Acta Polytechnica CTU Proceedings **51**:22–28, 2024
https://doi.org/10.14311/APP.2024.51.0022

Published by the Czech Technical University in Prague

GREEN MOBILITY IN COURIER SERVICES – ASPECTS OF USING ELECTRIC VEHICLES

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Abstract. Countries in the EU, as part of the Paris Agreement, committed to achieving EU climate neutrality by 2050. To meet this goal, the EU aims to reduce its net greenhouse gas emissions across the entire economy by at least 55 % by 2030 compared to 1990 levels, continuing the reduction of emissions until 2050. The transport sector, responsible for a quarter of EU greenhouse gas emissions, must transform, requiring a 90 % reduction in greenhouse gas emissions by 2050. It is crucial to enhance the efficiency of both personal and freight transport in the EU and reduce dependence on fossil fuels. Our paper presents the cost calculation results of using electric vehicles with a total weight of up to 3.5 tons in the courier services sector, compared to conventional vehicles. Based on our analysis, electric vehicle usage is effective and environmentally beneficial. However, BEVs (battery electric vehicles) have higher acquisition costs than ICEVs (internal combustion engine vehicles). This paper analyses the vehicle fleet of a significant courier company. Thanks to their data, it was possible to provide a closer look at the economic efficiency of BEV in courier services.

Keywords: Electromobility, alternative drive, electric vehicle, environmental impacts, calculation.

1. Introduction

Transportation accounts for one-quarter of greenhouse gas emissions in the EU, and progress in decarbonizing the transport sector has been slower than in other economic industries. While emissions have significantly decreased in other sectors, emissions from transportation have risen in recent years. Enhancing the efficiency of both personal and freight transport in the EU and reducing its dependence on fossil fuels are essential.

In recent years, a growing demand for products purchased online from the comfort of one's home has led to direct delivery to the customer's doorstep. The outbreak of the COVID-19 pandemic has further deepened this trend, and at certain times, online shopping has become the only alternative to accessing specific products. Delivery through courier services is gaining momentum, resulting in increased air pollution as more vehicles from various courier companies travel the roads. Therefore, it is essential to address the possibility of alternative drives for these types of vehicles.

Some companies operating in courier services have already taken steps towards carbon neutrality. Worldwide, there are many examples of using electric vehicles for delivering packages to end consumers, which do not produce harmful air emissions and contribute to environmental protection. Typical examples include electric scooters or e-bicycles used for deliveries within the central areas of large cities, significantly speeding up the delivery process.

This topic has also been addressed by the EU, and as part of the Paris Agreement, member states committed to achieving the EU's climate neutrality by 2050. To meet this goal, the EU aims to reduce its net greenhouse gas emissions across the entire economy by at least 55 % by 2030 compared to 1990 levels, and it will continue gradually decreasing emissions until 2050.

In March 2023, the Council adopted new rules for further reducing CO_2 emissions from new passenger cars and vans, amending the EU regulation from 2019. These revised rules establish gradual emission reduction targets. From 2030 to 2034, emissions must be reduced by 55 % for new cars and 50 % for new vans compared to the 2021 targets. All new passenger cars and vans must have zero emissions from 2035.

The proposal aims to reduce CO2 emissions in the road transport sector in line with EU climate targets. It involves increasing emission reduction targets for 2030 and introducing new targets for 2035 and 2040. The proposed rules expand the scope of the regulation to cover almost all new heavy-duty vehicles with certified CO_2 emissions, including smaller freight vehicles, city buses, coaches, and trailers, subjecting them to emission reduction targets. According to the updated rules, all new city buses will have zero emissions from 2035. Long-distance buses and coaches would continue to be subject to overall targets [1].

