COMMUNITY ESSAY

Sustainable approach to automobile society in Japan

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What is the difference between electric vehicles (EVs) in society and an EV society? “EVs in society” means simply the replacement of gasoline-powered cars with EVs without taking into consideration pervasive social issues. By contrast, an “EV society” is a concept whereby EVs are more fundamentally woven into the fabric of society with the aim of solving a range of social problems, while at the same time questioning the meaning of what an automobile “is” and “can be.” It is this “game-changing” principle of integration that drives our research.

Introduction

The number of private cars in Japan grew from approximately 2.3 million in 1966 to 58.1 million (including 17.3 million mini-cars) in 2009. This huge increase has led to a car society in which cars have a dramatic impact on socioeconomic systems such as housing, industrial activity, and health services. The annual volume of carbon-dioxide (CO2) emissions from the transportation sector is 236 million tons and accounts for about 20% of total releases in Japan (1.2 billion tons in 2008). About half of the CO2 emissions from the transportation sector come from private cars, amounting to some 10% of the country’s total volume.

Against this backdrop, Japan has had considerable interest in electric vehicles (EVs) for some time now. Besides an improvement in battery performance, EV developments in Japan include the provision of grants and subsidies for purchasing EVs and an increase in the number of battery chargers. However, these activities are based on the conventional idea that EVs should simply replace current gasoline-powered vehicles. This approach will be inadequate given the existence of more penetrating social problems such as an ageing society and excessive energy consumption. “Game changing” is therefore essential when thinking about developing a sustainable automobile society and calls for EVs with performance and convenience characteristics similar to current gasoline-powered cars. However, a different view is needed, one that no longer favors the personal car, which is likely to gradually fade out with future social changes. If this happens, a different kind of vehicle will spread. We argue that this new mode of mobility will be produced and integrated into society in response to radical changes such as an aging society, oil depletion, and altered purchasing behavior of young people. The traditional “current approach” outlined in Figure 1 to “energy scarcity” includes simply replacing cars powered by combustion engines with EVs. However, the new, game-changing approach integrates the features of EVs with social issues. Therefore, “EVs in society” and an “EV society” are radically different approaches, changing the meaning of what an automobile “is” and “can be.”

This interweaving of social issues with technological innovations is discussed extensively in the literature on sociotechnical transitions. Basically, a “transition” refers to a long-term change in an encompassing system that serves a basic societal function, a change that dramatically alters both the technical and the sociocultural dimensions of such a system (Elzen & Wieczorek, 2005). Much work has been conducted on the conceptual refinement of transition pathways, and it may therefore be helpful to view this “game-changing” attitude within the context of such research. The so-called multi-level perspective (MLP) outlined by Geels & Schot (2007) is especially helpful. The key feature of the MLP is that system innovations occur through the interplay of the dynamics between multiple levels.
First, the meso-level describes a specific social-technical regime, which in the case of this essay would be characterized by the current gasoline-powered automobile and its associated social and infrastructural system. Second, the macro-level is the socio-technical landscape, which describes factors that influence a variety of regimes: for example, social demographics, public concern about climate change, and so forth. Indeed, as Geels & Schot (2007) state, “changes at the landscape level create pressure on the regime.” Finally, the micro-level of the MLP refers to technological niches in which radical innovations—for instance related to EVs—are incubated.

According to this multilevel perspective, transitions occur through interactions among processes at these three levels. It could therefore be argued that this interplay between societal issues such as an aging society and technological innovations related to EVs can lead to instability of the current automotive regime. As Geels & Schot (2007) point out, “[d]e-stabilization of the regime creates windows of opportunity for niche innovations.” The imminent radical social changes building in Japan, coupled with the accumulating “side-effects” of automobile society, could potentially undermine the current regime and drive the game-changing approach toward the establishment of a new EV society. We now look at these two areas more closely.

Social Changes in Japan

Japan is confronting several radical social changes related to automobile society, as outlined below.

The World’s Fastest Aging Society

There is no precedent for a process of societal aging comparable to what Japan is presently experiencing. Figure 2 shows the elderly population (>65 years old) as a percentage of the population. According to the Japanese Cabinet Office (2009), the number of people over 65 is projected to reach 30% in 2025 and 40% in 2055. Furthermore, the percentage of people over 75 is increasing at a similar rate.

Over the Peak of Population

Japan passed its demographic peak in 2006 and, due to the low birth rate, the population has been contracting. Indeed, the percentage of children under fifteen-years old has been decreasing since 1982 (MIC, 2010). The ratio of productive age people (from 15 to 64 years old) to aged people (over 65) was 4.8 in 1995, 3.3 in 2005, and is estimated to be 2.0 in 2025 and 1.3 in 2055 (Figure 3).

