IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

Human Journals
Short Communication
November 2021 Vol.:20, Issue:1

Are Electric Vehicles More Beneficial Than Traditional Vehicles?

IJSRM
INTERNATIONAL JOURNAL OF SCIENCE AND RESEARCH METHODOLOGY
An Official Publication of Human Journals

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Submitted: 21 October 2021
Accepted: 27 October 2021
Published: 30 November 2021

HUMAN JOURNALS

www.ijsrm.humanjournals.com

Keywords: Electric Vehicle, Hybrid Vehicle, Depletion of Petroleum Resources, Emission of Harmful Substances

ABSTRACT

Internal combustion engines that obtain power by burning gasoline or light oil have been commonly used for automobiles in the past. In recent years, automobiles have been developed that incorporate a new drive system or both conventional and new drive systems. These include electric, fuel cell (hydrogen), and hybrid vehicles, the latter using both electricity and gasoline. The use of electric vehicles is becoming widespread because of the increasing understanding of the finiteness of petroleum resources and the amplification of environmental pollution caused by combustion. Furthermore, the ban on the sale of automobiles with internal combustion systems such as gasoline engines is scheduled to be enforced in many countries by approximately 2030. However, there are some negative factors involved with the use of electric vehicles, and conventional automobiles or those with other drive systems may be superior in some ways. In this study, we organized these differences and reported on the results.

INTRODUCTION

The first car was introduced to the world in 1769 by the French engineer Nicolas-Joseph Cugnot. Prior to the development of automobiles, which reflected the mechanism of the steam engine, livestock such as cattle and horses transported cargo and people by pulling buggies. Recently, automobiles with various drive systems have been developed, whereas previously it was common for automobiles to have gasoline- or diesel-powered engines to operate. These vehicles obtained power by burning petroleum-derived gasoline or light oil and were designed to run independently. Currently, the industry is changing to devote more resources to developing automobiles with new or both conventional and new drive systems for the following reasons: A) Petroleum is a fossil fuel and therefore finite, and the small amount remaining on the Earth is likely to be exhausted soon; B) The combustion of gasoline and light oil produces carbon dioxide that contributes strongly to global warming, which is a worldwide environmental problem; and C) Air pollutants that have carcinogenic effects are also emitted by these vehicles. The alternatives to fossil-fuel-powered automobiles include electric, fuel cell (hydrogen), and hybrid vehicles that use electricity and gasoline[1),2)]. The threat of enhanced environmental pollution has led to Europe and the United States announcing a ban on the sale of internal combustion engine vehicles (mainly gasoline vehicles) by approximately 2030, and Japan is intending to follow[3),4)].

Based on the above background, we conducted a literature survey and summarized the results to clarify the types of newly developed automobiles and the differences in their environmental effects and costs. Since the details of the cost and fuel consumption of the car itself vary greatly depending on the current exchange rate and car model, detailed numerical values are excluded.

Types and differences in drive systems

The differences between various drive systems are described. Conventional gasoline and diesel vehicles require an engine, which is an internal combustion system installed in the vehicle. Within the engine, a mixture of atmospheric oxygen and gasoline or light oil, which is used as fuel, is ignited and burned to move a valve (cylinder) that creates the driving force for rotating the wheels[5)]. There are differences in the details of the engine, output at low rpm, fuel consumption, environmental performance, *etc*. In general, light oil is a cheaper fuel, and diesel vehicles are often less costly to maintain. However, gasoline vehicles have quieter engine noise, are superior in acceleration performance and stability at high speeds, and are considered to have a better ride quality than diesels[5)].

Eco-cars and next-generation vehicles have become popular in Japan in recent years, and energy sources and power generation methods vary depending on the type. These are called new energy vehicles. The first is an an Electric Vehicle (EV), which uses a motor driven by electrical energy without the use of gasoline; therefore, no refueling is required. The maintenance cost is not gasoline, but electricity. Electrical charging is performed using a public charging station in a shopping mall, parking area on a highway, or a household outlet. Public stations with fast chargers can refill a small rechargeable battery in approximately 30 min. New homes may be designed with a car charging outlet installed, but traditional homes are not fully equipped and these cars can only be charged at car dealerships or public charging stations.