In 2021, there was a significant increase in interest in electric vehicles (EVs) in the EU (Figure 1), both in the M1 (passenger cars) and N1 (light commercial vehicles) categories. The adoption rate rose from 10.7 % to 17.8 % within one year. Additionally, the use of electric vans experienced growth from 2.1 % to 3.1 % [3]. Globally, electric vehicles are gaining

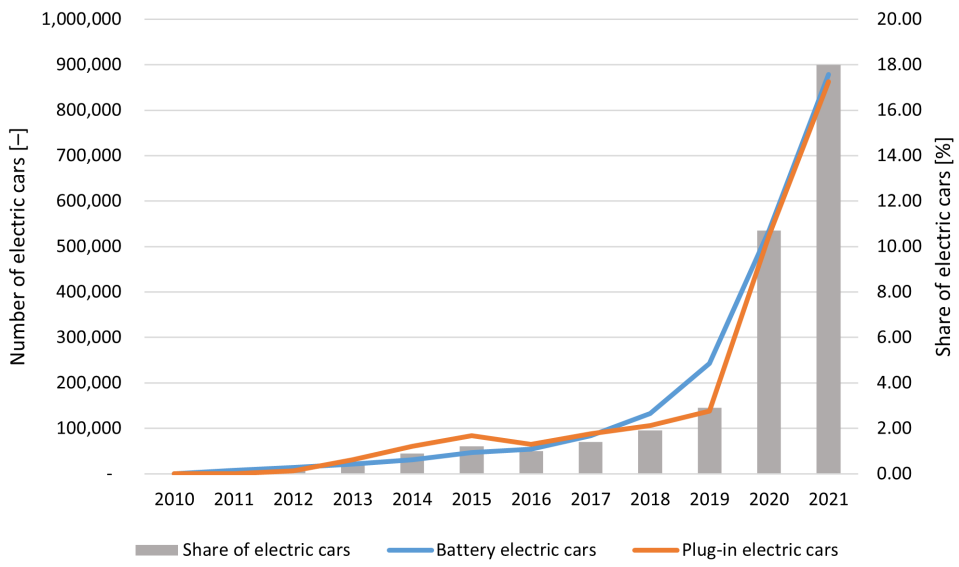

FIGURE 1. New registrations of electric cars, EU-27 [2].

popularity, with countries such as China and the USA witnessing a year-on-year increase in their numbers [4].

Thanks to the collaboration with the Department of Road and Urban Transport and a significant courier company which operates electric vehicles in Slovakia, it was possible to obtain the necessary dataset. This article describes an economic calculation based on these data, providing a closer insight into the economic efficiency of Battery Electric Vehicles (BEV) in courier services.

This article serves as a response to the following research questions:

(1.) Is the use of electric vehicles economically viable?

(2.) Do they represent a green future in delivery services?

(3.) Is the utilization of these vehicles profitable?

(4.) Do low operational costs outweigh the high acquisition price of the vehicle?

2. Materials and methods

2.1. Analysis of the current state in Slovakia

In Slovakia, the trend of electric vehicles has a slower pace (Figure 2); however, some companies operating in this sector are starting to adopt alternative propulsion systems for delivering parcels. Examples include DPD, SPS, and GLS Slovakia. Other companies are also making efforts with their pilot projects in electromobility.

When it comes to electric vehicles, several questions arise. BEVs have higher acquisition costs than ICEVs (internal combustion engine vehicles). An essential factor in decision-making are operational costs connected with a type of the vehicle drive. The electricity needed for charging is generally less expensive than the fluctuating fuel prices, which are currently higher than in previous years. However, indeed, electricity tariffs for businesses in Slovakia have also increased. Another crucial factor is the cost of service and maintenance for electric vehicles and insurance costs. The insurance prices are related to the vehicle's value, which tends to be higher for BEVs.

2.2. Characteristics of the selected company

The analysed company is among the leading providers of standard and express parcel services, serving thousands of customers daily across Slovakia [6].

In Slovakia, the analysed company became the first to utilize Voltia eNV200 electric vehicles with zero CO_2 emissions for parcel delivery, making it the pioneer in deploying these special vehicles for urban delivery. By 2025, the company aims to deploy 129 vehicles in Slovakia [7]. The Voltia vehicle, based on the Nissan eNV200, is from a Slovak manufacturer. Despite its compact size, it offers up to twice the cargo space compared to other electric vehicles in its category, with 8 m^3 of cargo volume, a payload capacity of 580 kg, and a range of up to 200 km on a single battery charge, producing no CO_2 emissions [8].

Table 1 shows an overview of the mileage of electric vehicles (BEV) from the analysed company and the number of parcels delivered by these vehicles.

Table 2 provides the number of vehicles that the company has in the capital city, Bratislava, and other locations across Slovakia.

