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Use of Energy Carriers; Legislation & Practicality Approach

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Table of Contents

Introduction	1
Literature review	2
Fuel crisis.....	2
Progress and achievement	3
Development of biofuels in the automotive.....	4
Politics biofuel production environmental, socio-economic and regulations	4
Automotive reactions and concern.....	5
Electric and Hybrid vehicles	7
Methodology.....	10
Methodology research.....	10
Results/ Analysis	11
Development of new energy sources	11
Toyota hybrid strategies	11
Electric Vehicles advantages	11
Autonomous Vehicles	12
Conclusions	14
References.....	15
Appendices.....	19
Appendix 1	19

Introduction

The UK Government has established that is going to ban petrol and diesel vehicles by 2030, with all new cars and vans with petrol and diesel to have fully zero emissions by 2035. 25,000 charging points have already been introduced all over the country, however, more infrastructure will be added in place to meet the transport needs.

The Office of Zero Emission Vehicles (OZEV) is aiming to introduce 4 new primary legislations (GovUK, 2021a):

- Obligation of more charging points for Electric vehicles (EV)
- Charging points into car parks
- New power to support the high current
- Improve the efficiency of EV vehicles to meet customer requirements.

Global warming and the growing need for renewable energy are still seen as the two biggest concerns facing society worldwide (Luque, Rafael, & Chenyu, 2010).

Currently, 88% of the energy used is made up of burning fossil fuel. In addition, the CO₂ concentration in our atmosphere has increased from 250 to 440 ppm within only 200 years. The massive impact on climate change is already visible and it is quite hard to adjust and improve. However, the only solution would be to turn all the energy into clean and renewable energy (Kumar, Ogita, & Yau, 2018). Road transport has become one of the main problems that cause CO₂ to increase in the atmosphere. In addition, the dependence on oil-delivered fuel at the same time, it caused an increase of price of oil and the supplier distribution, further, using diesel into an Internal combustion engine (ICE) causes PM₁₀, NO_x and VOCs that are very dangerous for human health. However, technology is moving on to ensure that the decarbonization is reduced and air quality is improved (Offer, Contestabile, Howey, Clague, & Brandon, 2011).

Literature review

Fuel crisis

The main crisis started in the late 2008 in Greece and is still ongoing (Musso, et al., 2013) . As mentioned before, the transport sector has become the main factor of the increase in the greenhouse gas emissions (GHG). In addition, the emissions of the transport have risen the CO₂ measurement across the world. At the same time, the reduction of carbon transportation is beneficial as it can reduce the emission and the reduction of cost for the transport and social environment (Ali, Dissanayake, Bell, & Farrow, 2018).

The United Kingdom is a small island countryside, and the global warming and the greenhouse issue have risen quite a massive concern, indeed by 2030 the Internal combustion Engine (ICE) will need to be replaced. The advantage of having fewer ICE vehicles on the road will result in a massive improvement in the air quality and the reduction of particles such as the nitrogen oxides (NO_x) (Gao, et al., 2022).

Progress and achievement

Policymakers are required more than ever to make sure that regulatory procedures are accurately captured on-road emissions of cars and ensure to prohibit the illegal deployment of defeat methods due to the persistent NO_x pollution in many cities across Europe (EEA, 2015). Since 2007, on-road tests in Europe using Portable Emissions Measuring Systems (PEMS) have shown that light-duty diesel vehicles certified in accordance with Euro 4 up to Euro 6 standards produce multiples of the amount of NO_x allowed by the corresponding emissions limit. The main PEMS have evidenced that diesel cars are able to produce NO_x on the road during the testing of the New European Driving Cycle (NEDC) (Degraeuwe & Weiss, 2017). However, the main goal of the Euro 7 (passenger cars) and Euro VII (commercial vehicles) is aimed to ensure that the vehicle are generating the lowest emissions as possible. Moreover, the On board Monitoring (OBM) will be installed inside all the vehicles to ensure that emission coming from the tailpipe exhaust are monitored. A model-based simulation environment is being used by AVL to determine emissions to conduct a study into the difficulties associated with the anticipated Euro 7/VII legislation. With future OBD/OBM regulations in mind, this technique enables examination of several potential engine and Exhaust Aftertreatment System (EAS) designs (Gunja, 2022).

