

# **Electric Drive Vehicle Market Outlook toward 2030 and Impact on Relevant Industries**

**Tomohide KAZAMA, Kazunori SUZUKI,  
Teiki CHO and Shotaro YOSHIHASHI**

**Nomura Research Institute**

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- I Electric Drive Vehicle Market Outlook toward 2030
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Many countries have been adopting increasingly stringent CO<sub>2</sub> emissions regulations in support of vehicle electrification. Automakers have been strengthening their electrification strategies to meet toughening standards. The synergistic effect brought about by these efforts in the public and private sectors has been accelerating the growth of the electric drive vehicle market in anticipation of transitioning to all-electric vehicles. In Europe, plug-in hybrid electric vehicles (PHEVs) are bridging a shift to all-electric vehicles (EVs). China's market for new energy vehicles (EVs and PHEVs) is expected to expand rapidly until 2020. Even after subsidies have been phased out by 2020, it is unlikely that the market will shrink rapidly. In the U.S., the inauguration of the Trump administration may accelerate the bipolarization of electrification. In Japan, the market structure currently focusing on hybrid electric vehicles (HEVs) may change.

In consideration of each region's approach to electrification and the electrification plan of each automaker, the authors estimated the size of the electric drive vehicle market (including EVs, PHEVs and HEVs). An optimistic estimate indicates that this market will reach a size of about 18 million units per year (about 17 percent of the overall passenger car market) by 2025.

The rapid expansion of the electric drive vehicle market may cause supply-demand tightness for lithium-ion batteries (LIB). To deal with a possible shortage of LIBs, automakers have been reviewing their strategies for procuring batteries and attempting to build strong partnerships with battery manufacturers. Even though the automotive industry has been shifting toward horizontal specialization, a trend of swinging back toward vertical integration has been seen. The impact of a rapidly rising electric drive vehicle market will extend to the upstream materials industry. With the aim of entering the global market, the LIB materials industry will see collaboration and partnerships between major materials manufacturers and specialized materials manufacturers. In this way, the industry is likely to experience reorganization.

The impacts of vehicle electrification on the automotive parts industry range from losses of business opportunities suffered by manufacturers of internal combustion engines and traditional transmissions to the acceleration of horizontal international specialization. In the energy industry, because electrification poses both opportunities and threats in terms of ensuring stable power supplies, the industry must work out appropriate operations and solutions to stabilize power supplies. The communications industry will see the emergence of new business opportunities by applying IoT to electric drive vehicle bodies and battery chargers.

# I Electric Drive Vehicle Market Outlook toward 2030

## 1 Region-specific trends in electric drive vehicle markets

### (1) Shifting to ultimately eco-friendly EVs with PHEVs as a bridge

In Europe, it has been predicted that automakers would shift their focus from diesel to electric drive cars in anticipation of a tightening of CO<sub>2</sub> emissions standards in and after 2021. The 2015 disclosure of Volkswagen's emissions software scandal has been accelerating these moves.

Toyota Motor Europe announced a year-on-year increase in sales of 44 percent for the first half of 2016 (January to June) for hybrid electric vehicles (HEVs) in Europe. In the wake of the disclosure of its diesel emissions scandal, Volkswagen was quick to unveil a major shift to developing electric drive cars. By following suit, other European automakers one after another announced their strategies to focus on all-electric vehicles (EVs) and plug-in hybrid electric vehicles (PHEVs). Given the VW scandal, the German Association of the Automotive Industry (VDA), which has, thus far, strongly opposed EU's stricter CO<sub>2</sub> emissions regulations, may weaken its voice. Such a possibility is likely to further drive Europe's transition to low- and zero-emission vehicles.

Targeting the 2020 – 2025 period, in Europe, the PHEV market is expected to grow first. Most European automakers plan to focus on the deployment of PHEVs because EVs have limited travel distance and many European countries provide incentives for PHEVs.

The EU's CO<sub>2</sub> regulations provide incentives for low-emission vehicles. They include a super-credit scheme and a reduction factor applied to measuring fuel consumption. A super-credit is given to each car with CO<sub>2</sub> emissions of less than 50 grams per kilometer (g/km), at which point it is counted as more than one car. The prescribed method of measuring fuel consumption (the United Nations Economic Commission for Europe Regulation 101 (UNECE R101)) allows a PHEV's CO<sub>2</sub> emissions to be divided by a reduction factor as determined based on the distance traveled exclusively on electricity. A new energy vehicle subsidy program provided in China, which is the market regarded by European automakers as the future growth market, provides subsidies for vehicles with a pure electric driving range of no less than 50 km. All of these incentive programs provide great benefits for PHEVs.