2.3. Cost calculation

2.3.1. Fuels, energy

To perform the given calculation, the authors had access to the company's internal data, which they provided for our analysis. It was possible to compare the usage of three electric and diesel vehicles, specifically

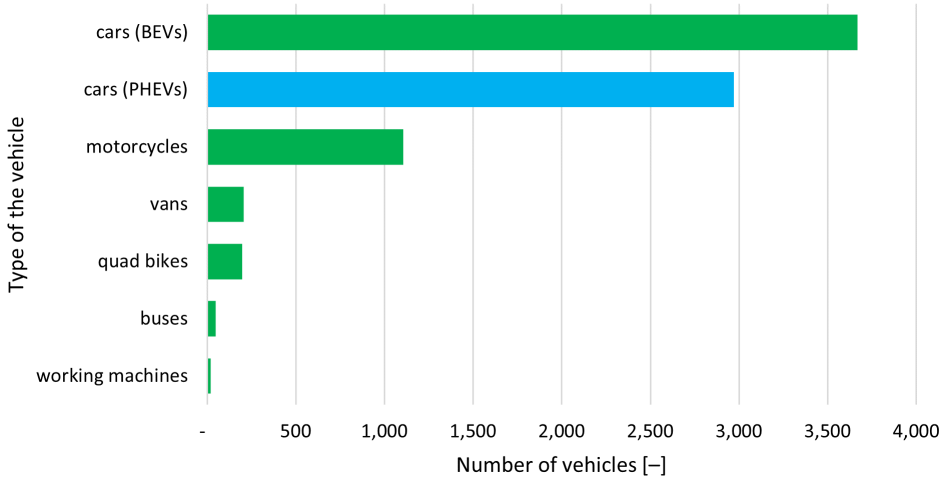

Figure 2. Number of registered BEVs and PHEVs in Slovakia in 2021 [5].

The number of kilometres travelled by electric vans in 2022	The number of parcels delivered by electric vehicles in 2022
929 623	1,5 million

Table 1. Basic data on analysed vehicles [9].

Type	Vehicle	in Bratislava	outside Bratislava
BEVs	STELLANTIS (Citroen, Peugeot, Opel)	24	18
	Mercedes-Benz E-sprinter	–	6
	Nissan e-NV2000	20	27
	$\sum$	**44**	**51**
	Total	**95**	
ICEVs (diesel)	Peugeot Boxer Citroen Jumper Fiat Ducato	570	

Table 2. Number of vehicles of analysed company [10].

Nissan eNV200 and Fiat Ducato, for parcel delivery in Bratislava, Nové Zámky, and Košice. The analysis involved analysing the kilometres driven for each month in 2022, used electricity in kW 100 km^{-1}, the number of delivered parcels, and the cost per kW. Based on the number of kilometres driven, we calculated these indicators for average daily, monthly, yearly, and kilometre-based costs. Refer to Figures 3, 4, and 5, and the summary Table 3.

For all analysed vehicles, we concluded that unit costs are lower for BEVs; however, this applies only to costs related to the most significant differentiating factor, namely the fuel or energy price.

2.3.2. Acquisition costs

The acquisition cost of an electric vehicle is more expensive than that of a combustion engine vehicle, primarily due to battery costs, which constitute the majority of the vehicle's total. See Table 4.

2.3.3. Repairs and maintenance

BEVs have less expensive repairs and maintenance compared to ICEVs. The main reason is that they have fewer moving parts. Electric motors are less prone to wear because they do not have components like pistons, clutch, or gearbox. There is no need for oil changes. In a vehicle with conventional fuel, there are many moving and functional parts that are susceptible to malfunctions and possible part replacements. Also, thanks to regenerative braking, the lifespan of the vehicle's brake pads and discs is extended. Research shows that the repairs and maintenance of a BEV are up to 30 % less expensive than a conventional vehicle [11]. Similar conclusions were reached by the authors in [12].

The authors established the average costs for repairs and maintenance for both BEVs and ICEVs through market research and price quotations. The findings are presented in Table 5.

FIGURE 3. Comparison of the vehicle costs – vehicles allocated in Bratislava [10].