The ph of oceanic uptake of CO₂ has shown that the water level has been reduced by 0.1% and the level of acidity has risen by 26%, which is hydrogen ion concentration. In fact, in the period between 1992 to 2011, in Greenland and the Antarctic the ice sheets have started losing its mass, and it is estimated that the larger quantity melted between 2002 and 2011 (Kumar, Ogita, & Yau, 2018).

Nowadays, due to the large number of new vehicle registered in the UK, emissions are a major issue especially in metropolis such as London. Recently, great improvements have been done by the UK Government as illustrated in the graph in Figure 1(Gao, et al., 2022).

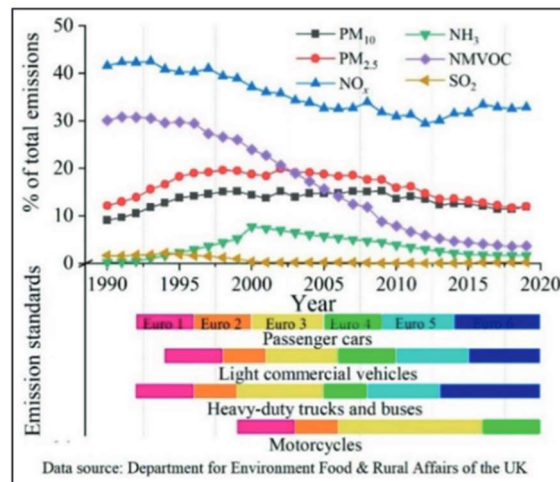


Figure 1. Total emissions in UK (Gao, et.al., p.2)

Development of biofuels in the automotive

One of the main issues that has become a very concern is the climate change and energy in the last years. Moreover, the effect of the climate change has pushed the European Union (EU) to find better solutions to reduce emissions in all sectors. However, the main sector which has been reviewed is the transport sector, because it requires the 30% of energy consumption, but on the other hand, there have been incredible improvements over the years.

Nowadays, the biofuel has been seen by the EU as one of the ways to meet targets of the Kyoto Protocol. The benefit of the biofuel is that is able to reduce the harmful greenhouse-gases (GHGs) and at the same time, reduce the dependence from the energy-rich nations (Hammond, Kallu, & McManus, 2008).

Politics biofuel production environmental, socio-economic and regulations

During the years, European regulations have not been able to make improvements in regard to nitrogen oxide emissions (NO_x) which comes from the diesel engine. The UK has taken very seriously in consideration the effect of the climate change. In fact, from November 2020 it has been announced that very important steps will be taken by the UK prime minister such as (GOV.UK, 2020):

- Stopping the sale of diesel and petrol cars and van bought after 2030.
- Only cars with fully zero emissions will be allowed on the road by 2035.

In addition, following the Transport Security Grant Shapps, the UK needs to make a huge step to decarbonise transport, clean energy and renewable technology by 2050. At the same time, it is able to create around 40000 extra new jobs opportunities by the end of 2030. Moreover, the UK government is aiming to help sector that use a clean and zero emissions vehicles (GOV.UK, 2020).

Automotive reactions and concern

The UK is aiming to invest a further £500 million of funding over the next 4 years into the Automotive sector to ensure this sector is able to bring a net zero emission vehicles (GOV.UK, 2020).

Even if smog pollution has been reduced, No_x pollution is still considered a major issue. Following the last Eu and UK regulations, countries needs to achieve the reduction of emissions to climate neutrality between 2030 and 2050. Furthermore, additional restrictions with the introduction of the Euro 7 will be implemented. The Euro 7 has been first introduced by the European Commission, which had the mission to ensure that all the vehicles produced from 2025 should produce zero emissions during the life cycle. As with euro 6, the No_x emissions are set to 60 mg/km for a petrol car and 80 mg/km for diesel vehicles and for carbon monoxide emission is set to 500 and 1000 mg km for petrol and diesel vehicles (Pahon, Bouquain, Hissel, Rouet, & Vacquier, 2021).

