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Can fuels be pollution free and produce zero emissions?

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Abstract

This report is about searching whether fuels used in cars can actually be pollution free and produce zero emissions both in production of the fuel and its usage in cars. This question is important because when burned, some fuels produce harmful greenhouse gases such as carbon dioxide, carbon monoxide and sulphur dioxide, that cause global warming to occur as well as multiple health issues especially lung diseases to become more common. The word fuel connotes to any material that when burned produces heat or power. Pollution means the introduction of a substance into an environment which has harmful effects to it while zero emissions mean a road vehicle that emits no pollutants from its exhaust. The aim of this report was to find out whether different fuels such as biofuel, hydrogen, electricity, and fossil fuels can be used in cars to be pollution-free and have zero emissions.

Fossil fuels are finite sources that are used currently in cars, while being combusted to produce energy, fossil fuels such as petrol and diesel also produce carbon dioxide, sulphur dioxide and particulates if complete combustion occurs. If incomplete combustion occurs, then carbon monoxide and particulates are produced, which tells that petrol and diesel (separated out by fractional distillation of crude oil) are not pollution free with zero emissions.

Biofuels are used in two types: Bioethanol and Biodiesel. Bioethanol is made from plant biomass and is fermented to produce bioethanol that can then work in the cars. It is carbon neutral as the carbon dioxide used is then captured again by the plants. Biodiesel is made from vegetable oils or animal fats and then is reacted with methanol/ethanol to produce methyl/ethyl esters. As biodiesel is made from living matters, it contains a higher amount of nitrogen, which produces nitrogen oxides but biodiesel is biodegradable and produces more energy.

Hydrogen uses a fuel cell propulsion system that combines hydrogen produced through either reformation of methane or electrolysis with oxygen from the air to produce water and electricity. Hydrogen supplies the most energy but not all is used as it is wasted through the production of water. Electricity, mainly comes from coal but can come from renewable sources as well. If electricity comes from renewable sources, then it is pollution free with zero emissions but if it is generated through coal then greenhouse gases are released into the atmosphere.

All the above raise an important debate as to the most environment friendly fuel that prevents pollution, however none of the fuel are perfect and so a new hybrid fuel would have to be used (mixture of bioethanol and electricity) for a sustainable future.

Fossil Fuels:

Fossil fuels especially petroleum and diesel are non-renewable sources of energy, which are used in cars are found on the Earth as crude oil. The crude oil must be extracted from the ground before it can be separated into smaller useful hydrocarbons such as diesel and LPG (liquified petroleum gas). To extract crude oil, the ground is first drilled, which causes the crude oil to flow outwards by itself. After that, a pump must be used to pull out the crude oil, this stage is called the primary recovery and it can last for many years or decades. After crude oil is extracted, it is processed through fractional distillation where the heated and vaporised crude oil rises up a vertical column that has different fractions and the crude oil is separated depending on the hydrocarbon's condensing temperature (it is cooler at the top of the fractional column). The larger remaining hydrocarbons in crude oil then undergo catalytic or steam cracking to break them into smaller alkanes and alkenes such as petrol. The energy required to extract, transport, and refine the crude oil comes from either previously extracted crude oil or other fossil fuels such as coal. On average, US refineries extract 42 gallons of crude oil from which 19-20 gallons are refined to petrol, 11-12 gallons to diesel and 4 gallons jet fuel. [(13)]

Regarding usage of petroleum and diesel, a typical car can travel 30 miles (48.28 km) on 1 gallon, which is equivalent to 4.5461 litres. In cars, petrol allows for fact acceleration and has a quiet operation, according to University of Michigan. It is also readily available to be used in cars and the systems/ factories for refining and producing petrol are already in place. Petrol and diesel both require a four-stroke engine [(9)], which are already used in cars now days. In a four-stroke engine the piston moves twice in a four-sequence step through which energy is created in cars by burning the petrol/diesel in the combustion chamber.

The four-stroke engine, which involves: intake, compression, combustion, and exhaust works by the air mixing with the petrol/diesel and getting compressed inside the cylinder [(10)]- this is important because combustion occurs in the presence of air, producing an exothermic reaction, which produces energy [(7)]. In the power stroke(combustion), a spark is ignited in the mixture of air and petrol/diesel which causes combustion to occur. The waste products are then pushed out of the tailpipe/exhaust in the next step.

