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The Implementation of Electricity as Road Transportation Fuel

Abstract

Road-based electricity increasingly is being considered as an alternative fuel of the future that would replace or reduce dependence on oil and its derivatives, resulting in a reduction at the negative impact on the environment. More and more countries are introducing stricter measures on greenhouse gas emissions, while increasing incentives to buy EVs. This paper looks at the environmental impact of electricity in road transport in ecological, economic, and social terms, highlighting the greater need for more energy efficient EVs than conventional vehicles. The aim of this paper is to emphasize the importance of the application of electricity concerning fossil fuel in road transport, i.e., to describe the impact of EVs on the environment regarding conventional vehicles.
Analysis of the use of the EV or the development of electrical infrastructure that is improving and introduced at high speed has shown that only countries with a high standard can monitor trends of EV. Therefore, despite all the advantages of EVs, the strategies and measures adopted by the EU, the implementation of electricity as road transportation fuel does not have a significant echo in countries with a lower standard, at least until the reach and prices of EVs are closer to conventional ones.

Key words: road transport, transportation fuel, electric vehicles, electricity.

1. Introduction

Over the past few decades, greenhouse gas emissions have been steadily increasing given the modern way of life, i.e., the increasing need for faster transport of people and goods. The European Commission also seeks to maintain as much environmental awareness as it can through set objectives. One way to reduce greenhouse gas emissions is to introduce EVs into road transport for high energy efficiency and not to release harmful gases into the atmosphere when used. Although EVs do not directly generate greenhouse gas emissions, while depending on the energy source occurs when generating electricity.

In a scientific paper “The effect of fiscal incentives on market penetration of electric vehicles: A pairwise comparison of total cost of ownership” [1], the roles of economic incentives in reducing total costs of ownership and increasing sales of EVs are examined. It is also stated that the biggest problem in EVs sales is the price which greatly exceeds the sales price of conventional vehicles.

According to “Electrification of road transportation with utility controlled charging: A case study for British Columbia with a 93% renewable electricity target,”[2] the result of research show that electrifying the whole road vehicle fleet will require generating electric energy to increase by up to 60%, however in case without electrification levelized cost of electricity only increases by 9%. In order to reduce emissions from the electricity and transport sectors, the policy influence seeks to increase the use of renewable energy sources.

Several studies, such as “On the electrification of road transportation – A review of the environmental, economic, and social performance of electric two-wheelers”[3], and “How do cities support electric vehicles and what difference does it make?, [4] explain how climate strategies in UK cities encourage the use and development of EVs. Further explained, electric two-wheelers are more efficient and environmentally friendly than standard vehicles.

The condition for the use of electricity as an alternative fuel in road transport is to overcome the costs of development, production, and application between conventional and EVs. The biggest problem for EVs is a small range with a long charging time and high prices. However, increasing production and development is expected to drive down costs and better performance of EVs, which results in better approaching customers. A major task that most countries are facing is implementing electrical energy in transport through various economic instruments and measures such as incentives for the public to choose electric or hybrid vehicles and seek ways to reduce the cost difference between hybrid and conventional vehicles.

Vehicle manufacturers are increasingly investing in the development of transport electrification considering the direction of environmental policy and the acceleration of EVs which requires increasing demand for raw materials.

According to the set goal, the paper will determine how electricity as road transportation fuel affects the environment and will seek to explain the importance of the application of electricity in road traffic.

2. Introduction of electricity as an alternative fuel in road transport

Electricity in road transport, and particularly in urban traffic, has significant advantages with the emphasis that EVs are much less polluting the environment. Also, noise pollution, which is a problem in urban environments, is significantly reduced, especially as cars move at low speed. Energy efficiency is another advantage that stands out given the possibility of returning unused energy into the energy system. Therefore, the need to introduce electricity into the transport sector would be promoted by environmental awareness and energy efficiency through the high development of technology. The potential of electric power arises not only through the possibility of production from various primary forms of energy, but through the production capacity or infrastructure for electricity distribution. The annual electricity consumption for a medium-sized EV is 3 MWh (assuming 15,000 km/yr with energy consumption of 20 kWh/100 km). Energy usage of one million cars is then approximately 3 TW/y, which is about 0.09% of total annual electricity generation in the EU 28 [5] (3070 TWh in 2018) [6].

The criteria for the introduction of electricity into road transport are [7]:

- Price lower than conventional vehicles or at least approximate
- Range, reliability, durability, and ability to sell EVs as well as conventional
- Range tailored for particular use cases
- Comfort in use (availability, refueling time and possibilities, passenger comfort, quantity of transport)
- Safe parking and infrastructure for two-wheeled direct connection to charging plants.

The use of electricity compared to other alternative fuels is evident in the already built infrastructure of electricity grid. Further expansion into the market will depend largely on battery development, increased vehicle energy efficiency, infrastructure availability, incentive measures and general acceptance by customers [5]. Reducing the use of fossil fuels in road transport using electricity would increase demand for certain raw materials, such as lithium, which is currently the primary raw material for battery production.

The European electricity industry has firmly committed to achieving coal-free electricity generation by 2050, while in 2013, more than half of the total electricity produced in Europe has been generated from low-carbon plants [8]. According to [9] by 2030, electricity will be generated from fossil fuels with a share of only 25% (Figure 1).