The European commission aim to introduce a further forceful air pollution emissions for the ICE engine vehicle by 2021. Table 1 illustrates the main benefits of cost saving and health environmental and improvement for the society (Deprez, 2022).

Table 1 Important benefit and cost involved (Deprez,2022,p.6).

Description	Amount	Comments
Direct benefits		
Regulatory costs savings: Testing, witnessing, type-approval and administrative costs savings	€5.25 billion	Main recipients of the benefit: Automotive industry and eventually citizens through reduced vehicle prices
Health and environmental benefits	€189.33 billion	Main recipient of the benefit: citizens
Indirect benefits		
Competitiveness: Access to international key markets	Moderate benefit	Main recipient: automotive industry
Competitiveness: Innovation	Moderate benefit	Main recipient: automotive industry
Free movement within the single market	Low benefit	Main recipient: automotive industry
Consumer trust	High benefit	Main recipient: citizens
Employment and skills	Low benefit	Main recipient: citizens

I.L.C Overview of costs for light- and heavy-duty vehicles – Option 3a							
Billion €		Citizens/Consumers		Manufacturers		Administrations	
		One-off	Recurrent (annual)	One-off	Recurrent (annual)	One-off	Recurrent (annual)
Simplification measures (cost savings see Error! Reference source not found.)	Direct costs (regulatory costs)	0.00	0.00	0.00	-0.20	0.00	0.00
	Indirect costs (prices)	0.00	-0.20	0.00	0.00	0.00	0.00
Medium ambition emission limits, real driving testing boundaries and durability (2a)⁵	Direct costs (regulatory costs)	0.00	0.00	16.30	1.32	0.00	0.00
	Indirect costs (prices)	0.00	1.94	0.00	0.00	0.00	0.00
Continuous emission monitoring	Direct costs (regulatory costs)	0.00	0.00	1.25	0.05	0.00	0.00
	Indirect costs (prices)	0.00	0.09	0.00	0.00	0.00	0.00

Moreover, the new Euro 7 rules will bring the emissions limits for all the motor vehicles. According to the Euro 7 proposal, the Nitrous-oxide (Nox) emission for petrol and diesel engines will be up to 60mg/km. Where the actual Euro 6 regulations allow the cars to emit up to 80 mg/km of Nox (Environment, 2022). In addition the performance of the vehicles have been verified and tested through the Worldwide harmonized Light-duty vehicle Test Cycles (WLTC) which is an harmonized cycle to ensure that vehicles have the right homologation around the world. The aim of the WLTC is to analyse diesel, petrol and hybrid vehicles and ensure that are meeting the right emissions to get eligible to be on the market (Robbio, Cameretti, & Mancaruso, 2022). Millo, Cubito, Rolando, Pautasso, & Servetto cited in Robbio, Cameretti & Mancaruso (2022) pointed out that the WLTC has been able to reduce the fuel consumption along with the New European Driving Cycle (NEDC), and at the same

time, to reduce the CO₂ by 11% and 23% respectively (Millo, Cubito, Rolando, Pautasso, & Servetto, 2017). On the other hand, the Real driving emissions (RDE) testing means of portable emissions systems (PEMS) which can potentially eliminate the discrepancy in between the lab and the road test (Hooftman, Messagie, Mierlo, & Coosemans, 2018). From November 2015, the European Council has given a green light to introduce the first package of RDE tests to measure the emissions of light vehicles. In addition, the first package will be producing an emissions measurement system which will be connected to the vehicle testing and it has been applied for monitoring purpose (Consilium, 2015). The results of Degraeuwe & Weiss (2017) illustrated that the vehicle tested tend to satisfy the Euro 4-6 NO_x regulations limits.