On the other hand, when petrol or diesel are burned the by-products of complete and incomplete combustion are released into the air through the tailpipe or exhaust. If complete combustion occurs, then carbon dioxide and water vapour is produced while if incomplete combustion occurs, then carbon monoxide and particulates such as soot and unburned hydrocarbons are released into the air. Carbon dioxide is a greenhouse gas that causes climate change through global warming, it is a non-toxic gas but can cause ocean acidification in excessive amounts [(14)]- it is noted that petrol- and diesel-powered cars produce 1.7 billion tons of carbon dioxide every year, according to the environmental protection agency [(12)]. Carbon monoxide is a toxic gas that is poisonous to humans while particulates are unpleasant to breathe in- causing lung diseases in humans. Oil also has impurities such as sulphur in it, these impurities are also burnt in combustion which produces sulphur dioxide [(8)], a colourless gas that forms acids when burned which can lead to acid rain or engine corrosion, and nitrogen oxides (the nitrogen is reacted from the air due to high temperatures of engines), a highly reactive gas that contributes to smog. [(14)]

While comparing diesel and petrol, petrol causes more air pollution and global warming as diesel usually has less carbon dioxide emissions but diesel does create more organic

compounds and oxides of nitrogen, which damage the Earth [10]. Diesel lasts longer than petrol as it has a 30% better fuel efficiency than in petrol vehicles [11].

Overall, petrol- and diesel-powered cars are not pollution free with zero emissions because air pollution through carbon dioxide, carbon monoxide and other products is created. This also shows that petrol and diesel cars are not zero emission either as they create pollutants while they are manufactured and while they are used. They are also non-renewable source of energy so they are finite and might run out if they are not used sustainably. While recommended, that they are not used for any longer, if they are used then cars could be fitted with special exhaust systems that can reduce air pollution by using a catalytic converter, which uses expensive transition metals as catalysts to change pollutant gases to less harmful gases such as: carbon monoxide + nitrogen monoxide --> (to produce) nitrogen and carbon dioxide. [7]

Bioethanol (Biofuel):

Bioethanol, a type of biofuel, is a renewable source of energy since it is made through the conversion of plant biomass such as sugar-cane, corn, barley, and other natural products. [9] Bioethanol is made through harvesting the crops, milling them to separate the starch, allowing the starch to ferment through yeast, distilling and then dehydrating the liquid produced to get rid of the water [15]. The energy required for distilling and dehydrating the plant biomass in the power plants would likely come from fossil fuels but the fermentation is done by yeast.

Bioethanol burns cleaner than petrol as it does not have any impurities that are usually found in crude oil such as sulphur. It also has a higher-octane rating than petrol, which helps prevent engine knocking [15] (engine knocking is a sound produced and occurs when combustion of fuel does not occur smoothly in the engine [16]). The higher-octane rating in addition with the fact that adding bioethanol in an engine has a better thermal efficiency so less energy is wasted- increasing vehicle performance. Next, to use bioethanol a new engine would not be needed as cars can run on 100% bioethanol but it is more used as an additive [9].

Bioethanol can also be blended with petrol so most cars can run on E10 (10% bioethanol added to petrol) and many cars accept E30 (30% bioethanol added to petrol) while it is researched by the Environmental Protection Agency that E85 (85% bioethanol) can also reduce fuel economy (how many miles can be done in 1 gallon) by 7 to 8 miles per gallon compared to petrol [15]. While burning bioethanol, it produces carbon dioxide and water vapour- the water vapour goes back into the water cycle whereas the carbon dioxide that is released is equal to the carbon dioxide captured by plants so bioethanol is carbon neutral as well as that corn-based ethanol production and use reduces greenhouse gas emissions by up to 52%.

On the other hand, bioethanol has an energy density (amount of energy store in fuel per unit volume) of 18.4-21.2 MJ/litres and a specific energy (energy content of fuel) of 23.4-26.8 MJ/litre, which is 34% lower than of petrol and diesel- this means that more bioethanol has to be combusted to produce the same amount of energy [19]. For the carbon dioxide produced to be captured again by plants, enough plants would have to be planted to ensure

that the levels of carbon dioxide do not rise as carbon dioxide is a greenhouse gas that causes lung diseases and global warming to occur.