The second is a hybrid vehicle (HV). As with conventional automobiles, it burns gasoline as an energy source to power the engine. It is also equipped with an electrically powered motor, which is only used as an auxiliary source in improving fuel efficiency. The car is not charged externally. Power is supplied by driving, as the vehicle generates electricity such as with the brakes. Since HVs are not externally charged as with EVs, gasoline costs only are required as the maintenance fee[6)].

The third is a Plug-in Hybrid Vehicle (PHV), which is sometimes referred to as a Plug-in Hybrid Electric Vehicle (PHEV). It is equipped with a function that allows the vehicle to be electrically charged while using the gasoline engine. The car can run on gasoline, but it also can use electricity via external charging, or internal power created while driving on gasoline. Generally, electricity is used at low speeds, which is switched to gasoline at high speeds, resulting in a good fuel economy. This will improve the short cruising range, which was a disadvantage of EVs while suppressing the high maintenance cost incurred by HVs; therefore, it that has the advantages of both vehicle types[6)].

The fourth is a Fuel Cell Vehicle (FCV). The structure is special compared to the previous three cars because it uses electricity generated internally as an energy source using hydrogen replenished from a dedicated hydrogen station. Therefore, even a car that uses the same amount of electricity does not require external charging, such as an EV or PHV. Since the fuel is hydrogen, the emissions consist only of water[6)].

Emission of harmful substances

Automobiles with internal combustion engines include gasoline, diesel, HVs, and PHVs. Among them, only diesel vehicles burn light oil, whereas the others use gasoline. As a result of fuel combustion, harmful volatile substances, dust, and carbon dioxide, which have been related to global warming, are contained in the exhaust. While gasoline and diesel vehicles obtain driving force exclusively from internal combustion engines, HVs and PHVs are also powered by electricity. Gasoline consumption can be reduced in these vehicles according to the amount of electricity used, thereby decreasing the direct emission of harmful substances. Conventionally, diesel vehicles emit a greater amount of harmful substances, including dust, which adsorbs and stabilizes these substances, and then scatters them into the atmosphere. However, diesel has been improved in recent years, and the amount of dust generated has decreased to a level similar to that produced by gasoline vehicles (clean diesel vehicles)[5)]. The emissions of harmful substances are generally: diesel ≥ gasoline> HV> PHV. As will be described later, the above-mentioned information relates only to harmful substances that are directly emitted from the automobile. Since FCV also oxidizes hydrogen to generate water, it can be considered to be a burning mechanism; however, FCVs do not generate other substances and the emissions are not harmful. EVs only charge externally; therefore, there is no burning process involved, and it appears as though no harmful substances are generated, but the method of production of this electricity also needs to be considered. Currently, thermal power generation is the main method used in Japan, and this generated electricity is transmitted to the power supply point for the automobile; therefore, the electricity received was generated from the combustion of heavy oil at the power plant. These plants produce a large number of harmful substances; therefore, it cannot be said that EVs are harmless. The degree of harm depends on the basis[7),8)]. Considering the amount of oil required to generate the level of electricity required for driving, the energy conversion efficiency of EVs is high, and the consumption of oil is low. For example, data on the fuel purchased by consumers and the related mileage are: FCVs cost USD 0.065 to drive 1 km, while gasoline cars cost $ 0.09, and electric cars cost only about $ 0.03[7)]. Since this is based on consumer burden, the amount of oil used to make electricity should be taken into account. This value appears to include the cost of the power transmission. However, one report states that there is little difference in energy consumption considering that the power plant produces excess electricity and stores or transmits electricity in advance at the power supply point[1),9),10)]. The report states that EV and gasoline-powered vehicles require similar amounts of oil to travel the same distance, and total emissions of toxic substances may not vary substantially. From the consumer's perspective, EVs have a lower fuel burden, so they have less of an environmental load and contain a decreased level of harmful substances, but this is because the companies responsible for the power generation cover the cost burden of stand-by.