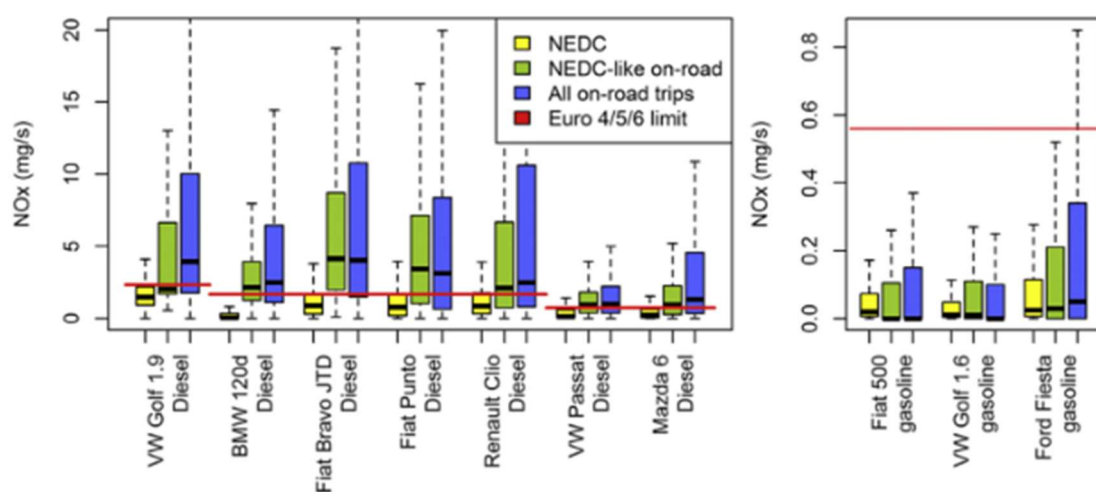


Figure 2. NO_x emissions graph of the NEDC testing (Degraeuwe & Weiss, 2017, p.236)

Figure 2 illustrates the graph of all cars for the NO_x emissions of all other vehicles over the NEDC model. The box plots of on-road data for diesel automobiles show little overlap with those of the NEDC even when only NEDC-like conditions are chosen. The green and yellow box plots should have a comparable range if driving dynamics account for the difference between NEDC and on-road NO_x emissions. In contrast, the on-road NO_x emissions from gasoline-powered vehicles are higher than those over the NEDC but still fall within the permitted levels. Box plots for solely NEDC-like driving situations are mostly overlapping with those of the NEDC (Degraeuwe & Weiss, Does the New European Driving Cycle (NEDC) really fail to capture the NO_x emissions of diesel cars in Europe?, 2017).

Electric and Hybrid vehicles

The main power of the electric vehicle are the batteries, which are plugged into the main disposer to get recharged. Most of electric vehicles have a range of up to around 100 miles (Denton, 2020). In addition, the electric vehicle will require a sufficient battery storage for the driving range. Nowadays, the cost estimated of a lithium-ion battery is around \$700/kWh, this is one of the reasons that Ev

vehicles are more expensive than a ICE vehicles. However, the downside of the electric vehicle is the long time required to charge the vehicle, therefore the best charging time is at night.

At the same time, that can be a disadvantage from an Ice vehicle customer, which for an Ev has a limitation of driving and a quite long wait to get the vehicle recharged (Wu, Gilchrist, Sealy, Israelsen, & Muhs, 2011). As the UK Government is aiming to improve the air quality of the air and reduce the harmful emissions, the amount of electric vehicle on the road will be increased by 10 million. For this reason, the UK Government is aiming to increase the number of charging station. The number of public charge points has increased already four times in the last five years. Appendix 1 illustrates that the number of fast chargers is much higher in the UK then in other countries (Government, 2022b) .On the other hand, Hybrid electric Vehicles (HEVs) subsist of two power sources output, the primary and secondary power source. Figure 2 illustrates a diagram of how an hybrid vehicle works (Ehsani, Gao, Longo, & Ebrahimi, 2018). The economic impact of EV vehicles has been investigated from two perspectives, from the vehicle owner and the electricity systems. The main cost of an EV's vehicle is to purchase, but in comparison with an ICE vehicle, the Ev is much affordable to run due to the high efficiency of the electric motor. Thiel cited in Richardson (2013) estimated that by 2030 the payback period of an EV and an affordable ICE vehicle would be around 20 years, however it should decrease by 2030 as the number of Electric Vehicles will rise in that period of time. Overall having an Electrical vehicle will increase the fuel cost and at the same time it will even affect the overall system cost (Richardson, 2013)