These trends raise three essential issues with respect to transportation practices in Japan. First, traffic accidents caused by elderly drivers have increased markedly, from 28.4% in 2001 to 31.3% in 2011 (65–74 years old), and from 12.3% in 2001 to 19.0% in 2011 (over 75 years old). Furthermore, Japan has a system whereby elderly people get special services from the public transportation system if they return their driver’s license. The number of elderly people participating in this practice increased from under 500,000 in 2000 to over six million in 2010 (MLIT, 2011). This suggests that even if they have a driver’s license, aging Japanese lose their desire to drive a car. Second, as the average age of the population increases, the total number of drivers in Japan will decrease steadily. Finally, parts of the country—mostly outlying rural areas—are becoming depopulated and senior citizens are living alone. These circumstances demand the design and implementation of new public systems of transportation.
Decrease in Oil Demand
According to the National Institute for Environmental Studies, it is essential to achieve a low-carbon society in Japan (NIES, 2012). However, there are some indications that the country will naturally move toward lower energy consumption without radical measures. The demand for gasoline in Japan has been decreasing, moving from 61.4 million kiloliters (kl) in 2005 to 57.5 million kl in 2008. The Ministry of Economy, Trade, and Industry (2009) estimates that gasoline consumption will be 49 million liters in 2013, down nearly 20% from its 2008 level and this general trend is expected to continue.

Consumption by Youth
Figure 4 shows the number of cars sold in the Japanese market, which peaked in 1996, increased again from 1998 to 2006, then has been in uninterrupted decline since 2006. For nearly two decades, the number of “light cars” (vehicles with total engine exhaust under 0.66 liters and weighing under 1,000 kilograms) has gradually become a large part (about 33% in 2009) of the national fleet. Paralleling this development, the annual growth rate of the country’s gross domestic product (GDP) was 0% in 1997 and -1.5% in 1998 (Cabinet Office Japan, 2011). During the period 2003 to 2007, car sales continued to decline despite an annual GDP growth rate of approximately 2%, suggesting that the decrease in car purchases has not been simply due to deterioration in economic conditions.

According to industry analysts, one factor responsible for this drop in demand for cars is declining purchasing activity by young people. A report issued by the Japanese Automobile Manufacturers Association (2009) noted that car sales have been adversely affected by increased use of videogames, personal computers, cellular phones, smart phones, and other handheld communication devices. At the same time, the “burdens” associated with car ownership, for example parking fees and maintenance and operating costs, increased as economic conditions worsened (JAMA, 2009). In short, Japanese youth are not buying cars with the same enthusiasm as previous generations, a phenomenon that suggests evolving attitudes toward the internal combustion-engine automobile. Such circumstances are an indication that young people may be open to the creation of an EV society.

Side-effects of the Current Automobile Society
Japan is a country with a heavy debt burden. Because of cost increases in medical service for elderly people, the financial burden will increase as Japanese society continues to age. The Japanese currently take air pollution and noise pollution caused by gasoline-powered cars for granted. However, as John Talberth and his colleagues (2007) observe, “[we] reap the benefit of freedom gained by transportation at great cost.” For example, the exhaust fumes from internal combustion can trigger medical conditions, such as respiratory disease, while the noise from these vehicles has been linked to mental stress. At great social cost, the government spends vast sums treating such disorders. How much money do we waste on such side-effects? Although precise data are scarce, regarding traffic accidents the estimated cost would be over 10 trillion yen (US$115 billion). The Japanese public also pays for measuring and mitigating the multitude of social and environmental problems caused by cars.

The issues outlined above suggest that the current automobile society is unlikely to continue. If this is the scenario that will unfold, how can we design for a future where EVs can naturally spread widely? We have already suggested that the “conventional style” of automobile or EVs would decrease in the future. However, both the elderly and the young would embrace an EV society because the new func-
tions that are integrated into the urban infrastructure would address a number of prescient issues, such as a lack of mobility and a short working life for elderly people and the economic burden caused by an aging society for young people. For example, an EV society based on the following scenarios would enable older workers to extend their active lives, which will have an impact on a range of economic issues. Their increased mobility will contribute to economic growth by helping them continue a consumer lifestyle. In addition, because an EV society will allow the elderly to extend their working lives, their pension-age threshold can be increased. These measures will reduce the economic and social burden as well as the anxiety young Japanese feel about problems linked to an aging population.