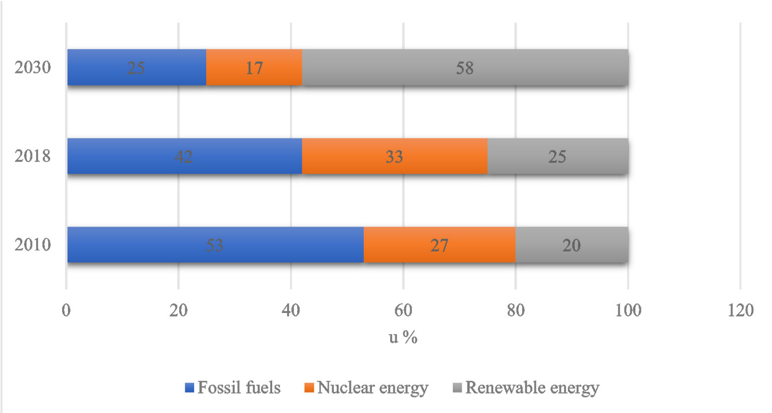

Figure 1: Part of the power generation source
Source: Created by authors from source [9]

Over the past ten years (Figure 1), it is evident a decreasing focus on fossil sources in electricity production, while trends in the use of renewable energy sources in the future are significantly growing.

Approximately 21% of the total CO_2 emissions in the EU came from road transport in 2016., while the share of light goods vehicles was 15% (cars and vans). EU legislation requires Member States to provide consumers with easy access to relevant vehicle information, such as a sticker showing the fuel efficiency in the vehicle or CO_2 emissions [10]. On 17 April 2019, the European Parliament and the European Council adopted Regulation (EU) 2019/631, setting new CO_2 emission standards for new passenger cars and new light commercial vehicles, which entered into force on 1 January 2020 [11].

Trucks and buses are considered heavy vehicles and produce about a quarter of road CO_2 emissions within the EU, representing 5% of all EU emissions. The first CO_2 emission standards for heavy-duty vehicles in the EU were set out in the proposal for the Regulation of the European Parliament and of the Council laying down COFMT emission standards in May 2018 [10].

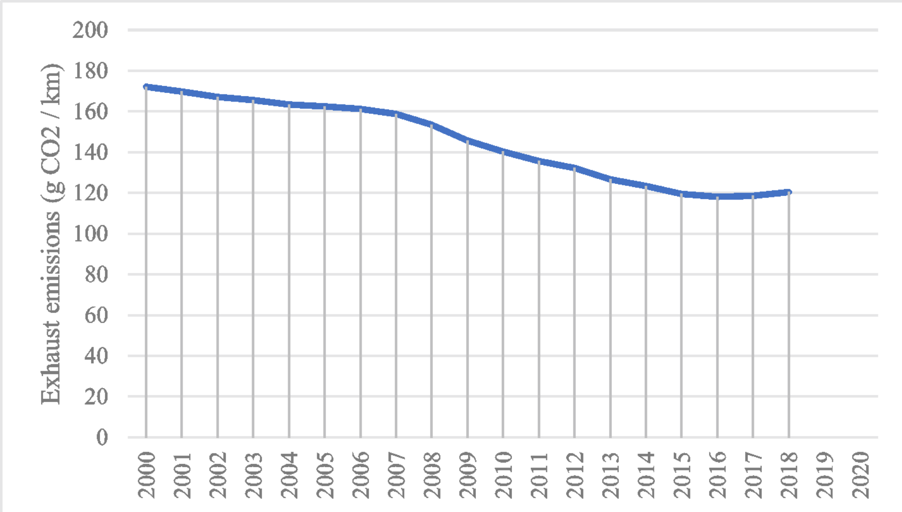

Figure 2: Average new car CO_2 emissions
Source: Created by authors from source [15]

Car manufacturers are required to limit CO_2 emissions from vehicles to 95 g CO_2/km by 2021. Figure 2 shows the average CO_2 emissions of new cars. In 2007, the average CO_2 emission per car was approximately 160 g CO_2/km, while in 2012 emissions were reduced to 132.2 g CO_2/km. In order to reduce emissions caused by heavy vehicles, the European Commission has adopted a strategy for heavy vehicles in May 2014 [12].

Replacing conventional vehicles with EV would reduce CO_2 emissions by approximately 30%, for example, replacing one million conventional vehicles with EV will reduce emissions of 1 Mt CO_2 per year [5]. The current number of EVs in the world is more than 5 million [13] so that the reduction in CO_2 emissions is approximately 5 Mt CO_2 on an annual basis, while all road transport in 2018 in the EU was responsible for emitting 920 Mt CO_2 into the atmosphere. Electricity generation capacity within the EU is currently more than satisfactory for EV energy requirements, so it is not necessary to build new electricity generation capacity recently.

The Transport White Paper sets targets for reducing greenhouse gas emissions by 60% by 2050 in comparison to 1990 [14]. Also, the aim is to reduce greenhouse gas emissions by approximately 20% by 2030 compared to 2008 [15]. While various legislative and economic mechanisms affect the reduction of pollutant emissions, road transport remains one of the major air pollutants. In 2017, restrictions on solid particles were exceeded by approximately a third of the permitted in the EU. As a result, the Clean Air Directive was established. The objectives are focused on zero greenhouse gas emissions from exhaust pipes and vehicle electrification. Electricity generation utilizing thermal power plants generates low NOx emissions but produces higher emissions of SOx. However, power plants are located outside cities and thus have less impact on human health than emissions caused by road traffic [12].