Nevertheless, the expansion of the PHEV market is seen as a transitional stage. As we move toward 2030, EVs will enter a stage of full-blown popularity in the electric drive vehicle market. In November 2016, Volkswagen announced a plan to have an EV share of

almost 25 percent in total vehicle sales by 2025. Volkswagen's "Strategy 2025" clearly indicates that EVs are at the core of their strategic plan. According to news reports, in October 2016, Germany's Bundesrat (federal council) passed a resolution to ban the sale of new internal combustion engine cars by 2030. The council also wants the European Commission to apply the proposed ban to other EU nations. While adjustments involving government and industry will be made, it would be reasonable to say that the decision has paved the way for EVs to be mainstream cars on European roads.

In addition, efforts have been made in Europe to develop mild HEV systems using 48V batteries as an effective technology for reducing CO<sub>2</sub> emissions that is equivalent to EVs and PHEVs. In 2016, Renault and Audi introduced such models to the market. Starting in 2017, Daimler plans to join these automakers by using 48V hybrid motors on its models. However, unlike EVs and PHEVs, not all automakers are keen to embrace 48V systems, and there is no policy support for them. For these reasons, it is considered difficult for 48V mild hybrid vehicles to become mainstream electric drive vehicles, with their acceptance expected to be limited only to some user segments.

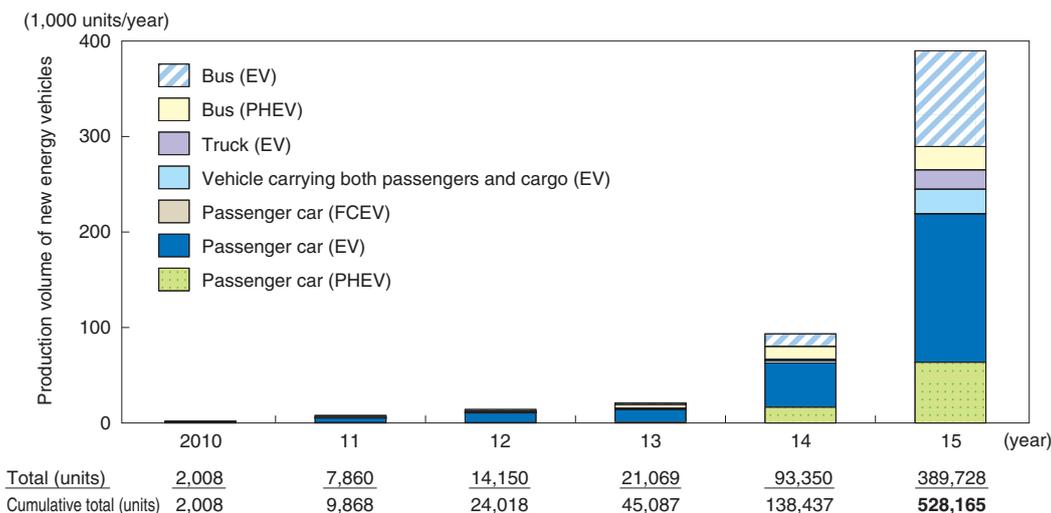
### (2) China: Market for new energy vehicles continues to grow; use of 48V mild hybrid vehicles will spread

According to the China Automotive Technology and Research Center (CATARC), China's new energy vehicle (NEV) market has been growing rapidly since around 2014 – 2015. In 2015, about 390,000 new energy vehicles (of which, about 220,000 units are passenger cars and about 120,000 units are buses) were produced. Such increasing NEV production has led to achieving China's target of putting 500,000 new energy vehicles on the road by 2015 (Figure 1).

A look at a breakdown by vehicle type reveals that passenger cars account for more than 50 percent. By type of powertrain, EVs have the overwhelming share, i.e., about 70 percent of passenger cars and about 80 percent of buses are EVs.

Huge subsidies from central and local governments have played a major part in the rapid rise of the new energy vehicle market in China. In large- and medium-sized cities, NEV subsidies are provided by both central and local governments, making the maximum subsidies per vehicle about 110,000 yuan. Other NEV purchase incentives include a free license plate and vehicle purchase tax exemption. The cost of obtaining a license plate varies from city to city. The fee is most expensive in Beijing at around 100,000 yuan and it is also high in Shanghai at about 80,000 yuan. Given such high cost, the incentive of a free license plate has an extremely large impact on the purchase of NEVs.