Growing plants just for the use of bioethanol would also require a lot of land space and energy, which could threaten the food security of people as well as cause the bioethanol crop to be more susceptible to pests and diseases through the depletion of minerals from soil due to monoculture. This net result of effects would cause an increase in demand use of pesticides and fertilisers which would produce more carbon dioxide. [17]

Overall, cars powered by bioethanol are pollution free but do not fit the criteria of being zero emission because they do produce carbon dioxide, a pollutant, while they are run. They can be considered pollution free because bioethanol does not produce any air pollution causing substance except for carbon dioxide and as the carbon dioxide is used up again by plants in a continuous cycle, bioethanol fits the criteria but this would only be possible if enough plants are planted. If bioethanol is produced more often, it could be made through microalgae or even industrial waste. Producing bioethanol through microalgae would ensure people's food security as microalgae can be cultivated on a marginal land with lost cost. Microalgae bioethanol has a high conversion energy and a high energy density but it is less stable. [18]

Biodiesel (Biofuel):

Biodiesel is a renewable source of fuel as it is a mixture produced from vegetable oil such as sugar beet oil, rapeseed oil or animal fats through a reaction with methanol or ethanol to produce methyl or ethyl esters [20]. To make biodiesel, the lipids (oils and fats) are processed in pre-treatment to remove any impurities from it; water is also removed so that the triglycerides in the lipids do not break apart into soap instead of biodiesel through the process of hydrolysis. The sample is then tested through titration to determine the concentration level of fatty acids in it, after this the sample undergoes transesterification (the process to make completely saturated ester molecules) with the assistance of a base-catalyst to react the lipids with alcohol to produce biodiesel and glycerol. If the oil has a high acid content due to the fatty acids, then acid-catalysed esterification can be used to produce biodiesel [26]. While making biodiesel, heat energy must make new bonds between the alcohol usually ethanol and the oil (biodiesel). [21]

Concerning air pollution and pollutants produced, biodiesel burns cleaner because produces 2.52-2.59 kilograms of carbon dioxide for every kilogram of fuel burnt, which is lower than the carbon dioxide production rate for diesel and petrol [22]. Pure biodiesel has approximately 10 weigh percent (mass percentage- mass of solute divided by mass of compound) oxygen. This added content of oxygen in biofuel leads to less emission of hydrocarbons, toxic compounds, carbon monoxide and particulates. [20] Using biodiesel can lower the production of particulate matter emission by 47% and it has 4 times faster biodegradability than diesel so that 80% of carbon is converted by soil in 28 days.

Biodiesel is easy to use as no vehicle modification is required-it works on the engines already set up in cars now days [23] and it helps extend engine life-span as it eases the movement of engine by supplying a greater lubricating effect. It also has a better fuel

economy than diesel or petrol so it can travel more miles per gallon and it reduces dependence on imported oil, allowing the economy of a country to increase. [24]

Alternatively, biodiesel has a specific energy of 37.8 MJ/kg and an energy density of 33.3-35.7 MJ/litre, which is lower than diesel by 10.3 MJ/kg and 5.8 MJ/litre so more biodiesel is used to get the same amount of energy. As biodiesel is made from living matter, it has a large amount of nitrogen so when burned, it produces nitrous oxide, which is poisonous to humans and contributes to acid rain [22]. The continuous production of biodiesel could also result in excessive deforestation [9], which could cause food and water shortage- affecting the food security for many people. The use of monoculture, would increase the use of fertilisers and more energy would have to be spent on growing plus rearing the animals than what would be given out- less energy would be given compared to what has to be used.

Biodiesel is also expensive at the moment in terms of economy so people might not be able to afford it. It also has a difference in quality depending on the lipid used and how much oil is present in it plus biodiesel is known to freeze in cold weather making it harder to pump in the car. Biodiesel can cause clogging to occur in the car as the dirt cleaned from the engine can get stuck in the fuel filter- causing more money to be spent on fixing the car. [25] Methanol, which is a pollutant also has to be manufactured, which takes up energy and is added to biodiesel to reduce its viscosity.

Taking everything into consideration, biodiesel is a suitable alternative to use to petrol plus diesel and has more energy content than bioethanol but it is not pollution free with zero emissions as it produces nitrous oxide, a greenhouse gas that causes the depletion of the ozone layer and there is no method for it to be taken back into use. Even though biodiesel cuts down on other pollutants such as sulphur dioxide and carbon, it still does not fit the criteria of being a fuel that is pollution free with zero emissions. To limit the problem of food security and water shortage, animal and plant waste could be used instead of animal fat to produce biodiesel, in which the animal and plant waste would also be used up instead of getting thrown away (limiting the things that end up in dumps).

