PLANNING TRANSPORT INITIATIVES IN URBAN AREAS – ELECTROMOBILITY AS A CASE STUDY

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Abstract

In the field of transport, various types of initiatives are undertaken to improve the organization, operation and management of a given transport system. Initiatives aimed at improving the quality of urban transport through the purchase of low- and zero-emission rolling stock are important in this respect. An inherent element of such action is the planning process, which covers a wide range of issues, including technical and organizational solutions for the operation of means of transport, while taking into account environmental, economic and social factors. The article presents the planning process on the example of an electromobility initiative implemented in a selected urban area. The analysed process takes into account the description, feasibility, implementation, financing and evaluation of the project of purchasing electric means of transport for urban transport.

Keywords: planning transport, urban areas, electromobility

1. INTRODUCTION

Initiative is a commitment, intentional action, undertaking, project, plan, an idea focused in a strictly defined area of activity. In relation to urban areas, a transport initiative is important, which aims, among others:

- increasing the competitiveness of environmentally friendly types of transport,
- creation of integrated transport chains,
- reduction of communication congestion in the selected area,
- increase in the number of passengers in public transport,
- limiting the negative impact of transport on the urban environment.

Currently, one of the basic transport initiatives implemented in urban areas is the electromobility.

Electromobility - is an issue regarding the use of electric cars, also referring to technical and operational aspects of electrical means of transport as well as technology and infrastructure of their charging.

The development of electromobility reflects activities aimed at environmental protection, including: reducing air pollution. It is emphasized that electromobility is the future of motorization and many other forms of mobility implemented in urban areas. The advantage of electric forms of mobility is that they do not emit carbon dioxide and noise where given transport needs are met, which is important for urban areas. This has a positive impact on the condition and quality of air and the quality of life of city residents.

In the literature, the issue of electromobility refers to a number of important research topics analysed by the authors. **Table 1** presents selected thematic areas of research in the field of electromobility.

Analyzing the literature, there is no reference to transport initiatives undertaken in urban areas, the aim of which is to improve the organization, operation and management of a given transport system in the aspect of

implementing the electromobility initiative in urban areas with up to 40,000 inhabitants. An important element in these activities is the size of a given urban area. Because in urban areas with up to 40,000 inhabitants, undertaking transport initiatives is limited for financial reasons. Therefore, the electromobility initiative is very often not undertaken or implemented in these urban areas.

The aim of the article is to present the process of planning an electromobility initiative through the description, feasibility, implementation, financing and evaluation of the project of purchasing electric buses to meet the transport needs in a selected urban area of up to 40,000 inhabitants. For the purposes of carrying out the research, an electromobility planning model was defined, individual elements of the model were described and the planning results were presented on a practical example.

Table 1 Research areas in the field of electromobility

No.	Thematic scope of the publication	Publication
1.	The issue of using decision support tools at the stage of organizing the urban transport system in which electric vehicles have been implemented	[1]
2.	Research on the operation of electric bicycles, electric scooters and other two-wheeled electric vehicles in the aspect of transition to a sustainable transport system	[2], [12]
3.	Analysis of scenarios for reducing urban environmental pollution through the introduction of electric vehicles	[3]
4.	Urban transport based on electric vehicles, energy flow	[4], [5]
5.	Analysis of charging infrastructure for electric vehicles	[6]
6.	Regulations in the electromobility sector based on the example of the implementation of electric buses in Brazil	[7]
7.	Electric vehicles and sustainable energy technology in a given area	[8]
8.	A multi-criteria decision support model at the stage of charging electric vehicles by users	[9]
9.	The revolution in urban transport on the example of tenders for the purchase of electric buses	[10]
10.	Prospects for the implementation of electromobility in Greece by 2030 from a regional and strategic policy perspective	[11]
11.	Implementation of the planning process for the implementation of a fleet of electric buses in terms of travel time and energy consumption	[13]
12.	Electromobility as a space in the logistics and business ecosystem	[14]

2. ELECTROMOBILITY PLANNING MODEL

The process of planning electromobility in an urban area is a complex process in which a number of important elements must be taken into account. Taking into account the complexity of the planning process, an electromobility planning model was defined, which specified the implementation analysis area, implementation plan, financing and evaluation of the electromobility initiative in an urban area. In mathematical notation, the electromobility planning model is written in the form of an ordered four elements:

$$\boldsymbol{PE} = \langle \boldsymbol{AE}, \boldsymbol{PW}, \boldsymbol{FE}, \boldsymbol{OE} \rangle \quad (1)$$

where:

$\boldsymbol{PE}$ – electromobility planning model

$\boldsymbol{AE}$ – analysis of the implementation of electromobility in the urban area

$\boldsymbol{PW}$ – plan to implement electromobility in the urban area

$\boldsymbol{FE}$ – financing of electromobility in the urban area

$\boldsymbol{OE}$ – assessment of the implementation of electromobility in the urban area