**Figure 1. Changes in production volume of new energy vehicles by vehicle type in China**



Source: China Automotive Technology and Research Center (CATARC)

Moving toward 2030, it is highly likely that EVs will continue to be the mainstream type in the Chinese electric drive vehicle market. For the time being, partly because of the weak technological capabilities of domestic automakers, EVs, which do not have complex mechanical systems as compared to gasoline-powered cars and thus present low entry barriers, will remain the mainstream type. If the performance of EVs is improved by overcoming the disadvantages of range limitation and long charging time, the shift from EVs to PHEVs will not be significant, leading to the likeliness of EVs remaining the mainstream type even toward 2030.

The biggest concern in forecasting the future of China’s electric drive vehicle market is that the government plans to phase out subsidies by 2020. If subsidy funds are used up, a remote – but not zero – possibility exists that subsidies might end before 2020. Given this situation, some observers say that China’s new energy vehicle market will shrink sharply after 2020. While opinions are divided, Nomura Research Institute (NRI) considers that a rapid market decline will not occur because, together with the other incentives mentioned earlier, NEV rules that are planned to be introduced in 2017 will underpin the NEV market in lieu of subsidies even after 2020. The draft of NEV rules, which are equivalent to the ZEV regulation, requires automakers that produce or import more than 50,000 vehicles a year in the Chinese market to ensure that at least 8 percent of sales are NEVs by 2018. This proportion would rise to 10 percent in 2019 and 12 percent in 2020.

From the perspective of achieving China’s fuel consumption targets, the use of 48V mild hybrid vehicles is also expected to spread rapidly. China has set a target of 4 liters per 100 kilometers (25 km/L) by 2025. It is considered difficult to achieve this target only by introducing new energy vehicles. The introduction of

strong (full) hybrid vehicles (HEVs) and 48V mild hybrid vehicles is assumed to be a means of supplementing new energy vehicles. In the domestic market, motor suppliers for electric vehicles such as United Automotive Electric Systems Co., Ltd. (UAES), which is Bosch’s joint venture in China, and E-drive, are engaged in the development of 48V mild hybrid vehicles. Furthermore, automakers, mostly European and Chinese manufacturers, have also announced a plan to launch 48V mild hybrid vehicles one after another. After 2025, along with the HEV market, the market for 48V mild hybrid vehicles is also expected to grow significantly.

**(3) U.S.: Inauguration of Trump administration may accelerate bipolarization of electrification**

Thus far, the spread of electric drive vehicles in the U.S. market has been facilitated by new auto fuel efficiency standards adopted in 2012 during the Obama administration and the California zero emission vehicle (ZEV) program.

The new fuel efficiency standards are very ambitious and aim to nearly double average fuel economy by the 2025 model year compared to about 12 kilometers per liter in 2012 when these rules were finalized. Similarly, the ZEV regulation is also projected to become more stringent. From 2018, target powertrains will be limited to all-electric vehicles (EVs) and hydrogen fuel cell electric vehicles (FCEVs), which are certified as ZEVs, and plug-in hybrid electric vehicles (PHEVs), which are categorized as transitional zero emission vehicles (TZEVs). In addition, the number of automakers subject to the regulation will be expanded to include those whose sales volume in California is 30,000 – 60,000 units. These two types of rules have exerted increased pressure on automakers to step up development of EVs, FCEVs and PHEVs.

However, with the start of the Trump administration, it has become highly likely that these tough fuel economy standards will be subject to review. In November 2016, the Alliance of Automobile Manufacturers submitted a letter to President-elect Trump's transition team calling for an easing of fuel efficiency rules. The factor lying behind the concerns of major automakers is that despite their increased efforts to develop electric drive vehicles to meet the ambitious targets that had been set, subsequent continuing low gasoline prices have led to weaken the demand for electric drive vehicles.

If the new administration eases fuel economy rules, such relaxation would have a major impact on each automaker's powertrain strategy and eventually on the market structure.

In the case where only fuel economy rules are eased by the new administration and ZEV regulations are implemented as planned, the bipolarization between the states that adopt ZEV regulations and those that do not in terms of the spread of electric drive vehicles is highly likely to accelerate. Specifically, the shift towards EVs, FCEVs and PHEVs will gain momentum in conformity with plans based on ZEV regulations in California and other states adopting these regulations. However, in other states, electrification may be stalled because of relaxed fuel economy standards and low gasoline prices.

