DOI: 10.7251/JTTTP2302023M
UDC: 656.1.08:005.51

PROFESSIONAL PAPER

The economic, ecological and safety impact of electric vehicles on traffic in the local community

Željko Marušić
B.Sc. Traffic Eng., professor, Faculty of Transport and Traffic Sciences, Zagreb, Croatia, zmarusic@fpz.unizg.hr

Received: September 29, 2023
Accepted: October 13, 2023

Abstract: The introduction of electric vehicles into city traffic enables a better use of economic resources, significantly reduces environmental pollution and increases traffic safety, because such vehicles encourage safer driving. In order to achieve the best results, it is necessary to ensure adequate infrastructure and all conditions that enable the greatest efficiency of individual influences and their complete synergy. The systematic and encouraged introduction of electric vehicles is the most important measure for improving city traffic.

Keywords: electric vehicles, pollution, traffic safety, urban traffic, resources.

INTRODUCTION

Electric vehicles are becoming an increasingly important segment of motorized traffic in urban areas, because they solve traffic, environmental and functional problems. Electric transport in urban areas refers to public transport, commercial transport, personal transport and micromobility of citizens. Each of the segments affects all essential features of urban traffic, and the most favorable effects are achieved through the synergy of all types of traffic. In the Western Balkans region, public transport in urban areas is not solved according to the standards of larger urban areas of the European Union with an electrified underground railway as the basis of urban transport. It places special emphasis on all other types of electrified traffic in order to improve the functionality, ecology and safety of city traffic. In this paper, the impacts of electric buses, electric delivery vehicles, electric personal vehicles and electrified micromobility of citizens are analysed in particular.

ELECTRIC VEHICLES IN URBAN TRAFFIC

The development of electric vehicles began at the end of the 19th century, and in the first decade of the 20th century, especially in urban areas, they were more promising than conventional ones. However, the accelerated development of internal combustion engines and the increasing production and availability of oil and oil derivatives pushed electric vehicles into the background. The problem was in the energy density of the fuel. Namely, 30 to 40 Wh of energy could be stored in a kilogram of lead batteries, while a kilogram of gasoline stored 300 times more energy. This limited the range and functionality of such vehicles, because the real range of 10 to 50 kilometers, depending on the type of vehicle and driving conditions, was inadequate for mass use.

Further development followed in the 1970s, when nickel-cadmium (NiCd) with a capacity of 40 to 60 Wh/kg and nickel-metal hydride (NiMH) - 75 to 100 Wh/kg began to be used, but this was still not enough for the development usable electric vehicles.

Further development followed in the 1970s, when nickel-cadmium (NiCd) with a capacity of 40 to 60 Wh/kg and nickel-metal hydride (NiMH) - 75 to 100 Wh/kg began to be used, but this was still not enough for the development usable electric vehicles. More intensive development began in the 2000s, when lithium-ion batteries with a capacity of 100 to 265 Wh/kg began to be introduced.

Electric vehicles in urban traffic were used with external power supply from the electrical network, rail (underground and overhead railways and trams) and road (trolleybuses), but in most urban areas in countries with less developed traffic, this type of traffic was neglected. For this reason, in this paper we analyse the impact of road electric vehicles with battery power on efficiency, ecology and safety in urban traffic, whose impact on urban traffic began to be felt in 2010, and more intensively since 2020, and their impact will grow in the coming years, especially when In 2035, the European Union bans the production and sale of passenger vehicles powered by internal combustion engines and restricts them to commercial vehicles.

Electrification of traffic refers to: personal electric vehicles, commercial electric vehicles, micromobility.