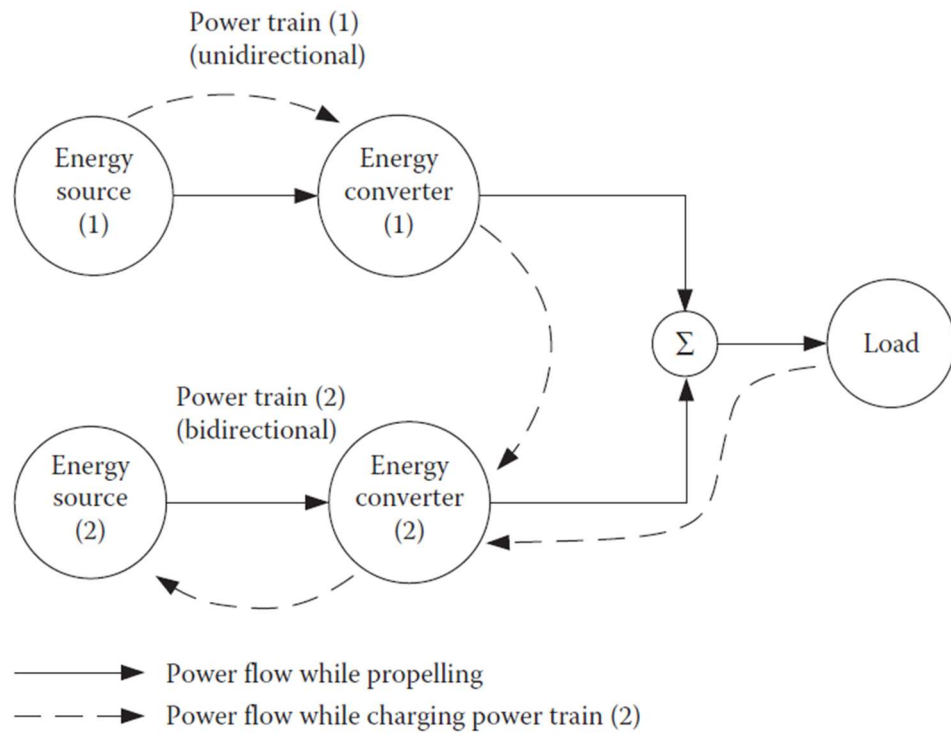


Figure 3. The conceptual illustration of hybrid electric drivetrain (Ehsani, Gao, Longo, & Ebrahimi, 2018,p.114)

In a hybrid vehicle, the steady power is given by the IC engine a Sterling Engine and a fuel cell (Ehsani, Gao, Longo, & Ebrahimi, 2018).

Methodology

For this technical report the European regulations and British regulations have been investigated and the potential future solutions have been illustrated

Methodology research

For this technical report initially, secondary data have been collected in regards to the emissions and the new UK and European legislations which are going to affect the economic. The main data that have been collected are the emissions data, legislations and the new technologies that will be in place in the future.

Results/ Analysis

Development of new energy sources

The need of renewable energy has been important in the last years, for many different factors. In addition, renewable energy could come from kinetic energy storage in a wind, water and thermal energy from the solar system. The biomass has become the main resource and it has been developed rapidly in the last years. Additionally, the biomass has been settled to be aside from the other resources and the advantages is that the energy is stored into a chemical bond (Vennestrøm, Osmundsen, Christensen, & Taarning, 2011). In addition, following the research of Chiang, Brooks, and Weir (2004) a person aged 33 does a mile's average of 13,400 or in other words 21,500 km, which is approximately 36.72 miles per day (Chiang, Brooks, & Weir, 2004). Therefore, any new technology should consider this data accurately.

Toyota hybrid strategies

The new model of the hybrid Toyota C-HR will be an hybrid vehicle able to be plug-in hybrid passenger car and will be manufactured in Turkey. Moreover, the TMMT is going to be a new European plan which is going to start having the first plug-in hybrid vehicle. Furthermore, this new version of Toyota's multi-technology will be able to achieve 100% of CO2 reduction and be able to meet the European legislations (Newsroom, 2023).