For the purposes of the research, the analysis of the implementation of electromobility in the urban area was written in the form of four ordered elements:

$$\boldsymbol{AE} = \langle \boldsymbol{OT}, \boldsymbol{IE}, \boldsymbol{CV}, \boldsymbol{OS} \rangle \quad (2)$$

where:

$\boldsymbol{OT}$ – a set of rules for organizing public transport in a selected urban area

$\boldsymbol{IE}$ – a set of technical information in the field of electricity, i.e. connection agreements, characteristics of the power grid, possibilities of connecting chargers, specific energy consumption

$\boldsymbol{CV}$ – a set of characteristics in relation to the used vehicle fleet

$\boldsymbol{OS}$ – environmental data set

The plan to implement electromobility in the urban area was written in the form of four ordered elements:

$$\boldsymbol{PW} = \langle \boldsymbol{SC}, \boldsymbol{AP}, \boldsymbol{PI}, \boldsymbol{HI} \rangle \quad (3)$$

where:

$\boldsymbol{SC}$ – organizational structure of the enterprise

$\boldsymbol{AP}$ – administrative and institutional regulations

$\boldsymbol{PI}$ – investment preparation plan

$\boldsymbol{HI}$ – investment schedule

Financing of electromobility in the urban area is written in the form of four ordered elements:

$$\boldsymbol{FE} = \langle \boldsymbol{AF}, \boldsymbol{CI}, \boldsymbol{CF}, \boldsymbol{CC} \rangle \quad (4)$$

where:

$\boldsymbol{AF}$ – financial analysis of the project applicant

$\boldsymbol{CI}$ – investment costs

$\boldsymbol{CF}$ – sources of funding

$\boldsymbol{CC}$ – assumptions and methodology of financial analysis of electromobility in urban areas.

Assessment of the implementation of electromobility in the urban area is written in the form of an ordered three elements:

$$\boldsymbol{OF} = \langle \boldsymbol{OR}, \boldsymbol{OT}, \boldsymbol{OU} \rangle \quad (5)$$

where:

$\boldsymbol{OR}$ – risk assessment of the electromobility implementation project in an urban area

$\boldsymbol{OU}$ – assessment of the feasibility and financial sustainability of the electromobility implementation project in an urban area

$\boldsymbol{OW}$ – evaluation indicators of the electromobility implementation project in urban areas

3. ELECTROMOBILITY AS A CASE STUDY

There are 15 buses in operation in the adopted urban area, the parameters of which are presented in **Figure 1**. The set of characteristics in relation to the used fleet of vehicles (buses) takes into account important parameters for the planning process of the electromobility initiative:

$$\boldsymbol{CV} = \{\boldsymbol{SJP}, \boldsymbol{NES}, \boldsymbol{SZP}, \boldsymbol{DPA}, \boldsymbol{JPA}\} \quad (6)$$

where:

$\boldsymbol{SJP}$ – year of bus production

$\boldsymbol{NES}$ – EURO exhaust emission standard

$\boldsymbol{SZP}$ – average fuel consumption of a given bus

$\boldsymbol{DPA}$ – vehicle length

$\boldsymbol{JPA}$ – number of kilometres covered by a given bus in an annual cycle.

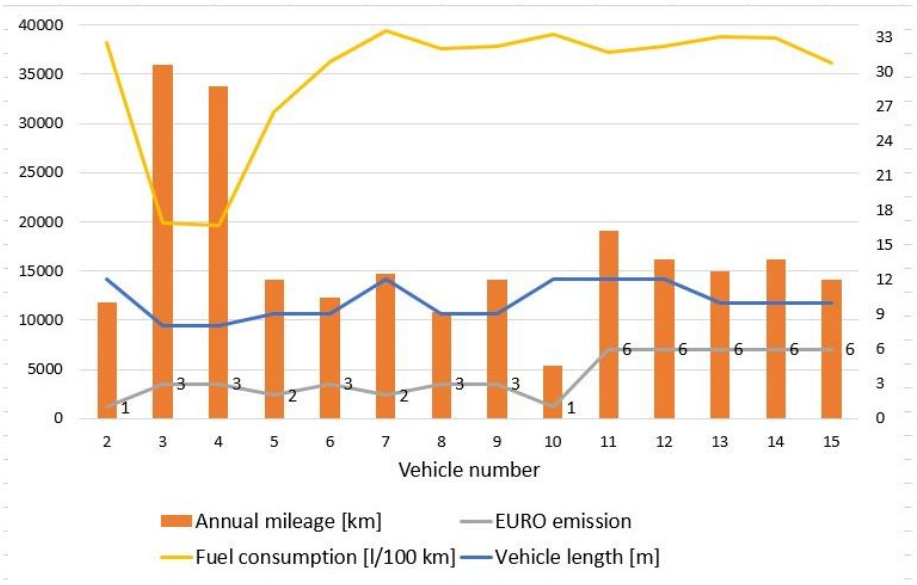

Figure 1 Operating parameters of buses used in a selected urban area

In the process of planning electromobility in a selected urban area, a decision was made to withdraw ten buses from service, the operational parameters of which are shown in **Figure 2**.