Road transport is most intense in urban environments that suffer a large amount of noise. According to the WHO[1], traffic noise has been found to affect the health of almost every third person in the European region. Therefore, the first report on the implementation of the Environmental Noise Directive published in June 2011 set the requirements for the application of the Directive. Noise in urban areas of the EU caused by road traffic at night is more than 50 dB, which affects more than 40 million inhabitants. As a result, regulation on the sound level of motor vehicles and replacement dampening systems and the setting of a maximum dB level for all types of road vehicles from 2016 has been adopted [12]. Although EV contributes to reducing noise in cities, because of the higher safety of pedestrians and other road users, the European Parliament adopted annexe 2007/46 EC Directive on the minimum noise level for electric and hybrid vehicles in April 2014.

Electric two-wheelers such as e-bikes, e-mopeds, and e-motorcycles are becoming more common in more populous areas for their simplicity and convenience. The advantage of these aspects of traffic is that additional infrastructure is not required because the vehicles can be charged through ordinary wall sockets. Due to the low mass of e-bikes, a small battery capacity of 0.4 kW/h is required, and for larger e-motorcycles battery capacity is up to 10 kW/h. Because their features they are the ideal solution for overcoming distances up to 10 km [3].

The development of a battery (approximately 110 Wh/kg) enables the reach of the electric bus for more than 100 km without reducing passenger capacity [12]. Further battery technology development, electric buses have the potential to replace conventional buses, while hybrid buses can also be used as a viable option mainly for fuel-charging flexibility.

3. Analysis of the application of EVs worldwide and in Europe

Today's trends strongly support implementing electricity into road transport, as shown in Figure 3. The number of EVs in 2017 was more than 3 million globally, while the most EV was positioned in the Republic of China [16]. Sales of electric cars have been growing significantly over the last ten years, with more than 5 million EVs worldwide recorded in 2018, which is an increase of 63% compared to the previous year [13]. In addition to the Republic of China, the importance of investing in electric mobility has been recognized by the EU and the US, which also plays an important role globally.

1 World Health Organization

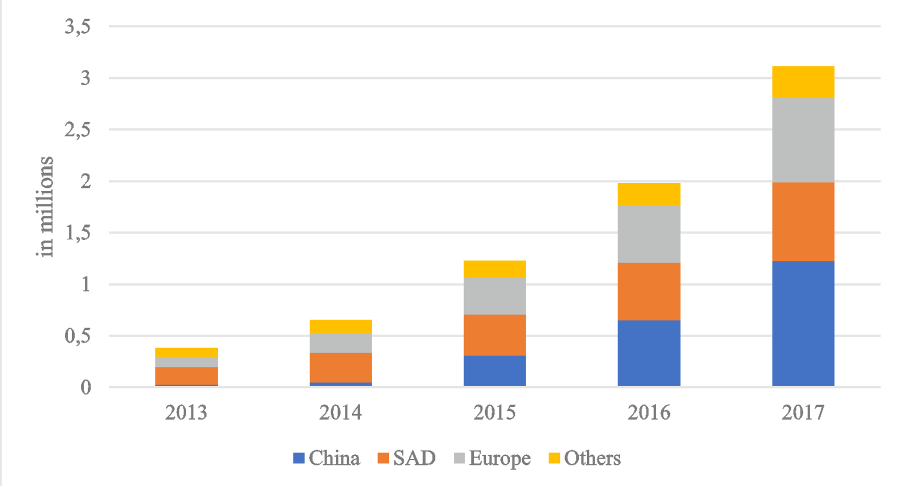

Figure 3: The number of electric cars in turnover in selected countries in 2013.–2017. Source: Created by authors from source [16]

EVs are not yet economically acceptable as conventional vehicles, so states seek to address the main obstacle to the introduction of EVs into road transport through fiscal incentives and subsidies. Tax relief and co-financing of the procurement of EV seek to overcome non-competitiveness.

Enhancing of environmental standards, such as average CO_2 emissions from new cars in 2021, will be 95 g CO_2/km (equivalent to a fuel consumption of about 4.1 l of petrol or 3.6 l of diesel) [17], puts an increasingly tricky task on vehicle manufacturers. Hybrid vehicles are one of the options with which the driving comfort would be inherent assuring the environmental standards.