Differences in expenses for each car type

As mentioned earlier, costs vary depending on the drive system. However, even with the same system, there are differences in fuel efficiency, vehicle purchase cost, *etc*., depending on the vehicle type. A comparison of the average values is not relevant; therefore, we will give a brief overview and introduce only the characteristic features. An overview is provided in Table 1. The cost of purchasing a vehicle tends to be lower for existing automobiles than previously. Gasoline and diesel vehicles, which have been competitively developed for many years, are generally cheaper, while newer FCVs and EVs tend to be more expensive. Since multiple manufacturers have started producing and selling EVs to some extent, their prices may decline in the future. As for fuel, EVs are cost-effective, as mentioned previously. FCVs also have relatively low fuel costs, but since only a small number of manufacturers are developing these vehicles, their prices remain high. For EVs and FCVs, it is necessary to replenish electricity or hydrogen, respectively, but it is challenging to find a place in Japan that provides these options. Diesel vehicles incur the next cheapest fuel costs, and gasoline vehicles, HVs, and PHVs are considered to be the least expensive, but the costs of the latter two can vary depending on the amount of electricity used. PHVs may reduce fuel costs more than diesel vehicles.

Ban on sales of internal combustion vehicles

In Japan, shocking news emerged on December 3, 2020, that by the first half of the 2030s, domestic sales of gasoline vehicles will be banned[3),4)]. This is part of the “carbon neutral (zero greenhouse gas emissions as a whole)” plan recommended by the Japanese government. However, the government has not yet officially announced this decision, and it appears that some of the measures for reforming the automobile industry led by the Ministry of Economy, Trade, and Industry have been leaked to the media. Therefore, the likely interpretation is that the exact date for the ban has not yet been determined. In addition, not only gasoline vehicles but also diesel may be included because they have an internal combustion system. Nevertheless, Japan is expected to follow the global trend and accelerate the tightening of regulations that promote the electrification of automobiles. According to regulations related to EVs overseas, in 1990, the state of California in the United States stipulated a ban on the sale of internal combustion engine vehicles (mainly gasoline vehicles) by 2035. China will sell only EVs and HVs as new vehicles by 2035, and European countries will also shift to EVs, considering carbon dioxide regulations. France plans to ban the sale of gasoline and diesel vehicles by 2040, and the United Kingdom intends to ban gasoline and HV sales by 2035[3)].

The Ministry of Economy, Trade, and Industry of Japan compiled a target in 2018 for the spread of next-generation vehicles, including EVs. By 2030, conventional vehicles (gasoline vehicles and diesel vehicles) are expected to account for 30-50% of the total market, with the remainder as other next-generation vehicles. The breakdown of next-generation vehicles in the market is 30-40% HV, 20-30% EV, and approximately 3% PHV, and FCV [4)]. The new regulation does not impose a penalty on automobile manufacturers if it is not achieved; it is currently just a goal. However, if the abolition of gasoline vehicles becomes mandatory by the first half of the 2030s, the number of next-generation vehicles is expected to increase by more than double the current count. However, regulations at the national level will only be applied to the sale of new cars. Automobile manufacturers are obliged to comply with this regulation, but consumers are still able to purchase a conventional type of used car. Furthermore, gas stations will also be affected as a whole. Currently, there are many gasoline and light oil providers, but it is conceivable that they will gradually shift to the sale of electricity and hydrogen. Depending on the acceleration of the progression and level of the inconvenience of refueling, this will greatly affect the use and purchase of gasoline vehicles, diesel vehicles, and next-generation vehicles that require partial refueling.