Electric Vehicles advantages

Ev vehicles have fewer moving parts than a ICE vehicle therefore it is less risk of mechanical failure and service. But Ev still remain a quite small part of the auto market, another advantage of electric vehicles is that they are able to be connected through a internet connection, and become even smarter than a Ice vehicle (Teece, 2018). Although, Ev vehicles require extra investments in relation to the electricity and the construction of the vehicle and the battery components, it is able to drastically reduce the GHG emissions in comparison to an ICE vehicle (Jochem, Doll, & Fichtner, 2016).

Autonomous Vehicles

Another future technology that is going to be evolving with time are the autonomous vehicles or in other words self-driving vehicles. This robotic/self-driving vehicle will also affect the road, parking facilities and public service. In the view of Litman (2017), the autonomous vehicles will be sufficient reliable by the 2030. Figure 4 illustrates the self-driving user costs (Litman, 2017).

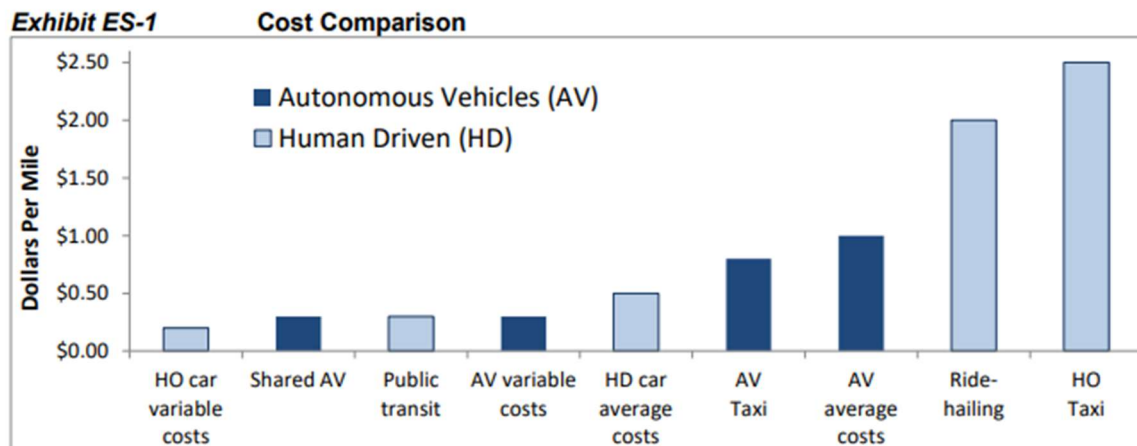


Figure 4. Normal vehicle against Autonomous vehicle(p.3)

They will probably cost more than human-driven taxis and public transportation, but less than ride-hailing services. Shared autonomous vehicles will be less expensive than private ones, but less convenient and comfortable (Litman, 2017). However, another problematic impact it could be the public health, and the level of automation can vary in regard to the type of vehicle such as with internal combustion engine, hybrid or electric vehicles (Rojas-Rueda, Nieuwenhuijsen, Khreis, & Frumkin, 2020).

