
Temperature conditions No. 3	21-30C^0

For the purpose of collecting and processing analysis data on reducing the average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility under different temperature operating conditions, various methods were considered [1-23].

3 Results

3.1 Results of the analysis of the reduction in average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility under different operating temperature conditions (0-10C^0, 11-20C^0, 21-30C^0)

3.1.1 Results of the analysis of the reduction in average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility under the first operating temperature condition (0-10C^0)

The results of the analysis of the reduction in average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility under the first operating temperature condition (0-10C^0) are presented in Figure 1.

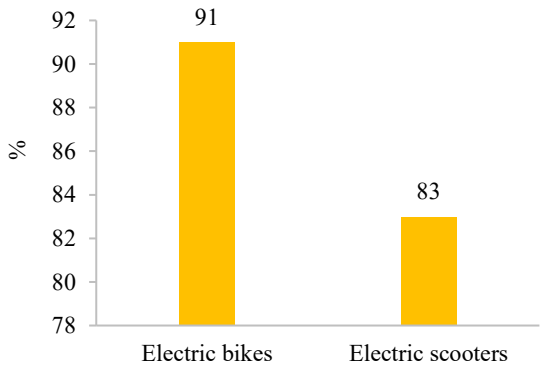

Fig. 1. Reducing the average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility under the first operating temperature condition (0-10C^0).

3.1.2 Results of the analysis of the reduction in average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility under the second temperature operating condition (11-20C^0)

The results of the analysis of the reduction in average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility under the second operating temperature condition (11-20C^0) are presented in Figure 2.

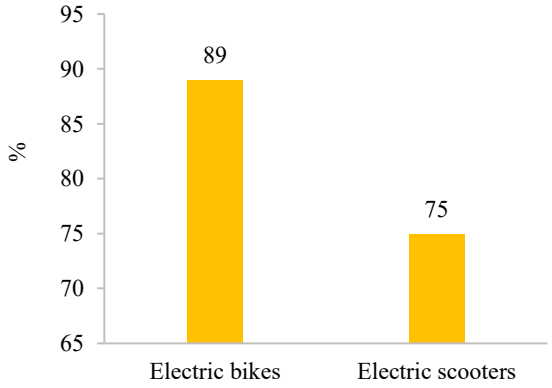

Fig. 2. Reducing the average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility under the second operating temperature condition (11-20C^0).

3.1.3 Results of the analysis of the reduction in average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility under the third operating temperature condition (21-30C^0)

The results of the analysis of the reduction in average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility under the third operating temperature condition (21-30C^0) are presented in Figure 3.

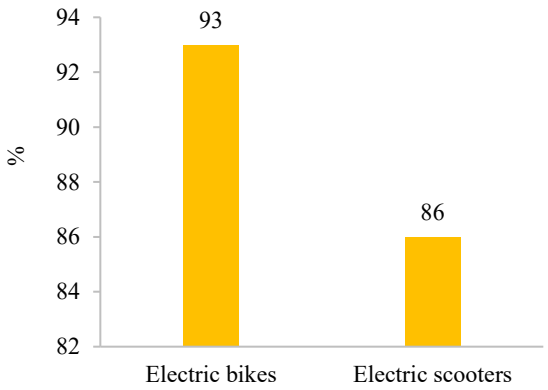

Fig. 3. Reducing the average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility under the third operating temperature condition (21-30C^0).

To process analysis data regarding the reduction in average energy consumption of urban households when switching to the use of electric bikes and electric scooters to ensure urban mobility under different temperature operating conditions, formulas 1, 2 and 3 were used.

$$SS_{fact} = \frac{\Sigma_j^p T_j^2}{n} - \frac{(\Sigma x_i)^2}{N} \quad (1)$$

$$SS_{total} = \sum x_i^2 - \frac{(\Sigma x_i)^2}{N} \quad (2)$$

$$M = \frac{X_1 + X_2 \ldots + X_i}{n} \quad (3)$$

Processing the results of reducing the average energy consumption of urban households when using electric bikes to ensure urban mobility under different operating temperature conditions confirmed the Gaussian distribution of data regarding the average energy consumption of urban households when switching to the use of electric bikes and electric scooters.

4 Discussion

From the data obtained (Figure 1, 2 and 3) it follows that the reduction in average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility under different operating temperature conditions is:

- electric bikes – 91%;
- electric scooters – 81%.

5 Conclusions

The results of this work provide evidence regarding the reduction in average energy consumption of urban households when switching to the use of electric bikes and electric scooters for urban mobility. An analysis was made of reducing the average energy consumption of urban households when using electric bikes and electric scooters to ensure urban mobility under three temperature use cases (0-10C^0, 11-20C^0, 21-30C^0). The data obtained reflects the degree to which average energy consumption of urban households

reduces when using electric bikes and electric scooters to provide urban mobility. These studies can be used in conducting research aimed at optimizing the energy costs of urban households while ensuring urban mobility based on the use of electric bikes and electric scooters.

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