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Use of Energy Carriers; Legislation & Practicality Approach

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Introduction:

This report is addressed to the United Kingdom's Department of Transport, to discuss and critique current and future legislation that will be enforced placing constraints on what Automotive manufacturers will be allowed to sell within the UK.

This report will include the current and incoming technological advances to help meet and achieve the sustainability and environmental targets set by the government. This is especially important due to the 2030 ICE ban getting closer. The government has set a target of net-zero carbon emissions by 2050, this is aimed to be achieved via different methods that have been placed by the government, however still ambitious.

This report will also review different forms of energy carriers which differentiate from the standard and most popular petrol and diesel, this will include analysis on which will be best suited to reach the 2030 target and whether they serve the needs of the owner or operation intended for, different forms of this are hydrogen, hydrogen fuel cell, electric etc.

At the current moment it is shown that present legislation is mainly promoting the use of sustainable transport such as electric and hybrid vehicles and reducing the useability of older vehicles that do not comply with the latest Euro Status, these are known as ULEZ zones which stands for "Ultra Low Emissions Zone". This has forced many vehicles owners to sell their older vehicles and switch to newer and compliant vehicles.

At the end of the document my own personal view will be expressed as to what I believe the government should be funding, this is solely based on the research gathered and what seems a viable option.

Current and Future legislation:

ULEZ Zones:

A ULEZ zone stands for (Ultra Low Emission Zone), this is often a set area in a city where vehicles that do not comply to a specific euro emission standard and not permitted to enter, without paying a daily charge or simply are not allowed to enter, these are often found in densely populated city centres where air quality has been reduced over the years and by using these means the government hopes to improve the air quality by discouraging the use of vehicles with a high emissions output.

The city of London is a great example of current and future changing legislation, this is due to the centre of London becoming a ULEZ zone on the 8th of April 2019, however on the 29th of August 2023 which is very near, this ULEZ zone is expanding across all of London's Boroughs, this is aimed to bring "clean air" to an extra 5 million people who reside in the outskirts of London.

The mayor of London has launched a £110 million-pound scrappage scheme to help businesses upgrade into a newer and more emission friendly vehicles, however this is not at access to everyone, this is only applicable for families of a low income, people with disabilities, charities, micro businesses, and sole traders. So, this leaves out individuals and families that earn more than what is deemed "low income", this leaves them forced to pay the required £12.50 daily charge to drive their vehicles, which on a standard working week is £62.50 which works out to over £200 a monthly.

However, with the current average disposable household income after taxes being £32,300 and with the current living costs crisis which has seen an astronomical increase in monthly outgoings for gas, electricity and fuel for their vehicles, how the government expects a family that classifies above "low income" to scrap or sell they're current family car is absurd, especially when the average cost of a compliant vehicle is circa £15,000-£20,000, with this new law coming in place this has left a large shortage of used compliant vehicles which has evidently driven up the prices of complaint used vehicles.

The automotive industries response to this has been to produce smaller and less costly vehicles that meet the latest Euro rating standards, to ensure that people that live amongst ULEZ city centres that still require a car can still have them, an example of this is the Citroen Ami becoming ever more popular throughout city centres, this vehicle is electrically powered and extremely small so that it is ideal for tight and compact city roads. These have become popular due to their low-cost financial plans at £19.99 a month which is helping many people say goodbye to their compact petrol/diesel powered cars and switch to a ULEZ compliant.

More and more manufacturers will follow the same route of low cost and environmentally friendly due to this being the demand amongst the UK, over the past 3 years we have seen a drastic increase in popular model variations to include a MHEV or fully electric option. This is evident with vehicles like the new Ford Fiesta offering a mild hybrid assistance which then classifies as a hybrid which is ULEZ compliant, the same scenario follows with the Vauxhall Corsa, Peugeot E-208, VW Up! Etc.

However due to the increase in demand and popularity of these vehicles, the ever-enticing government grant that would contribute toward the cost of a new plug-in hybrid or fully electric car has ended, this grant offered up to a £5,000 contribution towards the cost of the vehicle, which many reports say were needed to help people transition into electric vehicles.

2030 ICE Ban:

The 2030 ICE ban refers to a policy that will be enforced that will prohibit the sale of new petrol and diesel vehicles throughout the UK, ICE stands for Internal Combustion Engine that is found amongst most of the vehicles on the road today.

This policy was announced in November 2020 in conjunction with another plan that aims to get the UK's emissions to net zero, this means from 2030 the only cars that will be allowed to be sold will be powered by either electricity, or hydrogen. The aim of this policy is to ramp up the rate of change that people are replacing their petrol and diesel vehicles into electric or alternative fuelled vehicles, this is to transform transportation methods into a greener and less pollutive form.

To support this, change the government has had to ramp up the amount of car chargers that are being installed nationwide, and an incentive to change into an electric or alternatively fuelled vehicle is that there will be no need to pay any charges that apply to areas such as ULEZ or Clean Air Zones throughout the country.

