

Reality and Virtuality of Electric Vehicles

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Abstract

Electric vehicles are expected to contribute to a better environment and lower dependence on oil and this new boom has already begun. In this paper, the real possibility of electric vehicles and the impact on the Japanese and American automobile industries due to EV development in the future are described. The long history of electric vehicles as future mobility has been paid attention for more than 100 years. The performance of the battery has been the key issue to EV development. As discussed later, however, current battery performance is still completely insufficient compared to the performance of gasoline. So, it is important to clarify what electric vehicles can do and also to know what is impossible to contribute to solve the issues. In a publication by Minami and Chan [2009], titled "Current status and future of electric vehicles", 50 % is used to describe the current technologies of EV and another 50 % is used to write what EV could do. In recent international conferences on electric vehicles, the main theme seems to have shifted from the technological aspects to the ability of EV contribution to the future mobility. Amid concern over the depletion of oil resources, the development of electric vehicles as an important means of transport will support the future of civilization. It is pointed out here that electrification of passenger cars cannot contribute to solving environmental issues in advanced countries. To solve environmental issues of NO_x and PM, which are the main issues of environment in advanced countries, it is essential to perform electrification of big trucks and buses, because these are emitted by such heavy duty vehicles. Due to the insufficient performance of batteries, it is difficult to develop electrification of such heavy duty vehicles. One fact is shown based on the data of Japanese and overseas markets of forklifts. It is concluded that the electrification of passenger cars does not contribute to environmental issues and little effort can be made to save the waste of fossil fuels. It is very important for governments and automobile industries to notice what they are expecting about electric vehicles. There have so far been no such political actions in Japan.

Keywords

electrification, reality of EV, political issue, environmental issues, electric forklift

1. ABILITY OF ELECTRIC VEHICLES

The features of electric vehicles are described as follows:

1.1 No exhaust emission and quiet running

Electric vehicles are often considered to be the best solution to environmental problems. It is true that electric vehicles do not emit exhaust gas when they are running. This is a good feature for not only people in the vehicle, but also for people around. In my neighborhood, there is a man who has been riding an electric motorcycle for a long time, and he patrols to protect children during the morning school commute. When I met him, we could stand talking in the crisp morning air unpolluted by exhaust gas. If his motorcycle is a two-cycle engine, the mood would be ruined with exhaust gas.

The owner of an electric vehicle does not feel the benefits financially, because the exhaust gas of current



Fig. 1 For roofless boats, the benefits of electrification are greater with no exhaust emission (Osaka City University)

engines in Japan has already become cleaner and also superior sound insulation means no noise from outside. Only money spent on electric motorcycles and electric motor boats is appreciated. (Figure 1)

Why do people make and buy electric vehicles? It is important to clarify some points. There are many advantages. I think that the best merit is the contribution to a lower dependence on oil. I personally own some electric vehicles; however, I am not concerned

about quiet driving or no exhaust emission. Gasoline vehicles have achieved the level of being sufficiently quiet, and on the other hand, I feel that the noise from the tires of electric vehicles is enhanced instead.

The hybrid vehicle “Prius” is an excellent vehicle. During driving, the driver is not aware that he is driving a hybrid vehicle. The maximum potential performance of engine mechanism and control system can not be manufactured by a maker without such high technology. Also, it is difficult for electrical manufactures to enter the field. If there is enough oil for forever, Toyota’s current high position will continue. However, it is not so easy to generate new energy instead of oil. So, this is the reason to continue the development of electric vehicles.

1.2 Good efficiency

The efficiency of an electric motor is nearly 100 %, however, a gasoline engine is only about 20 %. Recently, the power efficiency of a thermal power station is over 50 % because of great effort. Comparing the total efficiency of the same oil consumption, an electric vehicle with a battery is higher than a gasoline vehicle. The battery is a higher cost, and also the cost of battery replacement is necessary. The ideal is to run without a battery, and the trolley bus is such an example. The greatest type of transportation is railway. Although not well known, a 250 ton train (30 ton weight of 8 carriages) can be run for the cost of about 10 JPY for 1 km. However, it is difficult to control the consistency of the number of passengers, and the automobile can travel from door-to-door with privacy, therefore, the automobile market can not lose.