Hydrogen (Fuel cells in cars):

Hydrogen, an energy provider rather than a source of energy/fuel itself, can be made from renewable sources such as biofuel and solar powered but is mainly produced through non-renewable methods using fossil fuels as the base power [31]. When used in cars, the hydrogen in the fuel cell reacts with the oxygen in the air to produce electric energy that powers the car. The hydrogen is pumped into the anode side of the fuel cell, while the oxygen comes by the cathode. The anode with the help of a platinum catalyst removes the covalent bonds between the hydrogen molecules and the separates the electrons from it. (At the anode hydrogen is produced: $H_2 \rightarrow 2H^+ + 2e^{-}$). The electrons are then passed onto a separate external circuit to from an electric current. The hydrogen ions (without electrons) are then combined with the electrons to produce water by a reaction with oxygen [33]. At the cathode, water is formed: $½\ O_2 + 2H^+ + 2e^- \rightarrow H_2O$). (Figure 2)

At the moment, hydrogen is majorly produced through a method known as steam reformation of methane but it can also be made through electrolysis of water. In steam reformation of methane, an endothermic reaction, methane that comes from natural gas is heated with steam plus a catalyst to produce hydrogen and carbon monoxide: $CH_4 + H_2O$ (as steam) $\rightarrow 3H_2 + CO$.

Next, in a 'water-gas shift reaction,' carbon monoxide with the addition of steam is reacted to produce more hydrogen and carbon dioxide, then the carbon dioxide plus other impurities are removed to get pure hydrogen [29]. Electrolysis, on the contrary, uses electricity to split water up into hydrogen and oxygen ions. When electricity is passes through the water, the hydrogen ions lose become electrons and become positively charged so are attracted to the cathode, similarly the oxygen ions become negatively charged as they gain electrons so are attracted towards the anode. This splits up the hydrogen and oxygen available in the water.

While comparing the two production methods, steam reformation of methane has a net positive energy (gives out more energy than is used up), produces no negative emissions at end point and is less expensive. However, it produces carbon dioxide, nitrous oxides, and sulphur (as methane can have impurities) the methane can also leak plus fracking can occur. Electrolysis of water, alternatively, is also a net positive source of energy but only if renewable sources are used to supply the energy and it also has no negative emissions at end point. Nonetheless, if the electricity used comes from fossil fuels, then the carbon net goes up, in electrolysis 40-60% stored electricity is also wasted and if the efficiency is only 20% if burned in steam or Carnot [28].

Hydrogen has a specific energy of 120-142 MJ/kg, which is 3 times more than the specific energy of fossil fuels and releases the most energy at 144000 kJ/kg [30]. Fuel cells, (engine type to hydrogen) have a direct transfer between chemical energy to electric energy so the energy is not converted into heat first- this means that there are fewer transfer stages so less opportunity for energy to be dissipated to the surroundings and lost. Fuel cells are also less polluting as the only product of hydrogen is water, which is non-toxic and unharmful to the environment as the water goes back to the water cycle. Fuel cells are lightweight and compact so there are no moving parts in it (fuel cells have 1/10 as many moving parts as an internal combustion engine), this is helpful as the greater the number of moving parts, the greater the energy lost to heat due to friction [34]. Hydrogen/ Fuel cell does not emit any harmful emissions such as sulphur dioxide and it overcomes the limitation of an onboard battery. It is also a non-toxic substance as well as capable of generating electricity with up to 65% efficiency.

On the other hand, hydrogen has to be liquefied to be used as a fuel which causes its energy density to come to 8.5-10.1 MJ/litre, which is much lower than fossil fuels so more hydrogen would have to be produced and liquefied to be used as a fuel. When hydrogen is burnt, not all of the energy can be used as water is also produced as a by-product so most of the energy is lost [30]. To extract hydrogen, expensive methods are used, which then produce the same amount of carbon dioxide as burning fossil fuels [27]. Hydrogen is also unavailable in nature in a form that can be used easily so it takes more energy to extract hydrogen from methane and water than burning it provides.

The production of hydrogen also depends on availability of energy, which comes mainly from fossil fuels at the moment, which are a finite source that might finish someday [32]. Hydrogen uses a fuel cell propulsion system, so a new type of engine is needed [31,34], which means that the cars used at the moment would not be suitable- increasing the rubbish in dumping sites. Hydrogen is also difficult to store as it is flammable (so cars are more likely to blow up if an accident occurs) and has an exceptionally low density so when storing

hydrogen, some gas has to be evaporated (energy is lost) so the car could also lose half of the energy provided by hydrogen without being driven. [32]

In conclusion, using hydrogen in a fuel cell to power a car is zero emission at the end but produces carbon monoxide and carbon dioxide if it is being extracted through reformation of methane. If hydrogen is extracted through electrolysis, then it produces no pollutants but that would depend on where the electricity is coming from- if the electricity is made through fossil fuels then greenhouse gases would be released but if renewable sources of energy are used- then producing hydrogen through electrolysis would be pollution free and would have zero emissions. In future, hydrogen could be produced through bioengineered algae that could produce hydrogen as a product of photosynthesis or reactions in the algae. The bioengineered algae would then need a small place to grow and could produce hydrogen that could then be used as a transportation energy provider.