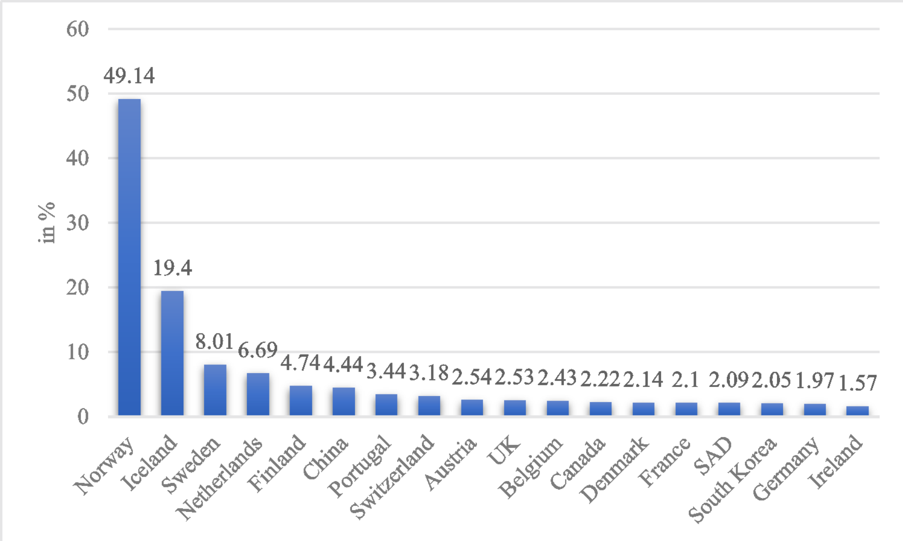

Figure 4: Countries with the highest share of plug-in EVs sales in 2018
Source: Created by authors from source [18]

Norway (Figure 4) stands out significantly from other countries per share of plug-in hybrid vehicles in total sales of new cars and light vehicles in 2018 with a share of 49.14%, while the only countries that follow it with more than 5% share are Iceland, Sweden and the Netherlands [18]. Therefore, it can be concluded that northern European or Nordic countries have a higher use of electricity in road transport compared to other countries. China ranked only sixth behind Finland in terms of the number of EVs sold.

Norway's incentive measures for EV such as the abolition of the purchase/import tax, the exemption of 25% VAT on the purchase of EV, the elimination of the annual road tax and other incentives, were positively reflected in the increase in the number of EVs [19].

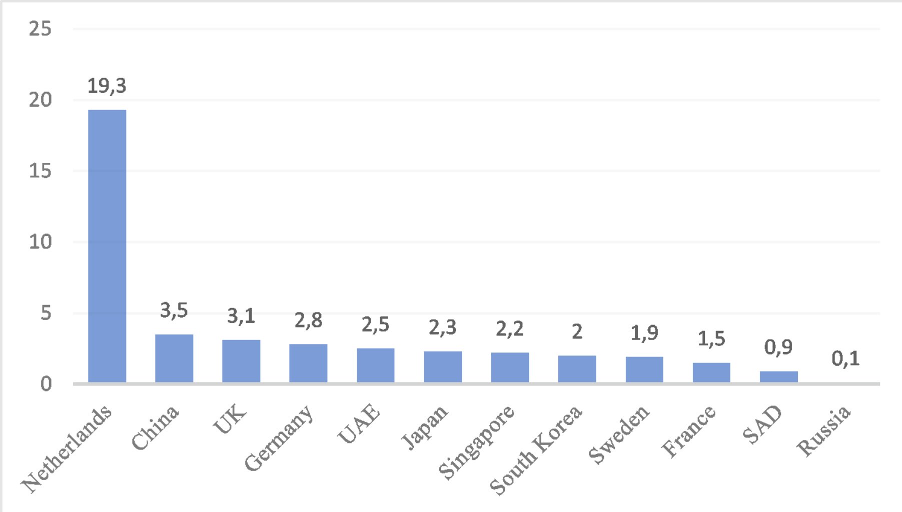

Figure 5: The number of car loader per 100 km of road
Source: Created by authors from source [20]

Figure 5 shows the number of charging points for electric points per 100 km of paved road. The Netherlands stands out from 19.3 charging points per 100 km compared to other developed countries by investing in EV charging infrastructure or the number of charging points. The Netherlands is followed by countries with a much lower number of charging points per 100 km, China with 3.5 and the UK with 3.1 charging points [20].

More economically stable countries have the highest share of EV as a result of energy-environmental policies. The number of charging stations for EV in the EU is increasing daily, and in 2018 the number of charging points was 37037 [21]. Countries such as the Netherlands, France and Germany are at the forefront of the EU in terms of the number of charging points for EV.

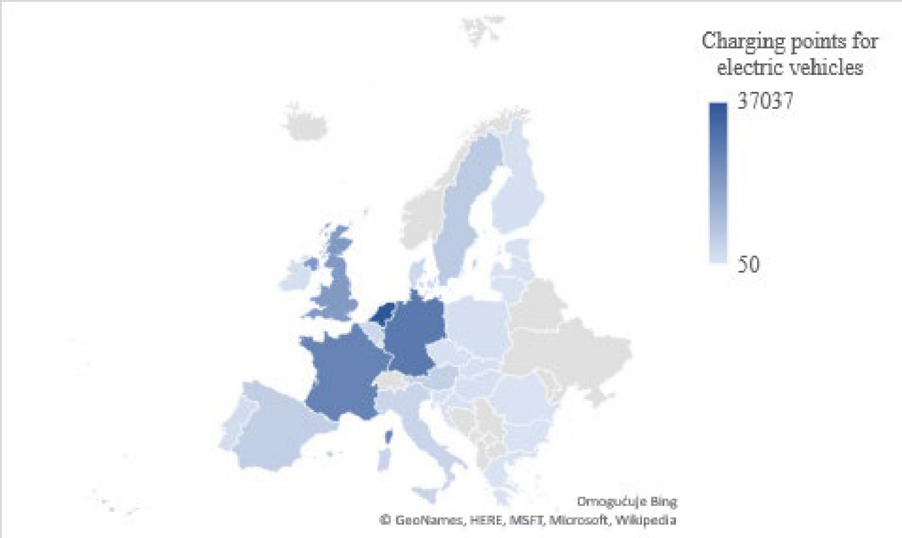

Figure 6: Infrastructure for charging EVs within the EU
Source: Created by authors from source [21]