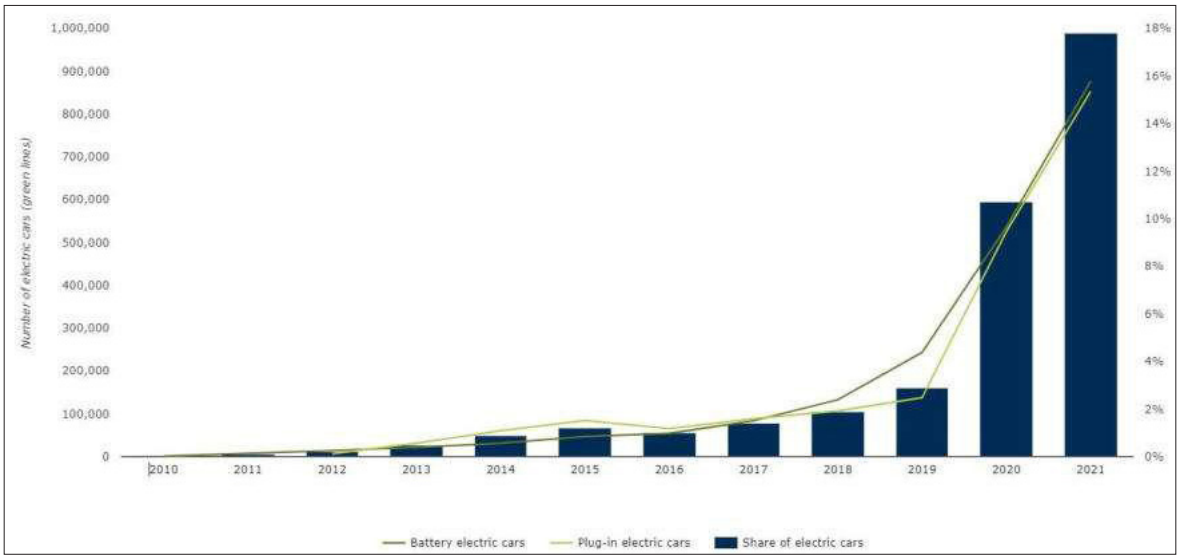

Figure 1. New registration of electric vehicles in Europe (https://www.eea.europa.eu/ims/new-registrations-of-electric-vehicles)

The winner of the 2011 European Car competition was the Nissan Leaf, which with a synchronous AC electric motor with a power of 80 kW and a lithium-ion battery with a capacity of 24 kWh had a range of 117 km, according to the American EPA (Environment Protection Agency) standard, or 175 km according to to the European standard NEDC (New European Driving Cycle). The first global success of a car with an electric drive was achieved by the Tesla Model S, which with two electric motors with a total system power of 340 kW and a torque of 967 Nm and a lithium-ion battery of 85 kWh achieved excellent performance, with a range according to the NEDC standard of 480 km. After that, with the introduction of smaller electric cars, Renault Zoe, Fiat 500e, Opel Corsa-e, Peugeot e-208, the introduction of electric vehicles to the European market began.

The share of electric vehicles on the European market reached 1% in 2014, 2.4% in 2019, and then the rapid growth began. During 2020, 1,061,000 electric vehicles were sold on the EU market with a market share of 10.7%, and in 2021, 1,729,000 electric vehicles were sold, with a market share of 17.8%, and in 2022, around 2 million electric vehicles are expected to be sold., with a market share of 20 percent.

"In 2021, the share of electric vehicles (BEVs and PHEVs) in national new car registrations increased in all countries (EU-27, Iceland, Norway) compared with 2020. The highest shares were found in Norway (86%), Iceland (64%), Sweden (46%) and Denmark (35%).

Germany, France and Norway accounted for about 63% of BEV registrations (in the EU-27 and non-EU EEA countries). In Norway, the country where the highest number of electric cars was registered in 2021, BEVs accounted for 65% of new car sales that year. In some other European countries, however, the percentage of BEV registrations remained around 1% of the total fleet (Cyprus, Poland, Czechia and Slovakia). PHEV percentage sales were highest in Iceland (36%), Sweden (25%) and Norway (22%).

The leading countries in electric mobility offered, over the years, financial incentives such as tax reductions