The reason why trains have good efficiency is because they drive on rails without much friction, and also, they can exchange kinetic energy to electric energy. It is possible to achieve speed only through inertia at long distances without the use of electricity after ac-



Fig. 2 A photograph of tram and trolley bus

celeration (for example 80 km/h) if there is little friction. If the speed is around 5 km/h, it is still possible to decrease speed with full power generation (Figure 2). Even if 100 % regeneration braking is made possible in the case of an automobile, much energy is lost by the friction with the road, and only approximately 40 % becomes fuel-efficient. Furthermore, when it is a regeneration braking in mud, there is a braking lock of the driving wheel and the car skids. Even though engineers are aware of this, commentators do not usually know this. Also, they praise regenerative braking, but it is never the work of magic.

1.3 Good controllability

Electricity can control delicately. In the past, the accelerator wire and carburetor were connected, but now, the current vehicle is controlled with valve and fuel injection by an electric signal when the accelerator pedal is pushed. The hybrid vehicle which has an engine and motor can not work without an electric signal. As an example, in our laboratory, it was demonstrated that a passenger car can be controlled by a driver’s pedaled motion. A small generator is rotated by foot and the generated voltage is fed into a vehicle to control the acceleration. It is aimed to improve a lack of exercise cancellation while driving. In the future, the steering wheel and hydraulic brake of vehicles will be controlled by an electric signal. These matters are because it is easier to control with an electric signal. The ultimate technology is for using an auto-pilot or formation driving with a navigation system. However, it may not be possible to introduce these systems in the same way as airplanes which have no cost limit.

2. DOES THE ELECTRIC VEHICLE CONTRIBUTE TO THE ENVIRONMENTAL IMPROVEMENT AND LOWER THE DEPENDENCE ON OIL?

Regarding the development of electric vehicles, a contribution to the environment is said to happen immediately. The lithium-ion battery of an electric vehicle carries only 1/10 of the energy of the theoretical capacity compared to a gasoline engine including less efficiency. Figure 3 shows the NO_x emission source of the vehicle in Japan. The NO_x becomes the cause of asthma, but diesel vehicles, such as almost all large-sized buses or trucks, are outbreak sources. Figure 4 shows that fine particles (PM) that appear from 100 % of diesel vehicles are the cause of hay fever.

When we think about the battery price and the exchange maintenance cost, it is not possible to think that electric trucks and buses that are loaded with a large quantity of batteries will spread. The Japanese atmosphere is clean enough, therefore, the light

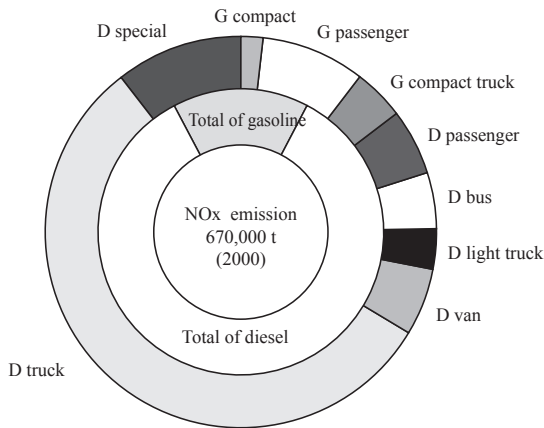


Fig. 3 Ratio of NOx emission source of the car in Japan

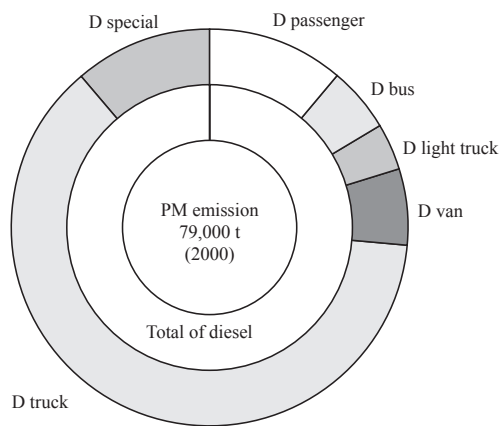


Fig. 4 Ratio of PM emission source of the car in Japan

weight electric vehicle will be unable to contribute to the exhaust problem of NOx and PM from vehicles. Fuel efficiency is surely a splendid thing. Therefore it will contribute to a lower dependence on oil if electric vehicles spread. This is the ability of the electric vehicle.