Electricity (as an energy provider for cars):

Electricity, much like hydrogen is a secondary source of energy which means that it has to be produced from different fuel/energy providers. Electricity is usually made from fossil fuels especially coal but it can be made through renewable methods such as solar, tidal, and geothermal as well- this means that electricity can be both renewable and non-renewable, depending on its raw production materials. The energy content in coal, main producer of electricity, varies from 10500 kJ/kg to 25000 kJ/kg, this means that if a 2012 Telsa Model S car is taken as an example, with a battery of 85 KW-h (kilowatt-hour) that runs 265 miles as an example- 11042.94 kJ/KW-h of heat energy is required to make electricity from coal (since coal has a heat value of approximately 20,000 kJ/kg to produce 1 KW-h, and 1 KW is 3600 kJ/hr plus the energy conversion efficiency is 32.6%, a heat input is required of 3600/32.6% = 11042.94 kJ/KW-h).

The main energy required to produce electricity comes from fossil fuel plants in which the energy conversion of coal takes place in two steps: firstly, the coal is combusted, which produces nitrous oxides, carbon dioxide and sulphur dioxide and then the coal is passed through the steam cycle. This causes the whole production of electricity to be 32.6% efficient (combustion is 88% efficient and the steam cycle is 32-42% efficient depending on the steam parameters so 37% x 88%= 32.6%) while the efficiency of petrol is 46.2%.[39]

As mentioned, as coal has an average heat value of 20,000 kJ/kg for 1 KW-h, only 0.552 kg of coal is needed to produce electricity at 1 KW-h [39] so only a small amount of coal is needed to produce a lot of electricity to power cars. Coal is also cheap to buy with the cost of coal per unit of electricity being 3.5 cents per unit. Next, energy sources for electricity can be directly introduced into the current electricity grid [31] so no new distribution system is required plus while uncoordinated charging of electric cars can cause a 7% national peak load, this could be solved by off-peak charging so no additional electricity generation would be required [38]- this shows that the systems and ideas for electric cars are already in place so to switch to them would not be hard for countries' economies. Regarding the environment, greenhouse gas emissions from electric cars depend on the type of fuel used so if renewable sources are used, then the emissions are 0 g km^{-1} so the production and usage would be completely zero emission [38]. Electric cars improve noise pollution, nitrous oxides emissions, carbon dioxide emissions [36] as they do not emit any pollutants directly into the air so electric cars have zero-tailpipe emissions. Once, the renewable energy provider has completed its

'energy payback' (time it takes to produce as much energy as it took to make them), then if an electric car is charged through that electricity then no-air pollution is created- either from car or from the power plant. [35]

Alternatively, when coal is burnt: carbon dioxide, carbon monoxide, nitrogen oxides and sulphur dioxide are created depending on the impurities in coal, which are greenhouse gases and cause global warming to occur- the greenhouse gas emission for coal or natural gas is 155 g km^{-1}, for creating electricity from an old coal-based plant [38]. Electric cars also release particle pollution from wearing tyres, brakes, and road surfaces- even when the electric motors are put into reverse braking, the extra weight of battery means more particle pollution is created in comparison to petrol/diesel vehicles [36].

The raw materials needed to build renewable energy providers/power plants take energy as well as are limited to how much energy they can produce as they are reliant on environmental factors such as how much sun shines through the day and where the power plants are placed. There is also a positive relationship between vehicle weight and non-exhaust fumes and as electric cars are 24% heavier, they produce almost the same amount of particulate matter emissions as a modern petrol/diesel car (only 1-3% lower)[37] .The batteries used to power electric cars also have environmental problems such as mining lithium from the ground to make them, which causes land pollution (destruction of habitats).

Overall, electric cars can produce no air pollution and have zero emissions if they are powered by electricity that is made from renewable power plant sources that have finished their energy pay-back. However, finding energy sources which match these criteria is hard because most electricity production is made through the combustion of coal, which means that the electric car is no longer air-pollution free with zero emissions (as pollutants are created when coal is burned). Next, some studies show that due to the heavy weight of electric cars, they produce as much particulate matter as modern diesel/petrol cars so for electric cars to be useful, car manufacturers would have to lower the weight of an electric car.