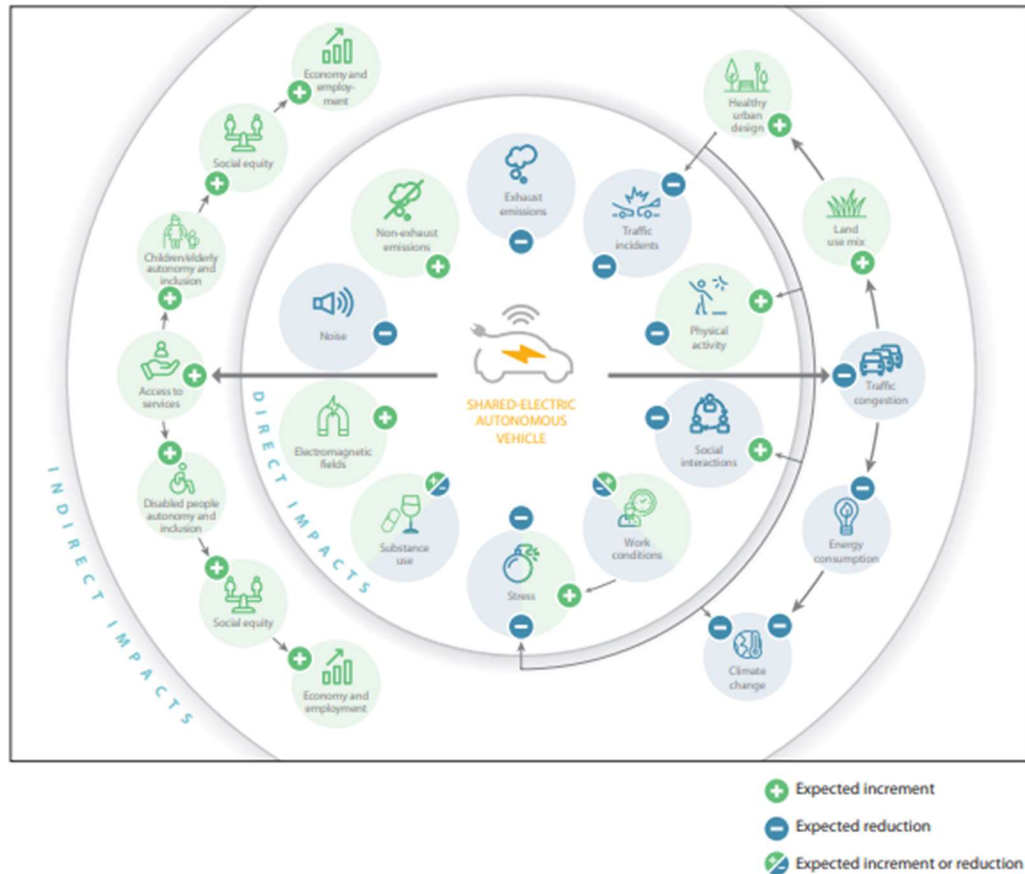


Figure 5. Framework of potential risk of a autonomous vehicle. (Rojas-Rueda, Nieuwenhuijsen, Khreis, & Frumkin, p.184).

Figure 5 illustrates the Entire framework of the autonomous vehicle, however, according to Luttrell et al. (2015) cited in Rojas-Rueda, Nieuwenhuijsen, Khreis, & Frumkin, (2020), 90% of vehicle in the United states are autonomous, the number of people that will be saved every year will be around 25,000 which is an incredible saving of \$200 billion in the United States (Rojas-Rueda, Nieuwenhuijsen, Khreis, & Frumkin, 2020).

Conclusions

In conclusion, the UK Government is aiming to ban petrol and diesel vehicle by the 2035. In addition, the Office zero is aiming to bring 4 new primary legislations to ensure the correct drivability of the new EV drivers. Since the fuel and oil have risen the prices as a result of the crisis started in 2008 in Greece, European countries have been pushed to find an alternative green energy to satisfy the final consumer. Euro 4 and Euro 6 have ensured that emissions generated from an ICE vehicle are drastically reduced. Where the implementation of the New Euro 7 will ensure that vehicle will produce the emissions as low as possible with an OBD installed to ensure that all vehicles are monitored.

On the other hand, the UK is still facing an emissions issue due to large numbers of vehicles presented on the road especially in the metropolis. Moreover, new technologies have been developed such as the biofuel which is going to reduce the demand from energy-rich countries. The UK government is aiming to invest an extra £500 million to ensure that the net zero of the emissions will be meet. Nowadays, the main technologies that will be able to phase out the ICE vehicles are the EV and Hybrid vehicles. Even though the UK Government is aiming to invest a further founding for Ev vehicles to ensure that there will be more infrastructure to recharge an EV vehicles, there are still so many disadvantages of having an EV vehicle such as a limitation of miles according to Chiang, Brooks and Weir (2004) and the fact that an average person is traveling 36.72 miles daily can dramatically affect the efficiency of the battery.

Another technology that is risen is the autonomous vehicle technology but that could affect the new parking facilities, roads and safety of the pedestrian.