3. IS THE ELECTRIC VEHICLE A FAIR WIND FOR THE AUTOMOBILE INDUSTRY?

The electric vehicle is comprised of a battery, a motor and a current controller, and the feature is that it is simple. Besides, it becomes the best environmental conformity vehicle without depending on the maker. It is different from the gasoline vehicle. Under the present environmental standard and mileage performance, it is found that the vehicle made in a developing country does not become a seller in the developed countries, such as Japan, the United States and Europe.

Therefore, with China in the lead, developing countries work on the development of the electric vehicle very eagerly. The automobile industry of Japan protected itself with the superiority of an engine technol-

ogy. If electric vehicles take over the market, their position will decrease. In addition, everyone thinks that such a vehicle will take over the Japanese market. However, there are only a few automobile makers thinking seriously in Japan. They think that such a vehicle, which has a lack of safety functions and not good design sense, would not be acceptable for the buyer. It is great optimism.

It is said that the future bipolarization of the vehicle will be the cheaper vehicle and the high-performance vehicle. At this moment, markets in developing countries still need rather larger vehicles. In the future, the vehicle which the actual market demands is cheap and simple. The reason why televisions sell well is because no one has a television in the country. I think that nobody will buy the television without a change to the digitalize system even if the image quality is bad.

It is the same situation for the vehicle, too. In the current Japanese market, there is a phenomenon of (1) young people who are not interested in cars, (2) cars are just a method of travel, so it is not necessary to change the vehicle when just a model change is made, and (3) vehicles are long-life. In such a market, a high-performance vehicle may be sold to some special people, but such a market will also shrink.

Even to export overseas from Japan or America, there are already cheap electric vehicles in other countries. The Japanese automobile industry should forget the way of the 20th century and reorganize a new style. If not, it will meet the same fate as the camera makers Leica and Zeiss when they lost to the Japanese single-lens reflex camera. The time of electric vehicles is not a fair wind for the Japanese automobile industry, but will also bring a severe situation. The company that worries about this situation will continue to have depressed days and the company that is optimistic will have no tomorrow.

4. FUTURE ELECTRIC VEHICLES

Concerning the spread of electric vehicles, there are various predictions. The following points are my opinion. The diffusion rate of the electric vehicle has not reached 1 %, and the future spread will be decided by various factors. The battery performance is important. The degree of spread of forklifts, which have a market for both engine and battery types, serves as a reference for the future of the electric vehicle. Figure 5 shows the ratio of spread of engine and battery types in Japan. It seems that all vehicles will change to the battery type. As show in Figure 6, the gasoline type decreases with the increase of the battery type. However, the diesel type does not decrease in the same ratio. It is because there are still cost difficulties for