The aims and objectives of this ban is to provide the nation with an overall cleaner air, reduction of carbon emissions, and a step in the right direction in meeting the 2050 net zero emissions target.

However, this ban only refers to engines that produce tailpipe emissions, this has left a large gap to which many manufacturers are jumping on researching alternative fuels that may potentially work with their current engine designs and hybrid systems. But this is still a very short time frame to produce a result of zero tailpipe emissions, especially when only in the last 5 years have electric cars made the advances in range and charge rate.

Another flaw that is anticipated to happen is that the infrastructure that is required to make this happen will not be ready in time, this is believed to be very ambitious due to the fact there is only 2 hydrogen refuelling stations for cars in Wales. Also, it is still uncertain whether car manufacturers will be able to enough zero carbon emission vehicles by this date, this is worrying as there has been mass delays over the last 2 years regarding brand new vehicles due to manufacturers not being able to get the materials required for the onboard electronics to build the vehicles.

This ban only applies to cars and light vans, and not to heavy duty vehicles, such as lorries and buses, these vehicles account for a significant portion of the emissions produced in the transport sector, which from the advancement's in the automotive sector it is believed that the commercial side will adapt that technology and advance on it based on their requirements.

The automotive manufactures are having to work faster than ever now to meet this deadline, many manufacturers have pledged to go fully electric prior to that date such as Jaguar Land Rover making that move in 2025 and Volvo in 2030, Audi in 2033 etc. These manufacturers are researching heavily into hydrogen fuel cells also, these produce zero emissions by generating electricity through a chemical reaction between hydrogen and oxygen to only produce water as a by-product, an example of this is the Toyota Mirai, however the only drawback of this is the lack of fuel stations throughout the UK, this type of vehicle could well be the future, however with the lack of infrastructure consumers will not purchase them.

Different energy Carriers:

Electric / battery powered vehicles:

The most popular alternative to a petrol or diesel fuelled vehicle now is electric, with Tesla being the leading manufacturer in this field producing over 3.6 million vehicles globally they have certainly made a dent in the automotive market, this leads to believe they must be doing something correct, and batteries must be a viable option it seems.

Electric vehicles use a large battery that is formed using lithium Ion, these battery cells are made up of a combination of different metals such as lithium, cobalt nickel, and aluminium. These metals are mined from many third world countries such as Chile, Bolivia etc, where their environments have been greatly impacted to meet the demand of the amount of lithium required by manufacturers.

These mines have a drastic impact on the atmosphere because many greenhouse gases are emitted during the mining process, especially as the electricity used in the mining process will come from a powerplant that is powered via fossil fuels, so this creates a continues toxic cycle.

Electric vehicles have suffered over the past few years with not being able to meet their quoted range that the manufacturer states are possible, this is why there is now a common test done by automotive reviewers called "real world range".

Electric cars energy efficiency is much greater than fossil fuel powered vehicles Electric cars are far more energy efficient (85-90% efficient) than internal combustion engine cars (17-21%), which means that they use less energy to get you from A to B. Less energy used means less produced, which in turn means less CO2 emissions produced by non-renewable energy sources and the wider energy supply chain (pod-point.com, n.d.). The reason ICE engines are far less energy efficient is due to some of the energy being wasted creating heat, sound and have a loss to internal friction.

Electric cars performance is unmatched in some parts when compared to ICE powered vehicles, this is due to the electric motors that power the wheels having instantaneous torque, this means rather than having to rev an engine out, these electric cars have full use of their total power output from standstill providing immense acceleration. They also support a low centre of gravity which makes driving stability greater as there is no weight above the wheels, so electric 4x4's do not suffer the same as ICE powered ones with the feeling of being top heavy or driving boat like.

One form of energy recovery systems that should be implemented within electric vehicles should be solar panels, these convert energy from sunlight into electricity which can be stored within the vehicles battery, this paired with regenerative braking will help reduce the amount of energy consumed in a complete drive cycle due to the vehicle receiving some charge while driving. Solar panels could also help charge the vehicle when parked in direct sunlight also, rather than having to park in a dedicated charge bay.

There are many forms of regenerating energy back into the vehicles energy storage system that are still not yet being placed into production vehicles. One form is regenerative suspension, this technology is done by using the movement of the suspension system to generate electricity to recharge the battery while driving, these should be implemented as they would improve the overall operating efficiency of the vehicle when it is under usage, therefore improving its overall energy efficiency. Considerable research has been carried out on energy harvesting suspensions. Zuo et al. [9] proved that the harvestable power in the suspensions of a middle-sized vehicle was 100–400 W, when driven at 60 mph on good and average roads. Zhang et al. [10] harvested 46 W from the suspension system of a passenger car. (Guo et al., 2021)

Hydrogen Vehicles:

Hydrogen powered vehicles have drawn a significant amount of interest since the government announced the 2030 ICE ban, this is because when built using a hydrogen fuel cell method they produce zero tailpipe emissions. This is ideally what the government is aiming for by prohibiting the sale of ICE powered vehicles that use petrol or diesel.