The Future EV Society

As noted above, many of the preconditions for a transition favoring EVs have begun to diffuse in Japan. However, these activities are based on the simplistic notion that EVs will replace current gasoline vehicles and have not considered the more expansive social and demographic changes taking place in Japan.

Depicting Future EV Society

We used scenario-planning and brainstorming methods to depict an “extreme” (100%) EV society. These methods were carried out during a one-year project. Experts from oil companies, magnet-parts companies, and EV researchers were interviewed. In addition, ten engineers, including four university professors, participated in an intensive two-day discussion on the development of an “extreme” scenario. Extreme thinking was encouraged to avoid “conventional” solutions, for instance that existing technologies would simply be replaced by nominally low-carbon ones to directly decrease CO₂ emissions. While many social factors will have a large impact on future society, we chose two uncertain issues that are likely to have a sizable effect on future social shaping: distance travelled by a car (no change or shortened) and functional value such as using an EV as a private room (no change or having new value). (This method is similar to scenario-planning methods such as those used by Sharpe & van der Heijden, 2007).

The former factor is closely related to urban structure in an aging society while the latter is associated with young people’s interest in cars. These two uncertain issues were expressed by two axes and four quadrants. The future society scenarios below were then placed in each quadrant (Figure 5).

Continuation of Current “Automotive” Society

Japan had 41.8 million ordinary cars and 15.7 million light cars in 2007 (MLIT, 2008). This scenario depicts a continuation of more or less the same situation, but with all gasoline cars being replaced by EVs. Battery chargers would be set up in all public places due to the low capacity of onboard electric storage. Furthermore, non-contact type battery chargers, the method of transmitting energy using electromagnetic waves, would be used on the highway. People could recharge their EVs in much the same manner as they do today.
same way that they refuel their gasoline cars. This is comparable to the usual scenarios considered by planning exercises to achieve a low-carbon society, meaning a lack of consideration for social changes, such as how to transport aged people (see Table 1 for more details).

**Clean Compact City**

In this scenario, EVs would not need to achieve high mileage and speed performance. Rather, they would be designed for “low speed” and would not harm people in a collision. Advanced controls would make auto-piloting and auto-parking readily and widely available. This future scenario, as with the first scenario, would be free from the negative social costs of traffic accidents and environmental impacts associated with vehicle exhaust and noise pollution.

Senior citizens could utilize a car and walk around safely in a “silent” town due to the EVs’ functional performance. Furthermore, an auto-parking system would make “park & ride” more convenient, reducing the time necessary to search for a parking space as well as simplifying the difficult procedure of parking a car. If this society is realized, it will solve issues of transportation for aged people. Moreover, even if the number of senior citizens using cars increases, overall environmental impact would be lower, as shown in Table 1. However, clear vision and governmental leadership would be essential to construct new “compact cities.” In this society, cars would be mere tools to enable people to travel short distances, used in much the same way as bicycles and scooters.

**Versatile Car Society**

Under this third scenario, the car changes from a “transportation device” to “my room with a vehicle.” By using the unique characteristics of being “clean” and having a battery, EVs could be usefully integrated into different niches. Some people could even bring an EV into a house and use it as a room. Furthermore, EV’s could be docked with a “public station,” a place with facilities that could be used by the public, such as a bathroom and kitchen. This concept is familiar to Japanese citizens. People could dock an EV with such a “public station” and share these utilities.

Because EVs have an automatic low-speed running mode, they could be a means of transportation for physically disabled senior citizens. Moreover, it would be possible to come home in the automatic running mode after alcohol consumption. Thus, accidents related to drunk driving would become obsolete.

This society could be moderately achieved by using innovative ideas from the private sector, for example, a robot that could change its form to fit the situation in which it is used. The government also has a role to assist this activity. Aged people could move freely, and young people could recover their interest in “cars” via a new style that combines ideas from growth industries such as information technology and robotics. This could help stimulate Japan’s economy while reducing environmental emissions.

**“Barrier-Free” Car Society**

In this final scenario, the distance travelled by a car is similar to the “continuation of current automotive society” scenario. However, there is the difference in how the cars are used. In this case, the frequency of short trips increases because of the barrier-free concept. “Everyone” can use EVs “always” and “anywhere.” “Everyone” means elderly people can use EVs while “anywhere” encompasses department stores, train stations, and so forth. “Always” means an EV can be integrated into any situation, whether in

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**Table 1** Current approach versus “Game Changing.”