4. CONCLUSION

When analysing the electromobility planning process in a selected urban area presented in the article, the criteria for decommissioning buses are an important element. For planning purposes, the following bus decommissioning criteria were adopted:

- traveller safety,
- fuel consumption,
- emission standard (EURO),
- burden for the urban environment,
- vehicle age,
- technical condition and failure rate of the vehicle,
- operating costs.

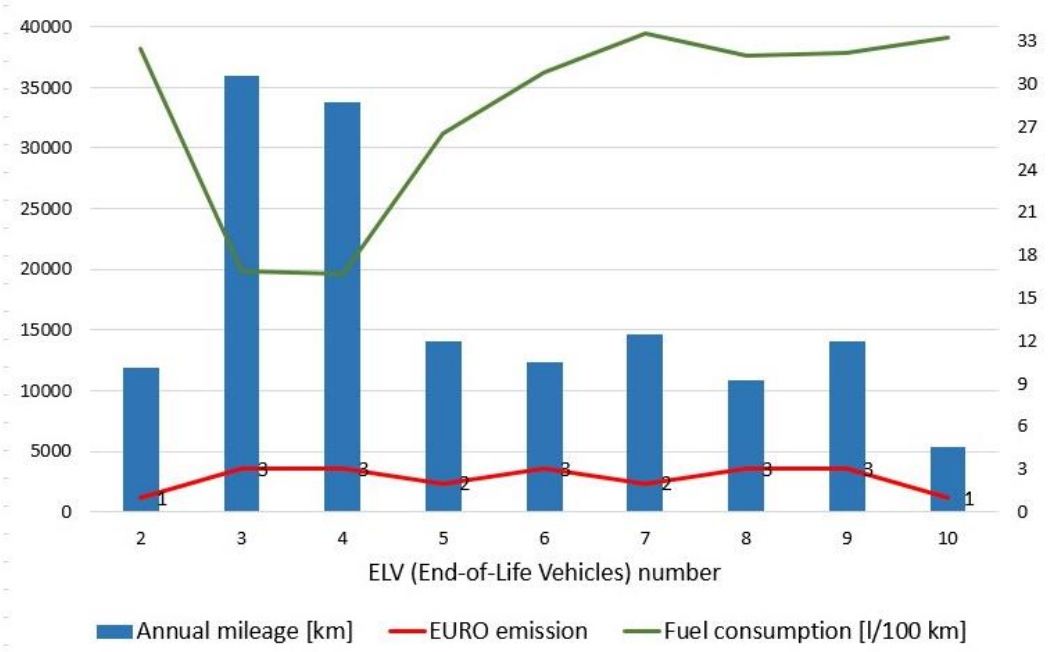

Figure 2 Operational parameters of decommissioned buses in a selected urban area

In the process of implementing the purchased electric buses, the following operational criteria were adopted:

- the bus must be equipped with a connection to connect a mobile charger,
- the bus must be equipped with an automatic locking system preventing the vehicle from starting during charging,
- the bus must be equipped with a charging process management system.

As part of the electromobility planning process in a selected urban area, it was recommended to purchase eight electric buses and four mobile fast charging stations. It was also assumed that each mobile fast charging station should enable simultaneous charging of two buses.

Taking into account the environmental effects, it should be noted that the withdrawal of ten buses from service will make it possible to reduce, among others, in a selected urban area: approx. 130 thousand kilograms of CO_2 on an annual basis (**Figure 3**).

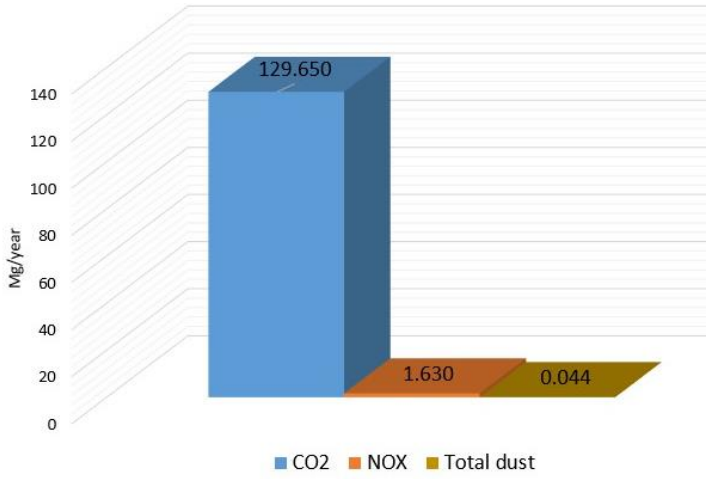

Figure 3 Environmental effects from decommissioning ten buses in a selected urban area

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