Today, a small number of electric cars is used, so the number of charging stations is not as branched as for standard vehicles. Still, with further increases in sales of electric cars, infrastructure will also develop. More developed cities have adequate support, while the number of publicly available charging points is continuously increasing. EVs increase electricity costs, however, through various economic mechanisms, the costs in relation to standard vehicles are striving to reduce

As far as in 2050 in Europe will be 80% of electric-powered cars, it would increase electricity consumption by approximately 10% while the highest share of consumption would concern the industry and households [22]. Therefore, further development of the infrastructure for EV and their further increase in transport will also develop the electricity grid. While this is an extensive undertaking, the EU is already implementing the integration of renewable energy sources into the road network.

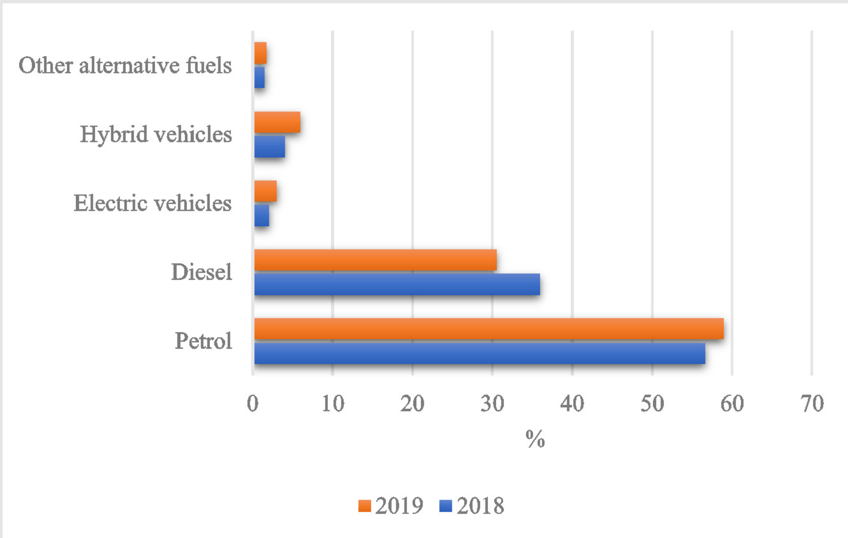

Figure 7: New Cars According to the type of fuel in the EU for 2018. and 2019.
Source: Created by authors from source [23]

Total sales of diesel vehicles in the EU in 2019 decreased compared to 2018. by 5,4 %, while sales of petrol and EVs increased by 2.3% and 1% respectively [23]. Hybrid vehicles still have the highest share among alternative-driven vehicles.

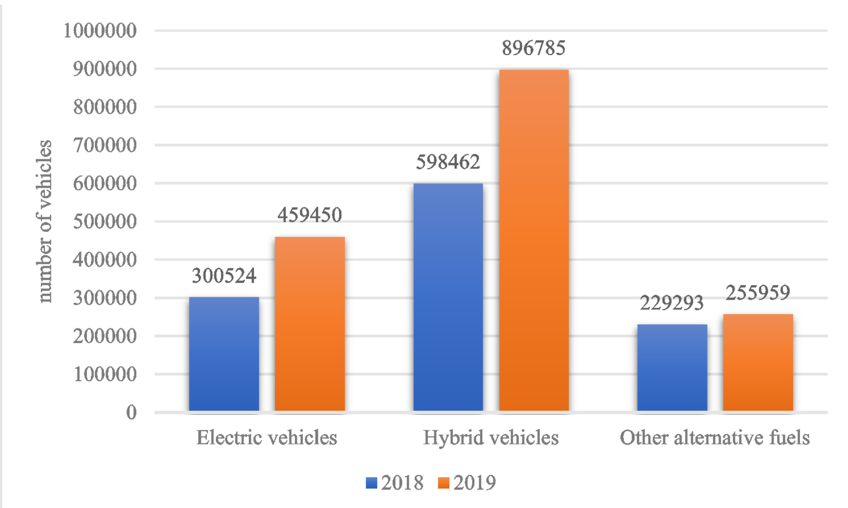

Figure 8: New registrations of passenger cars in the EU by type of alternative fuel
Source: Created by authors from source [23]

Looking at 2019, the number of electric-powered vehicles in the EU has been 1.356.235 of which 896.785 are hybrid vehicles (HEV), while the other 459.450 are pure EVs (BEV). Electricity as a road transportation fuel is not yet represented within the EU to an adequate extent for the environmental shift to be detected.

4. Analysis of the application of EVs in the Republic of Croatia

The primary economic mechanism for stimulating electricity in road transport is to subsidize the procurement of electric and hybrid vehicles. Croatia has about 2 million road vehicles, while approximately 1.5 million vehicles are related to passenger cars. The average age of vehicles is about 12 years, and their CO_2 emissions are estimated at around 3 tons per car, while at the same time, hybrid vehicles emit approximately one tone of CO per year [24].