#### **(4) Japan: There is a possibility that the Galapagos syndrome focusing on HEVs may lose momentum**

The Japanese electric drive vehicle market has evolved in a unique way in that the market has been driven by users and has expanded with HEVs occupying an overwhelming share.

The reasons for the user-led market are attributable to the facts that no penalties are imposed by fuel economy regulations and there are no rules akin to ZEV regulations that require automakers to develop electric drive vehicles.

The reasons for the overwhelming share of HEVs include three major points. The first point relates to the electric drive vehicle strategies of Japanese automakers. Toyota and Honda have placed emphasis on HEVs from the beginning of the development of electric drive vehicles. Nissan, which first focused only on all-electric vehicles (EVs), later shifted to a strategy involving both EVs and HEVs. The second point is related to an image-building strategy. Automakers made marketing efforts to evoke an image that "HEVs are environmentally friendly." This strategy has appealed to users who wanted to have a feeling of superiority and differentiation in the sense that they drive expensive, eco-friendly cars. In particular, by launching dedicated hybrid models, Toyota was successful in making these models iconic so that everyone would recognize them as hybrid cars. The third point concerns Japan's unique road conditions.

Because there are many curves and hills, drivers must frequently accelerate or reduce speed and must often endure stop-and-go traffic jams. Hybrid vehicles are efficient at dealing with such driving conditions.

Nevertheless, with HEV sales hitting their peak around 2013 – 2014, the Japanese electric drive vehicle market is heading toward a turnaround point. Behind this shift is that early adopters have started to lose interest in existing hybrid cars. On the other hand, users in the volume zone, who are cost-conscious, still consider existing hybrid cars as being expensive even with tax incentives and subsidies.

An incident demonstrating this trend is that according to the Japan Automobile Dealers Association, in November 2016, sales of the Nissan Note, which has gained popularity by featuring a new electric-motor powertrain "e-Power," beat the best-selling Prius (fourth generation) and ranked first in terms of monthly sales in the Japanese market.

As described previously, Japan's electric drive vehicle market is impelled by users. In particular, automakers' image strategy plays a key role in attracting users' attention. The popularity of the Nissan Note, a new model launched by offering two major marketing elements of freshness and reasonable price, reveals the prospect that if a company could successfully incite user interest and could win their attention, the product will sell like hotcakes. It should be noted that if such new models continue to appear on the market one after the other, the current market structure with HEVs dominating the market might shift toward one in which EVs and PHEVs take the majority share.

## **2 Estimating the size of the electric drive vehicle market**

In the past, the authors estimated the size of the electric drive vehicle market in the mid-to-long term on the assumption that automakers would achieve fuel economy targets. This estimation could be considered as forecasting the minimum market size, and is useful, for example, when establishing a new business plan with due consideration given to risk.

This time, by looking at the other side of the coin, the authors estimated the market size from the optimistic perspective. This method becomes useful, for example, when examining the risk of losing business faced by existing players. We set parameters in consideration of each region's approach to electrification, as described in Section 1, as well as based on the electrification plans of each automaker. The result, shown in Figure 2, is that the size of the electric drive vehicle market in 2025 is projected to be about 18 million units per year (about 17 percent of the overall car market). The average annual growth rate between 2016 and 2025 is projected to be 26.6 percent.

### 3 Electric drive vehicle market outlook toward 2030

In each country, policies aimed at fully expanding the EV market have been put in place and most automakers have been gearing up to compete for an EV market share.

In terms of policies, many countries, in particular, European countries and China, are expected to further strengthen fuel efficiency and CO<sub>2</sub> emission regulations even after 2025. Strong government support for the expansion of the EV market in Europe is indicated by Germany’s approval of a resolution calling for a ban on internal combustion engine vehicles. In China, it is the NEV regulations, and it is the ZEV regulations in the U.S.

Looking at the activities of automakers, in addition to leading EV makers such as Renault-Nissan and Tesla, as well as domestic Chinese automakers, other global automakers have announced their commitment to launch EVs. As explained in Section 1, after the disclosure of the diesel emissions scandal, Volkswagen and other European automakers announced plans to put large volumes of new models of EVs and PHEVs on the market. In 2016, Toyota announced its plan to start mass production of EVs by 2020. With the full-scale participation of the world’s top two automakers, i.e., Toyota and Volkswagen, the EV market seems certain to grow.

Among zero emission vehicles, the competition between FCEVs and EVs is expected to intensify. Even so, as of 2030, the possibility that FCEVs will erode the EV share is thought to be limited.