To summarize, at the moment there is not a clear solution but definitely more improvement have been done to ensure that the net zero emissions are meet by 2035. The hybrid vehicle and the last model of Toyota C-HR look the more reasonable and comfortable way where human and the UK Government should invest a bit more.

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Appendices

Appendix 1

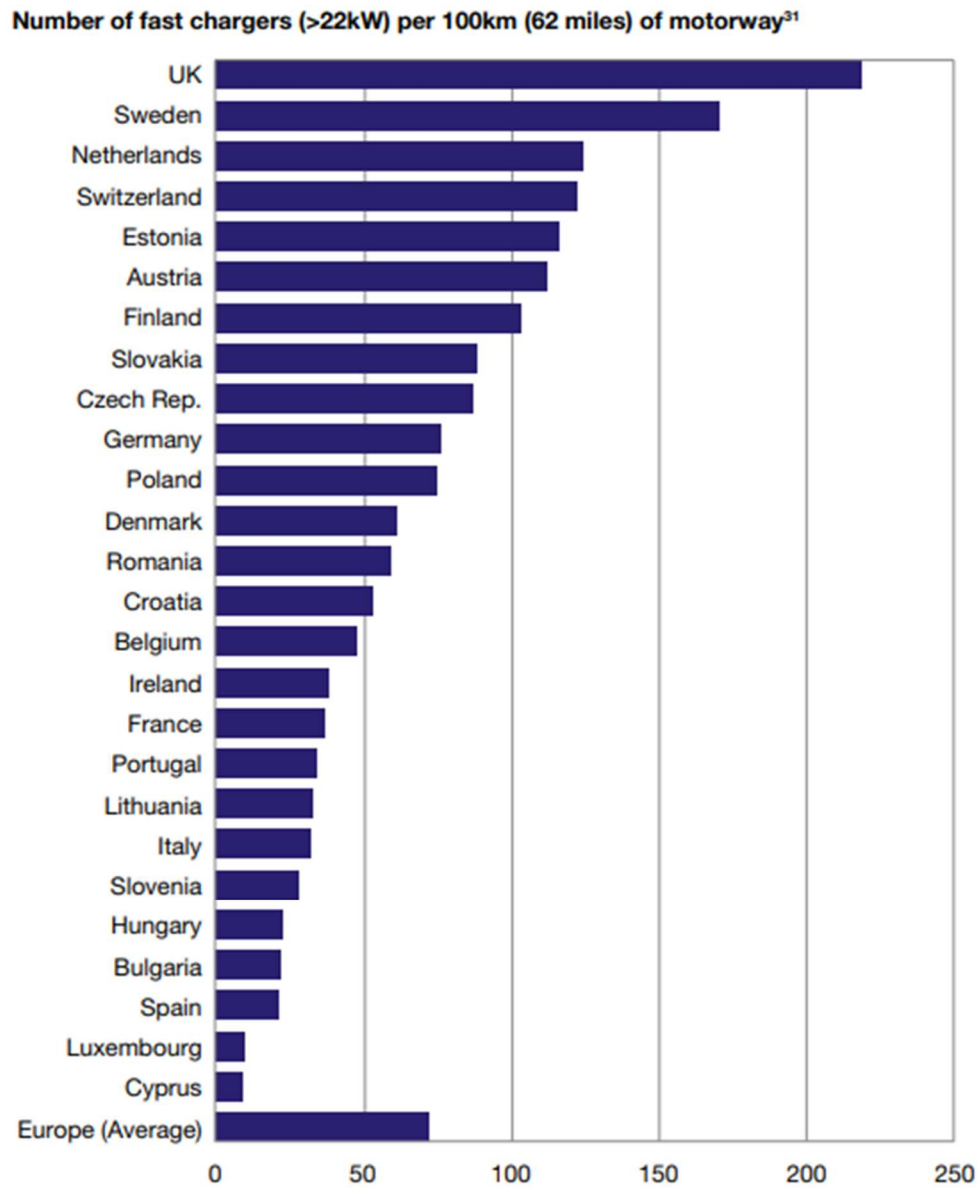


Figure 6. Number of fast charge in different countries (Government, 2022b, p.24)