Disadvantages of EV

Sales of automobiles with only internal combustion engines, such as gasoline and diesel vehicles, will be curtailed by 2030, and will eventually disappear. In addition, sales of next-generation vehicles that rely on gasoline internal combustion engines will likely gradually decline in the future. As a result, EVs will become mainstream, although there are some obvious issues with EVs that we will identify.

The EV uses the electricity supplied to the charging station to drive the motor. The performance of this rechargeable battery is affected by a temperature similar to a conventional battery, and it is difficult to sufficiently charge at temperatures below the freezing point. Therefore, the performance is likely to decrease with declining temperature in the winter. Another mechanism is required to control the temperature of the storage battery in these conditions. In addition, the rechargeable battery gradually deteriorates through use and aging, and costs relating to replacing the expensive rechargeable battery need to be considered in addition to the cost of the vehicle itself. This deterioration is thought to occur more rapidly than with gasoline vehicles, and even if power is supplied over the same amount of time, the distance traveled will be substantially shortened. Significant deterioration in driving performance can result, such as the inability to reach the destination. This may lead to future restrictions in that the vehicle can only be used for short-distance travel.

Internal combustion vehicles generate driving force by burning fuel on demand[8)], while EVs charge at one time and use electricity at another. Therefore, a power plant that supplies electricity to a charging station, or the like, must always produce or transmit electricity to prepare for charging to occur. However, even the location and amount of electricity needed are known, and electricity is prepared according to this demand, it is difficult to perfectly match the supply amount with the demand amount. In addition to EVs, there is a need for electricity for household and workplace electrical products, which fluctuate depending on the season, day of the week, and time of day. Not all the electricity generated for driving a car is used, and there is a loss in power generation, power transmission, and power supply that requires a large amount of electricity to be prepared. If electricity is stored in a car and not used, a loss in the storage battery occurs over time[8)]. To comfortably use the car, many power supply points are required in the immediate vicinity, so that it can be charged at any time. Unless improved infrastructure for that purpose is created or thermal power generation using oil is abandoned, the substantial effort will continue to be spent searching for power supply points.

It takes a relatively long time to charge an EV. A large-capacity storage battery that can secure a long cruising range takes more than an hour to fully charge, which is much longer than refueling with gasoline. Not only does normal charging require time, but if the charge is insufficient for the car to run, it takes a substantial amount of time to charge it to a level where it can be self-propelled. Such a situation occurred in Japan during a winter traffic jam on the highway. Gasoline cars can run if they are refueled in a short time, but with electric cars, it is difficult to remove the storage battery, which may lead to long-term and large-scale traffic jams on the road.

CONCLUSION

In terms of the burden on users, maintenance costs may be cheaper for EVs in the future; however, in terms of energy conversion efficiency and energy consumption, EVs are not always superior. As explained about the PHV, data are stating that using electricity is efficient in the low-speed range, and gasoline is better at high speeds. However, considering the problem of obtaining gasoline and the conversion from thermal power generation, it is unavoidable that the number of vehicles that consume oil will decrease due to the shift to EVs or the development of a completely different drive system.

In our opinion, EVs are currently still expensive and there are few charging places. In addition, there are problems with poor performance in winter. These challenges need to be promptly resolved before moving toward a ban on the sale of gasoline vehicles. EVs are not ready at this point. If such a shift must be made, it is necessary to be able to use EVs as economically, conveniently, and comfortably as possible, and to avoid inconvenience in terms of fuel supply; therefore, the ban on new car sales of conventional cars should be implemented promptly so that these needs can be fulfilled.