Only a few automakers (such as Toyota and Honda) are fully committed to launching FCEVs. In Japan, hydrogen refueling stations are being developed as planned, and the FCEV market is likely to reach a certain size by 2030. However, in the U.S. and Europe, the development of such infrastructure is not progressing

as scheduled and it is difficult to believe that FCEVs would become a threat to EVs by 2030. In Europe and China, the EV and PHEV markets will grow first. After 2025, the acceptance of HEVs including 48V mild hybrid vehicles is also expected to accelerate.

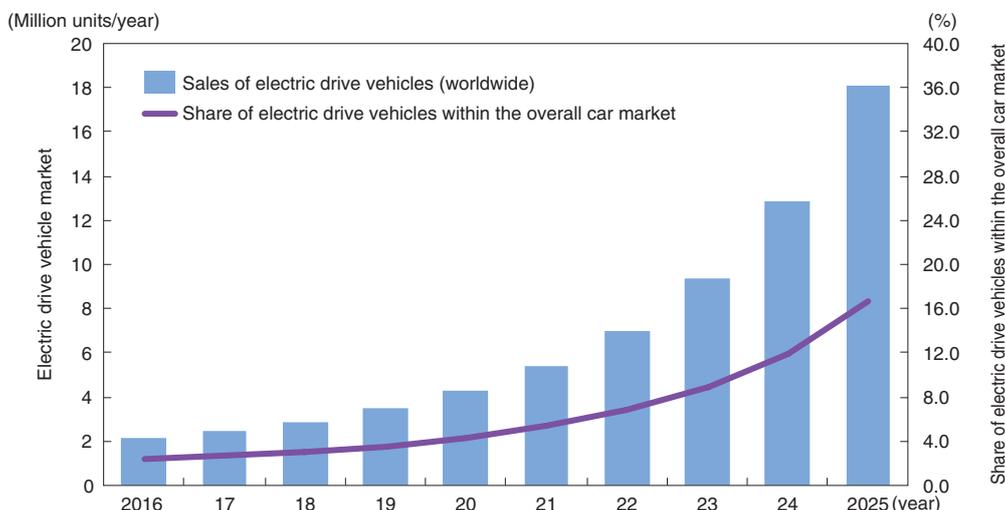
Even though EVs and PHEVs offer better fuel economy, these vehicles are more expensive than conventional cars. Because of the high price, buyers would be limited to some early adopters. If fuel economy and CO<sub>2</sub> regulations are further toughened after 2025, it will be difficult to meet these regulations by only adopting EVs and PHEVs. Therefore, to comply with these regulations, the adoption of HEVs including 48V system vehicles will become essential as a means of supplementing EVs and PHEVs. Compared to EVs and PHEVs, HEVs present a lower hurdle to purchasing a vehicle, making it possible to attract cost-conscious users in the volume zone.

## II Prospects of the Battery Industry Affected by the Expansion of the Electric Drive Vehicle Market

### 1 Impact on the battery industry

Key components of an electric powertrain include motors, inverters and batteries. In particular, batteries have a large impact on the performance of an electric drive vehicle, and account for an extremely large proportion of the cost of such a car. Most electric drive vehicles use lithium-ion batteries (LIB). LIB technology is the key component of an electric powertrain because it still has room for improvement in terms of performance and cost, and such improvement is essential for electric drive vehicles.

Figure 2. Estimation of the size of the electric drive vehicle market (optimistic case)



Note: In this chart, electric drive vehicles refer to four types, i.e., strong HEVs, PHEVs, EVs and FCEVs.

Lithium-ion batteries are already known to us as they are used in mobile phones and laptops. The LIB market started in 1991, and reached a size of about 2.6 trillion yen, or 68 gigawatt-hours (GWh) per year, for both automobile and consumer use by 2016. The industry’s capital investment increased by 2.7 GWh each year. As a result of our simulation, we found that future vehicle electrification is expected to boost the LIB market at a speed that is far faster than ever before. If the “optimistic” forecast of the market size of electric drive vehicles, which was given in Chapter I, is applied, by 2025, the size of the LIB market for both automobile and consumer use is expected to reach 480 GWh per year in terms of amounts of energy, which is about seven times the current amount. Similarly, the amount of capital investment will increase by 46 GWh annually, which is about 17 times the current figure (Figure 3).