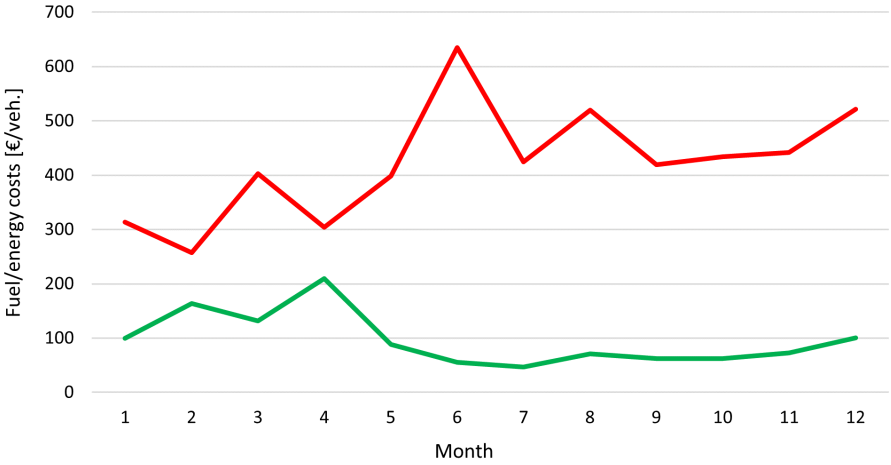

FIGURE 4. Comparison of the vehicle costs – vehicles allocated in Nové Zámky [10].

FIGURE 5. Comparison of the vehicle costs – vehicles allocated in Košice [10].

City/Vehicle	Nissan e-NV200 (BEV)	Fiat Ducato (ICEV)
Bratislava	0,1043 € km^{-1}	0,2031 € km^{-1}
Nové Zámky	0,0587 € km^{-1}	0,2047 € km^{-1}
Košice	0,1109 € km^{-1}	0,1984 € km^{-1}

TABLE 3. Comparison of unit fuel/energy costs [10].

Type	Vehicle	Price range
BEV	Nissan e-NV200	29 200–34 125 € without VAT
BEV	Citroen e-Jumpy 50 kWh	35 140–36 350 € without VAT
BEV	Citroen e-Jumpy 75 kWh	40 350–41 560 € without VAT
ICEV	Fiat Ducato	20 850–29 550 € without VAT

Table 4. Vehicle acquisition costs of BEVs and ICEVs in 2022.

Year/Distance	BEV	ICEV
2/40 000 km	178.00 EUR	234.42 EUR
4/80 000 km	514.36 EUR	359.52 EUR
6/120 000 km	397.69 EUR	822.31 EUR
8/160 000 km	692.36 EUR	422.58 EUR
Average price per year	**222.80 EUR**	**229.85 EUR**

Table 5. Service and maintenance costs for vehicles.

City	NISSAN eNV200 Total costs [€]	FIAT DUCATO Total costs [€]
Bratislava	1 724.91	3 509.48
Nové Zámky	1 605.02	5 873.37
Košice	955.47	1 940.41

Table 6. Total vehicle costs and conversion to unit costs.

2.3.4. Insurance costs

Based on market research, we analysed insurance providers and the prices for their services. Various insurance programs differ in the scope of services offered, including coverage for insurance events. Nevertheless, the average insurance price for electric vehicles is €217.62 per year, for diesel vehicle (ICEV) is €262.41 per year. Insurance costs were taken from source [13] for the vehicles included in this study.

2.3.5. Government subsidies

Currently, there is no government subsidy for the acquisition of electric vehicles in Slovakia; however, in the past, the state provided subsidies [14].

2.3.6. Vehicle tax

Vehicle taxes are subject to vehicles of categories: L1e to L7e, M1, M2 and M3, N1 to N3, O1 to O4. The subject of the tax is a vehicle used for business. Vehicles of categories L, M and N, whose only energy source is electricity, have a zero-tax rate in Slovakia [15].

2.3.7. Summary of costs

Based on the conducted calculations related to the vehicle propulsion costs, i.e., electricity or diesel, and defining expenses such as service and maintenance, insurance, and motor vehicle tax, it is possible to calculate total operating costs per vehicle and year. The summary and comparison are in Table 6.

3. Results

Several conclusions could be formulated from the analysis of the operating costs of an electric vehicle compared to a vehicle with a conventional engine. They are described in this chapter.

3.1. Advantages and disadvantages of BEV

The benefits of BEVs in our territory are as follows:

+ Fuel costs: Energy for charging is less expensive than fuel.

+ Repair and maintenance costs: Repairs and maintenance for a BEV is less expensive (compared to ICEV).

+ Insurance costs: Prices are comparable with minimal differences.