For more environmentally friendly transport in 2014, the project "We drive economically" was adopted, offering grants for the purchase of electric, hybrid, and plug-in hybrid vehicles. The project allows companies up to 700.000 HRK of co-financing when buying eco-friendly vehicles that are required to keep them in possession for up to three years while citizens receive incentives only to purchase one vehicle, they are obliged to keep in possession for one year [25]. Environmental and Energy Efficiency Fund co-financed 109.5 million HRK for the procurement of 3.681 electric and hybrid and plug-in hybrid vehicles.

Highest prices of EVs related to conventional vehicles, and underdeveloped electricity charging infrastructure is an obstacle to significant growth in EVs sales. Although in 2019, 459 electric and 3.717 hybrid vehicles were registered, which is an increase of approximately 65% of electric and 40% of hybrid vehicles in the last two years [26].

In the Republic of Croatia, environmental pollution from transport is not expressed as much as in industrially developed countries. However, because of the constant increase in the number of vehicles in, it is an imperative to achieve environmental awareness. This may be manifested by the road transport electrification which has many advantages such as [24]:

- Greenhouse gas emissions reduced to zero
- Reduced use of non-renewable energy sources
- Significantly reduced tax burden with vehicle procurement subsidies
- Reducing noise pollution
- Contribution to sustainable development.

The incentive program for the procurement of EVs in Croatia began in 2014. with the total grant of subsidies amounted to HRK 14.5 million, which resulted in increasing the number of EVs the following year. Although the co-financing of EVs is not negligible, their share of the total number of new vehicles sold is still insignificant and amounts to only 0.03%. In Croatia the ratio of EVs to conventional vehicles was

1:3700 in the year 2018. Also, a poor picture of the application of electricity in road transport is shown by the fact that in Croatia there are more than 700 charging ports of EVs that are currently installed, which is nearly equal to the number of EVs in the country [27].

The number of registered passenger vehicles in 2018 amounted to 1.666.413. The share of EVs in the total vehicle number was 0.027% [28].

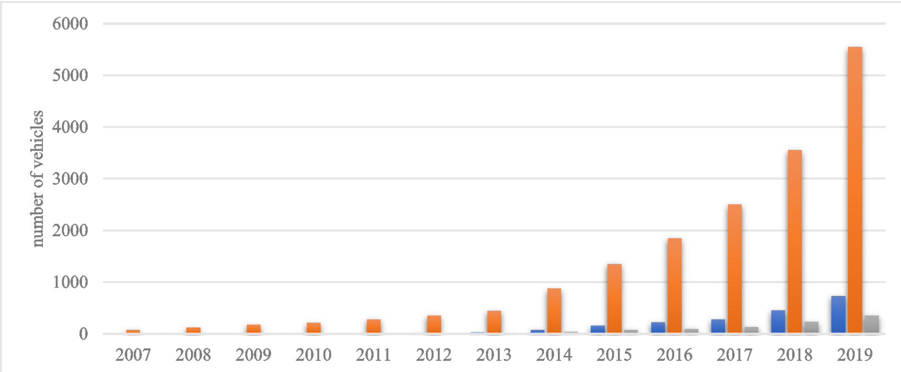

Figure 9: M1 category vehicles with an electric and hybrid drive
Source: Created by authors from source [29]

The adoption of Directive 2014/94 for establishing of alternative fuels infrastructure in the total number of vehicles has led to an increase of EVs in the country. For example, in 2014, there were 74 registered EVs, while in 2019, there were 730 registered EVs. Although the number of EVs almost doubled each year, it still does not account for a significant proportion of the overall number of vehicles.

By expanding the network of charging points for EVs on motorways more favourable conditions for the exploitation of EVs over longer distances will be ensured. In Croatia this would have an impact on the increase in long-distance travel of EVs, while at the same time having a favourable impact on tourism given the rise of EVs in Europe. The trends in EV sales are expected to grow by approximately 11-40% by 2030, so it is necessary to support it with the appropriate infrastructure [30].

In Croatia, there are several directives for implementing environmental measures into the transport sector such as [31]:

- Directive 2009/33/EC on the promotion of clean energy-efficient road vehicles, adopted to promote and stimulate a market for clean and energy-efficient vehicles,
- Directive 2009/28/EC on the promotion of the use of energy from renewable sources, which aims to achieve a 10% market share of renewable energy in fuels needed to maintain transport,
- Directive 2014/94/EC establishing alternative fuels infrastructure constitutes

a common framework of measures to set up alternative fuel infrastructure in the EU, as well as set minimum requirements for the construction of alternative transport fuels infrastructure.

Strategic documents provide incentive measures in the application of electricity as road transportation fuel and increase its competitiveness at the market. In Croatia, the following strategies were adopted [31]:

- The Energy Strategy of the Republic of Croatia, which adopts measures based on predictions or assumptions that will set higher standards for new vehicles. The strategy also plans the establishing of more efficient transport systems, with the prescribing of incentive schemes and subsidies for energy-efficient vehicles, i.e., vehicles with less than 120 CO2 emissions.
- The third National Energy Efficiency Action Plan of the Republic of Croatia for the period 2014 - 2016 which strived to meet all environmental criteria and at the same time, fulfill all economic and social transport needs.