REFERENCES

1) Keita Ishizaki, Masaru Nakano. The environmental performance of current mass-produced passenger vehicles in Japan. Bulletin of the Japan Society of Mechanical Engineers. 2018; 84 (866), 1-17.
2) Will the shift to electric vehicles get into full swing? -High energy efficiency and reduce oil demand. Huffpost, published October 27, 2017, https://www.huffingtonpost.jp/shinrinbunka/ev-car-economy_a_23255037/ (browsed September 2021).
3) How long can you ride a gasoline car? -What happens to HV cars and stands due to the ban on sales? gix's blog, news, published December 8, 2020, https://goldencup.jp/2020/12/08/gasorinnsyaitumade/ (browsed September 2021).
4) Kenji Momota. The reason why the government announced the "2030 gasoline car ban" -Manufacturers' strategy revision is indispensable due to sudden policy change. Toyo Keizai Online, Forefront of automobiles. published December 8, 2020, https://toyokeizai.net/articles/-/394007 (browsed September 2021).
5) [Diesel engine vs gasoline engine thorough comparison] What is the difference in fuel efficiency and maintenance costs? Moby, Cars are interesting, published January 22, 2017, https://car-moby.jp/article/car-life/useful-information/light-oil-engine-vs-gasoline-engine/(browsed September 2021).
6) EV, HV, PHV, ECV -The performance of the "new generation" is seen by comparing four eco-cars. Energy Saving.com, published May 20, 2021, https://www.shouene.com/v2h/v2h-knowledge/compare-eco-cars.html (browsed September 2021).
7) Comparison of fuel prices for hydrogen vehicles, electric vehicles, and gasoline vehicles! -Is the car's fuel the cheapest? Car Insurance Guide, Saving car maintenance costs, https://www.car-hokengd.com/saving-ijihi/fuel-compare/ (browsed September 2021).
8) Is EV (electric vehicle) really the final solution to environmental problems? -What about the thermal efficiency of EVs? Motor-Fan Tech., Cars are more interesting when you understand technology, published July 11, 2018, https://car.motor-fan.jp/tech/10004809 (browsed September 2021).
9) Yoshiaki Fujii. Energy consumption, carbon dioxide emissions, and cost of electric vehicles. Proceedings of the 2010 Annual Meeting of the Mining and Materials Processing Institute of Japan, 11. Material edition, p.143-144.
10) Do electric vehicles consume more oil than gasoline vehicles? Smart Japan, published July 12, 2013, https://www.itmedia.co.jp/smartjapan/articles/1307/12/news107.html (browsed September 2021).

Table 1 Differences in-car drive systems

Car type	Gasoline	Diesel	EV	HV	PHV (PHEV)	FCV
Internal combustion system	○	○	×	○	△	○
Need for charging/power generation	× / ×	× / ×	○ / ×	× / ○	△ / ○	× / ○
Fuel	Gasoline	Light oil	Electricity	Gasoline	Gasoline and electricity	Hydrogen
Vehicle body price	Medium	Somewhat low	High	High	Somewhat high	High
Fuel economy	Medium	Low	Low	Somewhat low	Somewhat low	Somewhat low
Maintenance costs	Medium	Low	High	Somewhat high	Somewhat low	Low
Basic mechanism	Burn gasoline to gain driving force	Burn light oil to gain driving force	Drive the motor with charged electricity	Mainly driven by gasoline. Charge when using such as with brakes and used as an auxiliary force.	It enables both gasoline and electric driving. Electricity can be charged from a plug, and gasoline	It burns hydrogen to produce electricity and drives the motor.

					can also generate electricity .	
Car generation	1 (old to current)	1	2 (current)	2	2	3 (current to next)
Current features (other than cost)	[standard]	Environmentally friendly. Not good at high speed. Engine noise and vibration are loud.	Short cruising range. Takes time to charge	Similar to a gasoline car, but the fuel consumption is slightly reduced by the amount of electricity generated.	Since it can run while generating electricity, it has a long cruising range.	There are a few vehicle types to choose from. Low penetration rate of hydrogen station.

〇 indicates Yes, ×indicates No, and △ indicates Yes in some cases.

Based on the contents of references 5) and 6).