+ Vehicle tax: Exempt from (motor) vehicle tax (in Slovakia).

+ Government subsidy: A possibility to cover the difference between the price of BEV and ICEV. Currently, it is not available in Slovakia.

+ Environmental benefits: Contribution to environmental protection, zero emissions.

+ Convenience: Smooth, quiet operation, automatic transmission, and more.

The disadvantages of BEVs in our conditions are as follows:

- High acquisition costs: The value of BEV depends on innovative technologies and expensive batteries.

- Low operation range – However, it is adequate for urban delivery.

- Vehicle lifespan – 8 years (estimation), recommended battery replacement period.

Of course, for an economic comparison of BEVs and ICEVs, it is necessary to study all the related costs. Authors all over the world are trying to quantify TCO (Total Costs of Ownership). For example, the TCO assessment in [16] shows that BEVs are currently more expensive than ICEVs.

3.1.1. Costs

The main factor in the operation of electric vehicles is the lower cost of electricity compared to fuel (diesel). It is the primary motivation for businesses to acquire

City	BEV		ICEV	
	Total energy costs	Unit costs per km	Total fuel costs	Unit costs per km
Bratislava	1 284.49	0.104	2 706.22	0.203
Nové Zámky	1 164.60	0.059	5 070.11	0.205
Košice	515.05	0.112	1 137.15	0.198
Total	**2 964.14**		**8 913.48**	

TABLE 7. Comparison of total fuel and energy costs.

and operate such vehicles, regardless of the environmental impact and companies' efforts to become carbon neutral. Based on the obtained data and calculations, this article confirmed that operating an electric vehicle can save fuel costs. Charging an electric vehicle is less expensive than refuelling a diesel delivery vehicle. Table 7 summarizes the costs of analysed vehicles in three Slovak cities.

Even though, in all cases, the diesel vehicle covered more kilometres than the electric one, the operation of the electric vehicle is less expensive.

3.2. Benefits for company

The idea of expanding the fleet of vehicles with an alternative fuel vehicle has ecological and economic significance [17]. Based on our findings after calculating the ownership costs of an electric vehicle compared to a combustion engine vehicle, we can assert that electric vehicles represent the future in the courier services sector. An electric vehicle has its ecological justification but also ensures a certain comfort for the employee with its quiet and smooth ride or automatic transmission; these factors can influence the driver's performance, whose working environment will improve. Despite the high acquisition cost of the vehicle, low operating costs can ensure economic efficiency. Several companies should consider incorporating such vehicles into their fleets because they can save costs and contribute to environmental protection.

4. Conclusions

Based on the provided data, it is clear that electric vehicles are efficient primarily due to their low operating costs. The energy costs required for charging BEVs are significantly lower than the fuel costs for ICEVs. It is the most significant differentiating factor in the utilization of electric vehicles. Similarly, the cost of repairs and maintenance is lower, the EV is exempt from motor vehicle tax (in Slovakia), and the insurance cost is comparable to that of combustion engine vehicles. The drawback is that the acquisition cost of the vehicle is higher. However, in most cases, despite this, it can save companies a considerable financial resource, thanks to its low operating costs.

One form of support is state subsidies. Currently, there is no project in Slovakia supporting the development of electromobility. Based on past projects, however, we can consider subsidies as a successful tool for promoting and developing electromobility in Slovakia. A subsidy of several thousand euros can cover the price difference between an electric and a diesel vehicle. It serves as motivation for potential owners to purchase electric vehicles. The subsidy also applied to N1 category vehicles, which could be appealing to businesses and courier service companies. It is essential to consider the lifespan of the vehicle, approximately 8 years, during which the battery degrades, and its replacement is theoretically necessary with prices ranging from €10 000 upwards.

Nevertheless, this article proves that BEVs represent the future of urban delivery services.

It is also important to note that the significance of Battery Electric Vehicles (BEVs) in the courier service sector is substantial because courier vehicles cover only short distances daily, with a significant portion of stop time.

Battery electric vehicles (BEVs) currently face several drawbacks hindering their broader adoption. Their limited driving range poses a significant challenge, particularly in long-distance freight transport. Additionally, heavy batteries reduce the vehicle's effective weight, impacting its performance. Moreover, the weight of the cargo also affects the electric car's energy consumption.