Table 1: Co-financing of the procurement of energy-efficient vehicles

<table>
<tr><th colspan="3">INCENTIVE AMOUNT - up to 40 %</th></tr>
<tr><th>TYPE OF VEHICLE</th><th>DRIVEN TECHNOLOGY</th><th>MAXIMUM AMOUNT</th></tr>
<tr><td>Electric bike</td><td>Electric Drive</td><td>5.000,00 kn</td></tr>
<tr><td>Electric vehicle L1, L2, L3, L4, L5, L6, L7 categories</td><td>Electric Drive</td><td>20.000,00 kn</td></tr>
<tr><td rowspan="2">M1 category vehicle
• vehicles of lower and middle class (urban and compact vehicles), i.e., according to the European categorization of the so-called A (mini), B (small) and C (middle) segment of the vehicle.
• SUV vehicle (Sport utility vehicle) and MPV (Muti-purpose vehicle) with corresponding subtypes within A, B, C segments</td><td>Plug-in Hybrid drive (emissions of CO2 pollutants up to a maximum of 50 g/km)</td><td>40.000,00 kn</td></tr>
<tr><td>Electric Drive (CO_2 pollutant emissions of 0 g/km)</td><td>80.000,00 kn</td></tr>
</table>

Source:http://www.fzoeu.hr/hr/energetska_ucinkovitost/poticanje_energetske_ucinkovitosti_u_prometu/sufinanciranje_nabave_energetski_ucinkovitijih_vozila/ [24]

Table 1 shows the amount of incentives for EVs by category. For hybrid vehicles is provided an amount up to 40.000,00 HRK, while for vehicles exclusively with electric propulsion is allocated the amount of 80.000,00 HRK. Electric bikes also have a subsidy for procurement and their maximum incentive is 5.000,00 HRK. EVs of the category L1-L7 are co-financed by up to 20.000,00 HRK.

5. The tendency of the future development of the road-based EVs market

Growing trends in EVs are seeking to except the use of fossil fuels from in road transport. The complete removal of fossil fuels linked to EV is not a simple process unless electricity generation is turned towards renewable energy sources. Although there are overall lower emissions of harmful gases in relation to conventional vehicles, the electrification of traffic will not be able to solve all problems in urban environments such as crowds and high parking needs.

The high use of EVs leads to a higher load of the electricity grid, especially in winter due to the need of heating and charging EV. If such a scenario occurs, it is possible to provide support for the storage of renewable energy sources using the "vehicle-to-grid" (V2G) option. This option contributes to the balancing of the grid and the use of variable renewable sources, however it is only sustainable in countries with a developed electricity grid [32].

Sustainable transport is currently facing many challenges arising from climate change or environmental conservation. Globally, around 55 % of the population lives in urban areas and according to the UNs forecast, this proportion could rise to 68% by 2050 [33]. Urban areas can design socio-technological transitions, but they remain responsible for 70% of greenhouse gas emissions.

The future of EVs depends on their further environmental impact where the possibility of recycling or reuse can also be highlighted. EVs are made of various metals and other hazardous materials whose processing requires a large amount of energy with the use of toxic chemicals. Reusing parts such as batteries would reduce the harmful impact on the environment.

Increasing the efficiency of EVs plays a major role in the sustainable development of EV, taking advantage of the greater potential of the vehicle. If EVs could exceed 70.000 km, efficiency would not be higher about conventional vehicles, given the higher energy needs in production. Therefore, the aspiration of the manufacturer is that EVs can withstand a minimum of 150.000 km, thus achieving greater efficiency than standard vehicles [22].

The impact of EVs is much less threatening to human health, as the vehicles themselves do not directly affect air quality. However, air quality will still be compromised by power plants, although they are mostly positioned outside urban areas. Over the past ten years, the EU has invested over 1 billion euros in research and infrastructure for EVs mainly on primary transit corridors. It also encourages battery production in Europe as they are mainly produced in Japan, South Korea and China.

A number of measures and actions have been implemented in many countries of the world in order to reduce the negative impact of transport on the environment Agreements such as the Kyoto Protocol (1997) and the Paris Agreement (2015) aim to mitigate climate change caused by excessive environmental pollution. The Kyoto Protocol is an international agreement adopted in 1997, however due to the complex ratification process, it only came into force in 2005. The task of the agreement is set limits on greenhouse gas emissions to industrially developed countries in accordance with the permitted [34]. However, the next ten years marked further environmental disruption, so the 21st session of the Conference of the Parties (COP 21) of the United Nations Framework Convention on Climate Change (UNFCCC) and the 11th session of the Kyoto Protocol (CMP 11) meeting of the Parties to the Kyoto Protocol (CMP 11) were held in Paris. The agreement aims to keep global warming well below 2°C compared to pre-industrial levels, with an effort to keep the temperature rise from 1.5°C [35].