These vehicles are an ideal replacement for ICE powered vehicles due to them sharing the same characteristics as another, such as the owning experience, rather than charging the vehicle, a visit albeit different will still be made to a fuel station rather than a charger, and this can be refuelled in the same amount of time as a standard petrol or diesel vehicle.

However, the infrastructure is an issue with hydrogen, due to its storage, the form of hydrogen that would be used in cars and vans would be compressed hydrogen, this means that on board the vehicle there would be a compressed and pressurised tank carrying the fuel. Storing this at fuel stations means that all the tanks would need to be changed for high pressure capable tanks,

These vehicles seem to be far more superior to electric vehicles since they can be re-fuelled in a short period of time rather than having to wait for a charger which on a superfast charger can still take around 1 hour. Another benefit to using hydrogen rather than electric is that hydrogen isn't mined from the ground leaving catastrophic damage to ecosystems like lithium does, it can be formed in many clean methods such as electrolysis using electric from solar, wind etc so that it is completely green.

This paper will focus on FCEVs. There are two main reasons why FCEVs are superior to electric vehicles (EVs): 1) shorter refuelling times; and 2) longer ranges [6]. FCEV refuelling times are only a few minutes, while an EV needs several hours fully recharge. FCEVs are more efficient than conventional internal combustion engines vehicles and produce no tailpipe emissions, only emitting water vapor and warm air. FCEVs use a propulsion system similar to that of electric vehicles, where energy stored as hydrogen is converted into electricity by the fuel cell. Furthermore, they are equipped with advanced technologies to increase efficiency, such as regenerative braking systems that capture the energy lost during braking and store it in a battery [7]. (www.ieafuelcell.com, n.d.)

Consumer Engagement:

The motorsport industry is playing a crucial part in promoting emission friendly and electric vehicles, this is being done via promoting many events such as Formula E, this is a similar event to Formula 1, whereas it uses fully electric cars rather than ICE engines. This showcases globally the advancements and capabilities of battery powered vehicles in a dynamic and exciting event.

The motorsport industry has provided crucial technology that is required for fast charging abilities for vehicles and high capacities in batteries, these have therefore made electric cars more appealing and more useful to the standard consumer. One of the burning issues to defeat is the battery's 'thermal management'. Arnaud explains: "To reduce the charging time by three you increase the heat that must be removed from the battery by 10. "If you repeat the process of fast charging several times, you'll damage the battery quickly. With existing technology that's in the street today, I would say you have 2-3 maximum fast charges before you destroy the battery". Katy Brown Aviva (Sep 2022, 2022)

Motorsport events that include EV's have proven to be a very exciting area and draw a lot of attention bringing the manufacturers that also participate in standard formula 1, by bringing a brand to the event it will draw brand loyal fans and team supporters to watch and gain an interest for the event. One way that these brands could help is to advertise their electric vehicle range at the event and allow viewers and supporters to view the vehicles up front, rather than having to go to a dealership to see them.

By motorsport moving into the electric racing events this has forced more research in this area for the better, in order to get a longer range, faster charge time, better battery heat dissipation etc, these are all the worries manufacturers have that produce a high performance electric vehicle, this is often found with Tesla's where after some high speed driving that batteries can overheat. This means that the batteries must be kept from plummeting to below-freezing temperatures, and care should also be taken so that they don't overheat. Charging a battery at freezing temperature is not recommended; that is why some manufacturers offer options to prepare the battery prior to charging in freezing scenarios. (Ramos, 2022)

Conclusion:

To summarise in what direction, I believe the Government should be focused on at the current moment is hydrogen. This is because hydrogen is a far more superior option regarding zero tailpipe emissions, this is because it mimics the standard vehicle ownership that most of the population are used to, there is no need to have a charge point placed outside your home, no need to plan journeys prior to leaving the home to ensure there are suitable charge points along the way, this is dependent on petrol stations converting some tanks to store hydrogen in the future, which hopefully will be the change.

More funding needs to be allocated to research how to mass produce hydrogen in a green manner, this is to ensure we are not polluting the atmosphere anymore by creating the hydrogen, the same cannot be said for the production of lithium ion batteries.

There also is not a need to stop and recharge and wait 45 minutes to an hour on a fast charger that over many uses will damage your battery which results in lesser range gained per charge, this over the next few years I believe is going to become a mass issue amongst electric car owners due to them having a depleting range. There is no costly replacement for batteries when the cell eventually fails on the vehicle.

It seems that electric cars will be staying for a while as the government pushes for more and more chargers to be placed, however with the issues faced by them such as a charger being out of operation, charging bays being full etc, it seems that with more and more EV's being on the road these problems will only get worse.

For the future I anticipate that hydrogen will take over in the mass market of vehicles on the road, however there are hurdles to get over with the storage and distribution of the compressed hydrogen.

In my opinion the government needs to allocate far more funding into Hydrogen fuel stations and push these to be the future of cars, as no owner will suffer from range anxiety, or be required to change their daily plans to suit to how much time they'll need between places to charge the vehicle.

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