Electric vehicles represent the green future in the courier service sector because online shopping is still more popular, leading to increased demand for courier companies. Some customers are also interested in a company's ecological practices, so they consider the company's behaviour toward the environment [18].

Acknowledgements

This paper has been developed under support of the project: MŠVVŠ SR VEGA No. 1/0178/22 KALAŠOVÁ, A.: Basic research of the sharing economy as a tool for reducing negative externalities.

References

[1] European Council. Clean and sustainable mobility. [2023-10-23]. https://www.consilium.europa.eu/sk/policies/clean-and-sustainable-mobility/#Road

[2] New registrations of electric cars, EU-27. [2023-10-23]. https://www.eea.europa.eu/data-and-maps/daviz/new-electric-vehicles-in-eu-3/#tab-chart_2

[3] New registrations of electric vehicles in Europe. [2023-10-23]. https://www.eea.europa.eu/ims/new-registrations-ofelectric-vehicles

[4] E. Macioszek. Electric vehicles – problems and issues. In G. Sierpiński (ed.), *Smart and Green Solutions for Transport Systems*, pp. 169–183. Springer International Publishing, Cham, 2020.

[5] Ministry of the Economy of the Slovak Republic: Electromobility in the Slovak Republic in Q4/2021 figures. [2023-10-23]. https://e-mobility.sk/wp-content/uploads/2022/01/Elektromobilita-v-%C4%8D%C3%ADslach-Q42021-2.pdf

[6] I. Kremeňová, D. Koncová. Green delivery v oblasti poslednej míle v poštových podnikoch na Slovensku [In Slovak; Green delivery in the last-mile sector of postal enterprises in Slovakia]. *Pošta, telekomunikácie a elektronický obchod* **16**(2):37–41, 2021. https://doi.org/10.26552/pte.C.2021.2.6

[7] DPD: DPD is expanding its fleet of electric vans. [2023-10-23]. https://www.dpd.com/sk/sk/news/dpd-roz-iruje-flotilu-elektrick-ch-dod-vok-naslovensku-ich-m-u-sto/

[8] DPD: Voltia electric vans have proven themselves in Slovak cities. [2023-10-23]. https://www.dpd.com/sk/sk/news/elektricke-dodavky-voltia-sa-vslovenskych-mestach-osvedcili-spolocnost-dpd-ich-pocet-navysi-trojnasobne/

[9] DPD: Green delivery. [2023-10-23]. https://www.dpd.com/sk/sk/zodpovednost/zelene-dorucovanie/

[10] Internal materials of a logistics company DPD concerning the utilization of its vehicle fleet, 2023.

[11] Electric van running & service costs. [2023-10-23]. https://www.vansalesuk.co.uk/electric-buyers-guides/runningservice-costs/

[12] M. A. Delucchi, T. E. Lipman. An analysis of the retail and lifecycle cost of battery-powered electric vehicles. *Transportation Research Part D: Transport and Environment* **6**(6):371–404, 2001. https://doi.org/10.1016/S1361-9209(00)00031-6

[13] Netfinancie.sk: Vehicle insurance. [2023-10-23]. https://www.netfinancie.sk/pzp/

[14] Ministry of the Economy of the Slovak Republic: Final evaluation report of the project. [2023-10-23]. https://e-mobility.sk/wpcontent/uploads/2019/05/zaverecna-hodnotiaca-sprava-projektu-celostatnapodpora-MH-SR-a-ZAP-SR.pdf

[15] Financial Administration of the Slovak Republic: Information on motor vehicle tax. [2023-10-23]. https://www.financnasprava.sk/sk/podnikatelia/dane/dan-zmotorovych-vozidiel/info-dzmv

[16] A. König, L. Nicoletti, D. Schröder, et al. An overview of parameter and cost for battery electric vehicles. *World Electric Vehicle Journal* **12**(1):21, 2021. https://doi.org/10.3390/wevj12010021

[17] J. Ondruš, J. Dicová. Potential of prediction quantification and trends in transport requirements as tool of transport management and development. *Transport and Telecommunication Journal* **14**(4):316–324, 2013. https://doi.org/10.2478/ttj-2013-0027

[18] P. Cubon, K. Hrudkay. Energy optimisation of small electric urban vehicle through modification of driving cycle with implementation of the extended data. In *Proceedings of 21st International Scientific Conference. Transport Means 2017*, pp. 806–813. 201.