The potential for the development of the EV market is not diminished despite the development of other alternative fuels. Over the past few years, the number of EVs has been steadily increasing, especially in countries that actively implement a policy of reducing transport-induced CO_2 emissions. Therefore, in addition to further developing batteries and perfecting more energy-efficient vehicles, it is important to provide the necessary infrastructure to make vehicle growth sustainable in the coming years. Charging infrastructure is already available in individual car parks, however charging points vary by power or speed of the vehicle. The following power fillings are recommended [8]:

- Charge with “normal” power (<= 3.7 kW)
- Charge with “medium” power (3.7 – 22 kW)
- Charging with “high” power (>22 kW)

Charging with “normal” power (<= 3.7 kW) would correspond to the charging mode at home, while charging with “high” power (>22 kW) requires certain public places, i.e., a charge point for that purpose. For example, charging an e-Golf electric car on a home socket would last about 17 hours, while using public DC charging points (CSS rapid charging system), the charging time is reduced to approximately 45 minutes by 80% of the vehicle’s charge [36].

Economic sustainability is another potential for the use of electricity as road transportation fuel, namely the use of EVs will significantly reduce Europe’s dependence on standard energy supplies in the coming years.

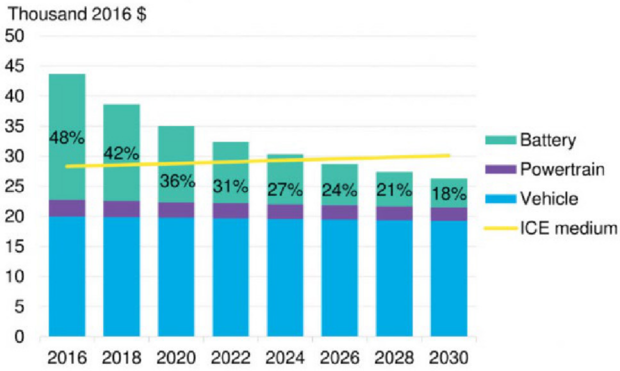

Figure 10: View of total cost of ownership/accessibility
Source: Created by authors from source [37]

According to Figure 9, it can be concluded that currently, the costs of purchase and use of vehicles are lower for conventional vehicles, while in the period 2024 - 2026 these costs will be almost equalized Following the trend of reducing costs for EV, the average cost of ownership for EV will be 0.04 - 0.06 € / km lower than conventional vehicles by 2030, which would result in savings of 140 billion to 210 billion euros annually. If this trend will be continued, Europe would have a chance to save approximately 1,740 million barrels of oil or 78 billion euros considering the average price of a barrel of 45$ by 2050 [37].

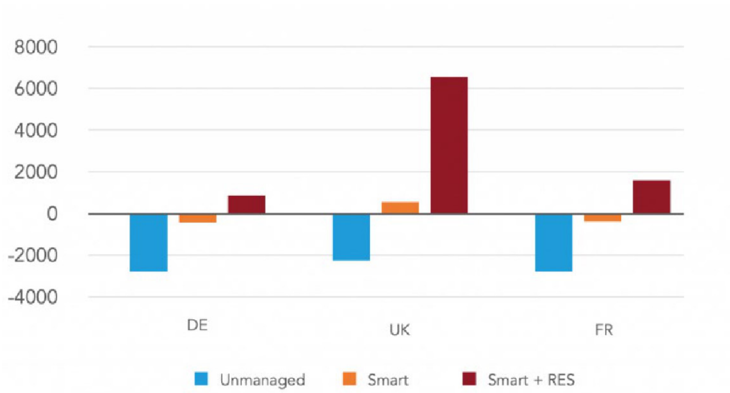

Figure 11: net cost/benefit of charging deployment in each country, 2050 (€m/year)
Source: Created by authors from source [37]

The increasing use of electricity to electrify transport requires appropriate access and implementation of measures so as not to raise concerns about the load on the electricity network.

Methods such as smart charging and vehicle to grid (V2G) have been innovated to achieve greater energy efficiency, which would reduce charging costs at home and allow more vehicles to be charged with less investment in facilities.

6. Conclusion

Increasing economic growth has affected the increased need for vehicles to exchange goods and transport passengers, so such an increase in road transport in view of dependence on fossil fuels is harmful to the environment and human health. With the development of technology, EVs achieve the qualities of conventional vehicles while meeting environmental standards, so they have the possibility of sustainable development. Although EVs have enhanced in the cost of ownership, conventional vehicles are still a more affordable option for users. However, with increasing environmental health and environmental disruption, especially in urban environments, countries' policies are turning in favour of EVs. Under the circumstances of the impaired climatic conditions, EVs aim to replace conventional at least in the form of light and urban vehicles. Reducing environmental pollution, noise and dependence on fossil fuels would meet the conditions for sustainable urban mobility. According to the trend of battery development, it is expected that EV beside environmental awareness and speed will soon be able to equal with conventional vehicles in range.

Preserving the environment is considered one of the primary tasks of humans, so it is necessary to develop the technology further or increase energy efficiency to turn to renewable energy sources in transport and electricity generation plants. As technology exists, the market is increasingly turning to electrification of the sector. In addition to appropriate measures, incentives and investments by countries' policies, conditions will be created for maintaining stable transport of people and goods by EVs.

The growing number of charging points in Croatia shows that conditions for the acceptance of EVs are enabled, and besides various subsidies by the state the facilitate procurement of EVs is ensured. Electrification of transport in Croatia offers the potential to strengthen competitiveness and attract tourists. The electric grid in Croatia is stable and well developed, making it easier to install charging points, while their increasing is affecting the comfort of driving with EVs due to greater availability. Further encouragement, in addition to educating people and promoting the use of electricity in road transport, will reinforce the tendencies for the sustainability of the development of the EVs market.

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