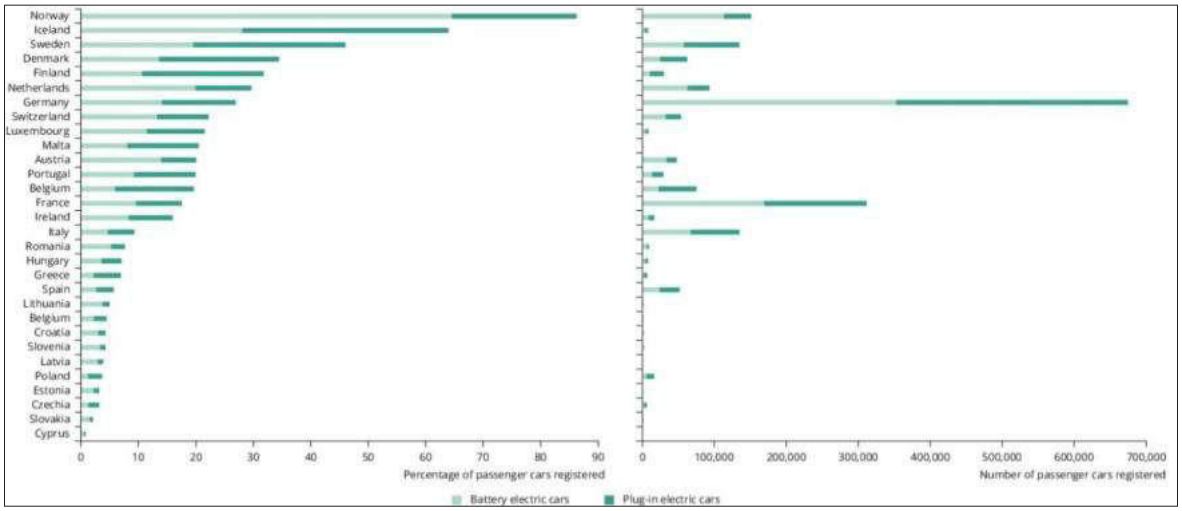

Figure 2. Electric vehicles EU 2020 (https://www.eea.europa.eu/ims/new-registrations-of-electric-vehicles)

and exemptions for electric vehicles, designed to stimulate an increased uptake of these vehicles. More countries are increasing the number of incentives for electric mobility" (https://www.eea.europa.eu/ims/new-registrations-of-electric-vehicles).

INFLUENCE OF ELECTRIC CARS ON URBAN TRAFFIC

Electric vehicles affect urban traffic according to three criteria: ecological, safety and functional, and significantly change the structure and characteristics of personal and business mobility in cities. Therefore, it is necessary to analyse each of the mentioned influences separately.

Environmental impact of electric cars on urban traffic

Replacing an internal combustion engine with an electric motor directly affects the ecology in urban areas, as the following harmful and toxic gaseous compounds are produced:

- Carbon monoxide (CO), Hydrocarbons (HC),
- Volatile organic compounds (VOC), Nitrogen oxides (NOx),
- Particulates (P).

Electric vehicles almost completely remove harmful gaseous emissions and thereby significantly contribute to the ecological characteristics of urban areas, which affect the health of citizens, visitors and tourists, and thus positively affect the economic and tourist characteristics of urban areas. Regardless of the fact that electric mobility, in the production of vehicles and in the production of electrical emissions, create indirect and global pollution, which is still less than the pollution created by fossil fuels, their ecological contribution to urban environments is direct and decisive, which, in addition to the reduction of harmful gaseous emissions also applies to noise reduction.

Safety impact of electric cars on urban traffic

Electric vehicles affect the safety of urban traffic in a number of ways, both negative and positive, which need to be considered and properly treated, so that their overall impact on the safety of urban traffic is synergistic and positive.

Negative impacts of electric cars on urban traffic safety

Electric vehicles have two negative impacts on safety in urban traffic:

- they do not create noise, which, in addition to the negative ones, has significant positive effects, primarily on the safety of pedestrians, cyclists and moped riders in urban traffic,
- significantly better accelerations of electric vehicles encourage drivers to violate regulations and occasional fast driving, which reduces traffic safety in urban areas, in the event of a collision or technical failure, there is a risk of the