Summary Table

Fuel	Energy density (MJ/litre)	Specific energy (MJ/kg)	Cost per mile (£)	Emission of CO_2 (kg)
Fossil Fuel - Petrol	32-34.8	45-48.3	0.13	2.3
Fossil Fuel - Diesel	40.3	48.1	0.14	2.64
Biofuel- Bioethanol	18.4-21.2	23.4-26.8	0.21	0
Biofuel- Biodiesel	33.3-35.7	37.8	0.17	2.52-2.59
Hydrogen	8.5-10.1	120-142	-	-
Electricity (coal)	39.85-74.43	29.3-33.5	0.094-0.02	1.7-1.83

Conclusion:

After carrying out all the research on different fuels, it can be concluded that in an obvious manner, no fuel fits the criteria of being both air-pollution free and zero emissions because

pollutants are usually created in either the production of the fuel or their usage in cars. Fuels such as bioethanol are considerably better for the environment as while they do produce carbon dioxide, it is reused through the carbon cycle if the plants are regrown, similarly, electric cars can also fit the criteria but only if they are produced through renewable energy sources and they are lighter in weight. The worst fuel to continue to use would be fossil fuels as they are neither zero emissions and cause air pollution throughout their life even though they supply the most energy to run the car. The best cause scenario going forward could be to move away from fossil fuels and convert our energy production through renewable energy sources so that then the current coming in the electricity power plugs would be air pollution free with zero emissions. A new hybrid car could also be made that is lighter in size, to limit the amount of particulate emissions that could run on both bioethanol (as its main fuel) and renewable sources of electricity (to provide acceleration and fluidity of speed) so that the car would produce no air-pollution and would be zero emissions completely from production to usage. It would also be carbon neutral as the carbon dioxide produced would be used again in a cycle for new plants to photosynthesise. To enhance this research idea, recent technologies being used in cars could be looked at such as the use of electromagnets to run cars to produce hover cars (like the hover trains being used) and self-drive cars. Primary conducted experiments could also be carried out such as measuring the air pollution produced by cars averagely in a day (could not be possible now due to traffic being rare on streets).

Implication:

After looking at every fuel used at the moment, it can be concluded that no fuel is perfect as it produces pollution and emissions usually in usage or production. This means that the fuels used now in cars would have to be changed as they cause cardiovascular and respiratory illnesses as well as lung cancer in people, leading to reduced life expectancy of the overall population. The fuels used at the moment also cause first hand environmental problems such as smog, ozone depletion and global warming, which would cause a chain reaction of more environmental issues such as rise in sea levels. This tells that for 'future travel,' a new fuel would have to be used or a new type of car would have to be made that combines various fuels, in a way that produces the least amount of pollution.

My own solution:

A hybrid car that could run on bioethanol and electricity produced from renewable sources would be an ideal fit to the criteria because it would air pollution free due to the fact that if the electricity comes from renewable sources, no pollutants such as carbon dioxide are produced. To ensure the electricity is coming from a renewable source, the electric chargers could have a green symbol on them, which would inform the driver. While it would not entirely have zero emissions as carbon dioxide would be produced from the exhaust due to bioethanol, this gas could be recaptured and used by plants again in photosynthesis. The only problem this would encounter is that enough plants would have to be planted so that all the carbon dioxide produced could be reused to produce oxygen (photosynthesis)- this could be ensured by having a policy that would state that for every kilogram of carbon dioxide produced, a plant has to be planted or for every plant cut down for the production of bioethanol, two plants have to be planted in place. This hybrid car would use the

electricity for acceleration and speed due as electric cars have a higher acceleration rate due to their reduced drivetrain frictional losses as well as their immediate, smooth, and silent acceleration, which would cut down noise pollution as well. Regarding the engine, the hybrid car would have an internal combustion engine for the bioethanol and a smaller battery pack plus motor to run the electricity. This would be useful as most cars run on petrol have an internal combustion system so new cars would not be required (the same cars used now, can be used again with a little modification), which would keep the price of cars cheap and would be more convenient for people (so people are more likely to swap to this hybrid because not only would it be more sustainable but also accessible). The smaller battery pack would also keep the weight of the car lower, which means that the particulate emission rate would also be lower- further preventing air pollution and lung diseases from occurring.

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