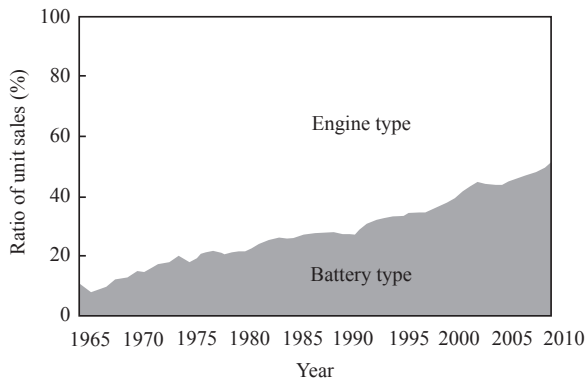


Fig. 5 Unit sales of forklifts in Japan

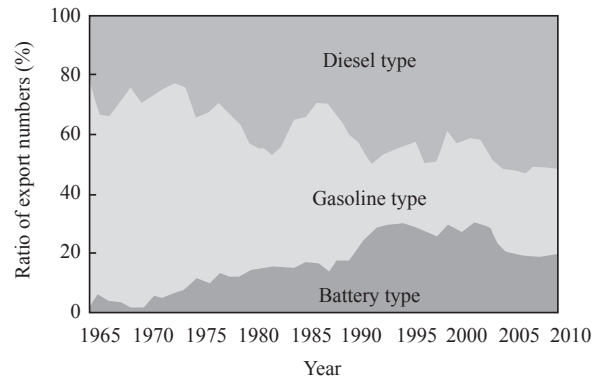


Fig. 8 Ratio of forklift export number

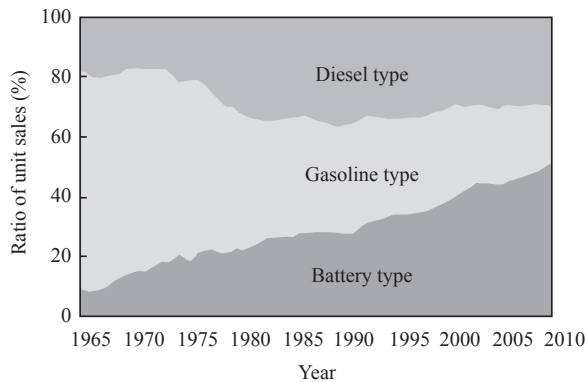


Fig. 6 Ratio of unit sales of forklifts in Japan

electric motion of large-sized forklifts.

As for the market overseas, Figure 7 shows export numbers of forklifts to foreign countries. Battery types seem to increase steadily. However, to see the ratio, the increase of diesel types is greater as shown in Figure 8. This is because the cost of diesel types for heavy duty is cheaper than battery types. The world gives priority to cost over environment, and this tendency is stronger in developing countries.

As for the future electric vehicle, this fact suggests that the compact car may change to electricity from gasoline, however, there are practical difficulties with

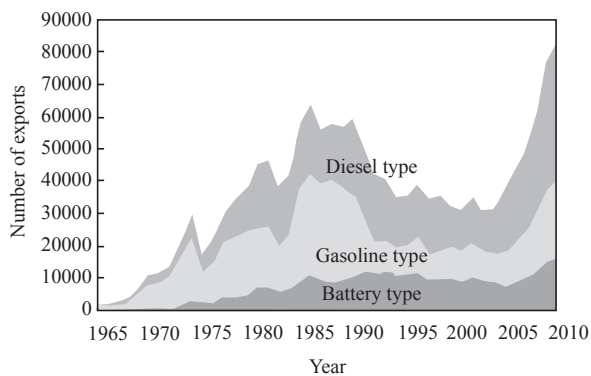


Fig. 7 Export number of forklifts

electrification for large-size vehicles. Also, if it is not possible to use large-size electric vehicles, there is no merit for the environment.

5. CONCLUSION

Recent electric vehicles are new products in a sense. However, for the automobile industry such as in Japan, which prospered with the superiority of the gasoline engine, it is not a business chance but a menace. Japanese consumers purchase a vehicle without thinking about the immediate loss and gain and they should support the industrial prosperity which indicates the big ratio of the GDP at present. However, misconceptions, such as “car sharing” which can reduce the maintenance cost, have appeared. The vehicle is sold in large quantities, so the price becomes cheaper. Even though the automobile industry makes an effort, the consumer wants to get the benefit without knowing their effort. The business which doesn't think about such an economy is only a niche business. Surely, “car sharing” has a value in the meaning of experiencing an electric vehicle. However, such egotistic thinking of engine vehicles is negative for the spread of electric vehicles.

The electric vehicle features a low electricity bill and expands sales. It is the same as 100 years ago. However, in order to buy economically, it does not hold well when the cost of battery exchange is considered. Currently, the meaning of buying an electric vehicle is to support advancement.

Only electric vehicles make it possible to be used in the situation of underground or tunnels. So, there is such a market for only electric vehicles. However, there is no reason for all vehicles to change into electric. It is important to make the purpose clear. Regarding China, as for the electric motorcycle, the number of sales has reached 100 million already. In China, each city is forced to change to electric motorcycles. Through so much change of such electrification, it will be possible to finally solve the lower dependence

on oil and environment issues of exhaust gas from 2 cycle engines. Compared to this example, the Japanese government and automobile industry do not have the measures or the passion to promote the spread of such electrification with a clear purpose. Even if it is possible to buy an expensive electric vehicle with a subsidy cheaply, it does not hold good for the spread period. Now, discussion should be about what electric vehicles can do or can not do, this is required in predicting the future of the automobile industry in Japan.

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