Tier	Date (type approval)	Date (first registration)	CO	THC	VOC	NO_x	$HC+NO_x$	P	PN [#/km]
Diesel									
Euro 1[b]	July 1992	January 1993	2.72 (3.16)	–	–	–	0.97 (1.13)	0.14 (0.18)	–
Euro 2	January 1996	January 1997	1.0	–	–	–	0.7	0.08	–
Euro 3	January 2000	January 2001	0.66	–	–	0.50	0.56	0.05	–
Euro 4	January 2005	January 2006	0.50	–	–	0.25	0.30	0.025	–
Euro 5a	September 2009	January 2011	0.50	–	–	0.180	0.230	0.005	–
Euro 5b	September 2011	January 2013	0.50	–	–	0.180	0.230	0.0045	6×10^{11}
Euro 6b	September 2014	September 2015	0.50	–	–	0.080	0.170	0.0045	6×10^{11}
Euro 6c	–	September 2018	0.50	–	–	0.080	0.170	0.0045	6×10^{11}
Euro 6d-Temp	September 2017	September 2019	0.50	–	–	0.080	0.170	0.0045	6×10^{11}
Euro 6d	January 2020	January 2021	0.50	–	–	0.080	0.170	0.0045	6×10^{11}
Petrol									
Euro 1[b]	July 1992	January 1993	2.72 (3.16)	–	–	–	0.97 (1.13)	–	–
Euro 2	January 1996	January 1997	2.2	–	–	–	0.5	–	–
Euro 3	January 2000	January 2001	2.3	0.20	–	0.15	–	–	–
Euro 4	January 2005	January 2006	1.0	0.10	–	0.08	–	–	–
Euro 5a	September 2009	January 2011	1.0	0.10	0.068	0.060	–	0.005[c]	–
Euro 5b	September 2011	January 2013	1.0	0.10	0.068	0.060	–	0.0045[c]	–
Euro 6b	September 2014	September 2015	1.0	0.10	0.068	0.060	–	0.0045[c]	6×10^{11}[d]
Euro 6c	–	September 2018	1.0	0.10	0.068	0.060	–	0.0045[c]	6×10^{11}
Euro 6d-Temp	September 2017	September 2019	1.0	0.10	0.068	0.060	–	0.0045[c]	6×10^{11}
Euro 6d	January 2020	January 2021	1.0	0.10	0.068	0.060	–	0.0045[c]	6×10^{11}
Petrol and diesel									
Euro 7[21] (proposed)	2025[22]	2025[22]	0.1 to 0.3[23]			0.030[23]			

Figure 3. EU emission standards for passenger cars (https://www.eea.europa.eu/ims/new-registrations-of-electric-vehicles)

vehicle catching fire, which is more intense and difficult to control than fires in vehicles powered by internal combustion engines.

Positive impacts of electric cars on urban traffic safety

Positive impacts are:

- encourage calmer driving (the profile of people who buy them and the knowledge that any sudden acceleration shortens the range), they have a larger mass, which reduces inertial forces in the event of a collision, greater mass improves the grip of the tires on the asphalt,
- lower centre of gravity that increases static and dynamic stability,
- more intense engine braking significantly contributes to safety, because every reduction in pressure on the power pedal activates regenerative braking and reduces the car's speed, the combination of intensive electric braking and the working brake system ensures better overall braking capabilities of the car.

With the introduction of the artificial sound effect of electric vehicles, sufficient to achieve driving safety and the recommended limit of vehicle engine power for young drivers, the negative effects are minimized, and the large positive effects make a great contribution to the safety of urban traffic. The positive effects on safety in urban traffic are increased by electric micromobility, i.e. by increasing the share of electric two-wheelers in urban traffic.

Functional impacts of electric cars on urban traffic

The electric motor concept facilitates the production of smaller, nimble vehicles, which are ideal for urban vehicle conditions. It also facilitates the construction and performance of smaller delivery vehicles for urban environments, which contributes to functionality and environmental friendliness in urban traffic. The role of electric micromobility is particularly important, because it reduces the number of cars and delivery vehicles in urban areas and thus achieves a large, indirect positive effect on ecology and functionality in urban traffic.

In order to achieve all this, it is necessary to provide the appropriate infrastructure. Primarily, ensure the conditions so that citizens can charge these vehicles at their place of residence and build a network of standard and fast charging stations at the necessary locations in the centre and outskirts of urban areas.

CONCLUSION

The introduction of electric vehicles into city traffic enables a better use of economic resources, significantly reduces environmental pollution and increases traffic safety because such vehicles encourage safer driving. For this reason, it is important to ensure a gradual increase in the share of electric vehicles in urban transport through a systematic approach, improvement of infrastructure and incentive measures for the purchase of electric vehicles. The systematic and encouraged introduction of electric vehicles is the most important measure for improving city traffic, in terms of ecology, economy and safety. This will ensure better living and working conditions for citizens in urban areas and improve the conditions for the growth of the economy and tourism. This is why the promotion of electric mobility is the most important measure in urban areas with multiple and synergistic effects on all sectors of the economy.

LITERATURE

New registration of electric vehicles in Europe, European Environment Agency, https://www.eea.europa.eu/ims/new-registrations-of-electric-vehicles

European emission standards (Wikipedia).