| Feature of EV | Current Approach | Game Changing |
|---------------|------------------|--------------|
| Intended user | Productive people | Productive/aging people |
| Policy | Advanced technology development, increase in number of battery chargers, grants for purchasing | Social system change in various areas, relocation of residence, assist innovative ideas from private sector |
| Main player in Industries | Car, electronics | Car, information technology, robotics, materials, electronics, construction |
| Social cost reduction | Medical, environment | Medical, environment, traffic accident, public transportation, financial support needed for aging society |
| Resource/Energy increase | Electric power consumption:(50–100TWh (5–10%)), copper material (4.4 million tons), rare earth materials (17,000 tons) | ~ 100 million tons (~10%) |
a house or a shop. Therefore, a “ubiquitous automotive society” would be achieved. A compact EV could be brought onto a bullet train (Shinkansen), thus realizing the “automatic compact making” function such as the case for a robot that can change its form to fit the situation in which it is used. Since an EV could be taken into a shopping center without difficulty, this may reduce the need for stocking large amounts of food in the home. This society is similar to the “versatile car society,” but has the added concept of being “barrier-free” for cars. Aged people could even travel long distances in Japan, radically changing their daily life and likely motivating them to postpone retirement. This would have a positive effect on social problems such as a decreasing work force and increasing financial support needed for a rapidly aging society. However, the government would need to be called upon to help solve technological problems, such as reducing a robot’s volume and weight and maintaining its security, for achieving “barrier-free” cars.

Radical Solution Provided by EVs

Table 1 compares the business-as-usual scenario with the game-changing scenarios depicted in Figure 5. It is clear that a quite different society is developing and different planning procedures will be needed whether one takes the anticipated social changes into consideration or not. Regarding the main players in industry, EVs in the “continuation of current automotive society” scenario would be manufactured by the car industry. By contrast, EVs in the other scenarios, such as “clean compact city,” could be manufactured by new firms that blend information technologies, robotics, materials, and interior design. The current automobile companies have supplied different types of gasoline-powered cars, for instance, “high-speed,” “long-distance travelled,” and “safe/comfortable” cars in several countries. Accordingly, when we consider Japan’s “car society” in the future, we cannot ignore the effect of globalization on manufacturers themselves. Regarding resource/energy consumption and CO₂ emissions, we assumed no large differences in the various scenarios.

What is sustainability in Japan? One definition of a sustainable Japan entails maintaining the country’s current affluent society. However, a number of barriers need to be overcome, such as the decreasing “productive-age” population, increasing aging population, and social costs related to environmental issues.

The decreasing “productive age” population will depress Japan’s economy because such individuals currently constitute the highest percentage of consumers and workers. The country’s aging population will increase social costs related to welfare. Furthermore, growing environmental stress, such as air pollution and climate change, will increase social costs. As economic stagnation means a shortfall in tax revenue, an increase in social costs will have a serious impact on Japan’s sustainability. We believe the following scenarios could help solve such problems:

1. Negative social cost reduction: Continuation of current “automobile society” will lead to the reduction of negative costs related to air pollution.

2. New lifestyle provided for young people: “Versatile car society” will help stimulate young people’s consumption with social cost reduction.

3. Recover motivation for extending the working lives of an aging population: “Clean compact city” will reduce the social costs related to air pollution and traffic accidents. Moreover, providing low speed and autopilot cars may support daily life activities and extend the working lives of elderly people.

4. Recover the consumer mind in aged people by increasing their daily life activities: “Barrier-free car society” will help recover motivation for extending the working life and consumer mindset of elderly people, leading to reductions in social costs. The size of the Japanese population is decreasing. This means even if we do not take any measures, environmental impacts will tend to decline. It is necessary to maintain a balance between social activities and environment impact.

Figure 6 highlights differences between current approaches of substituting gasoline-powered cars for EVs and a game-changing approach toward a sustainable car society. By considering a range of social factors, we can depict various social scenarios that contribute to such a vision.

Conclusion

As outlined in the introduction, in the same way that the authors had to undergo a radical change with regard to their method of study from pure engineering to a more “open” strategy, the scenarios show that the Japanese approach to societal planning must also experience a radical change in the way it utilizes and integrates technology. The current method of substituting gasoline-powered cars for EVs is misguided if we consider future social changes in Japan. This is the conventional approach informed only by technological innovation.
If we employ a more radical strategy where technology is integrated with social issues, EV technology provides us with an opportunity to profoundly transform societal organization. A new kind of society can be created, which will attenuate many of the social problems we face in our current automobile society. These include issues related to an unprecedented aging population with a low birth rate and increasing social costs with respect to transportation and medical care. It will be more effective to start investigating game-changing approaches that broaden our horizons. We have to possess a holistic view of social issues that spans climate change, poverty, global population growth, and economic security and understands the causality among them. The integration of social science perspectives related to human behavior and culture with technology is inevitable.

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