The problem is that it is difficult for automakers in advanced countries to immediately use lithium-ion batteries produced by startup companies. Because lithium-ion batteries contain flammable liquids, there is the need to ensure safety. In recent years, Chinese LIB suppliers have been building up their capacity. However, their products are designed only for the Chinese domestic market (partly due to the matter of patents). They would not be able to serve as suppliers to cover the expansion of the market. As such, it is highly likely that automakers in advanced countries would look to major LIB suppliers who already have experience such as Samsung SDI, LG Chem and Panasonic. The concentrated demand on these battery makers would require them to sharply increase their capital investment and would cause them to face shortages of the human resources needed for additionally constructed factories. In view of these hurdles, there is concern over supply-demand tightness for lithium-ion batteries.

To overcome these challenges, automakers face the need to review their strategy for procuring batteries.

They are actively implementing the initiatives to take control of LIB technology, which include the option of building their own battery factories. For example, having the idea that the key to success in EVs and PHEVs is the in-house production of lithium-ion batteries to ensure quality and safety, Daimler has continued to invest in building battery factories. Volkswagen is said to be moving toward building its own battery factory in China in partnership with a local LIB maker. In contrast, Nissan plans to sell its stake in Automotive Energy Supply Corporation, a Nissan-NEC joint venture manufacturing lithium-ion batteries. It appears that Nissan is pursuing the reduction of battery cost through horizontal international specialization. From the perspective of establishing relationships between automakers and battery makers, attention should also be given to how Tier 1 suppliers such as Bosch and Denso develop their business in the future (Figure 4).

## 2 Reorganization of the battery materials industry

Section 1 discussed the impact that vehicle electrification would have on the battery industry. Such impact will extend to the upstream materials industry. Lithium-ion batteries were first commercialized in Japan. This commercialization was made possible because of the support of Japanese materials manufacturers. As the LIB market expands not only in scale but also geographically, several Japanese materials manufacturers will change their policy of business expansion from self-sustaining growth to alliance. For example, Toda Kogyo Corp., which manufactures and sells cathode materials for lithium-ion batteries, and Germany-based BASF established a joint venture, “BASF TODA Battery Materials LLC” in 2015. In December 2011, Ube Industries, an electrolyte solution manufacturer, and

**Figure 3. Simple market size estimation for lithium-ion batteries for both automobile and consumer use (optimistic case)**

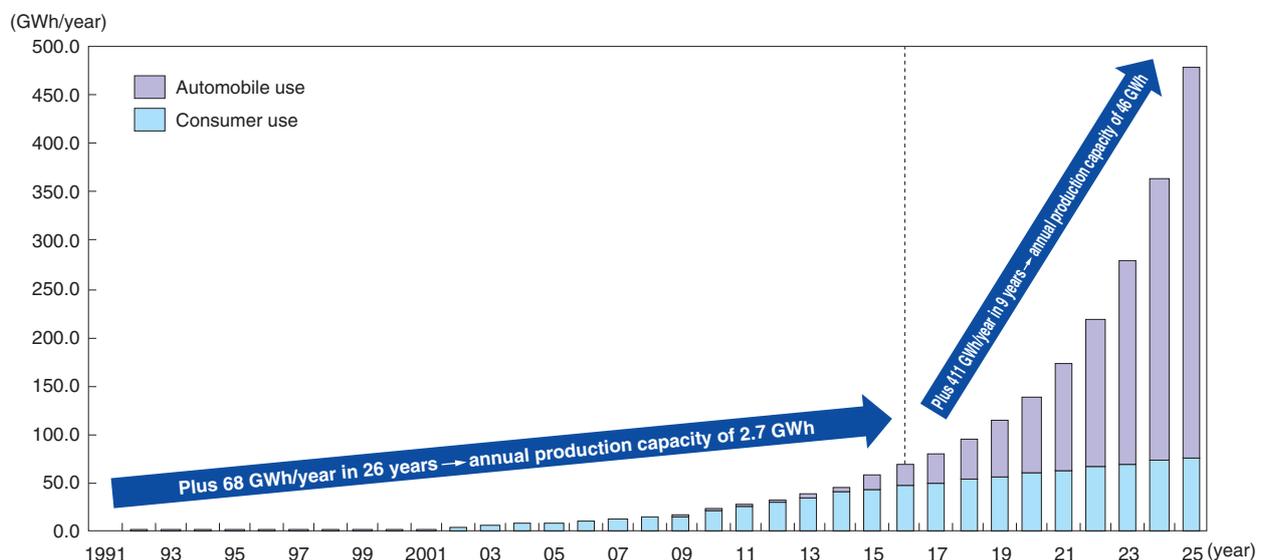
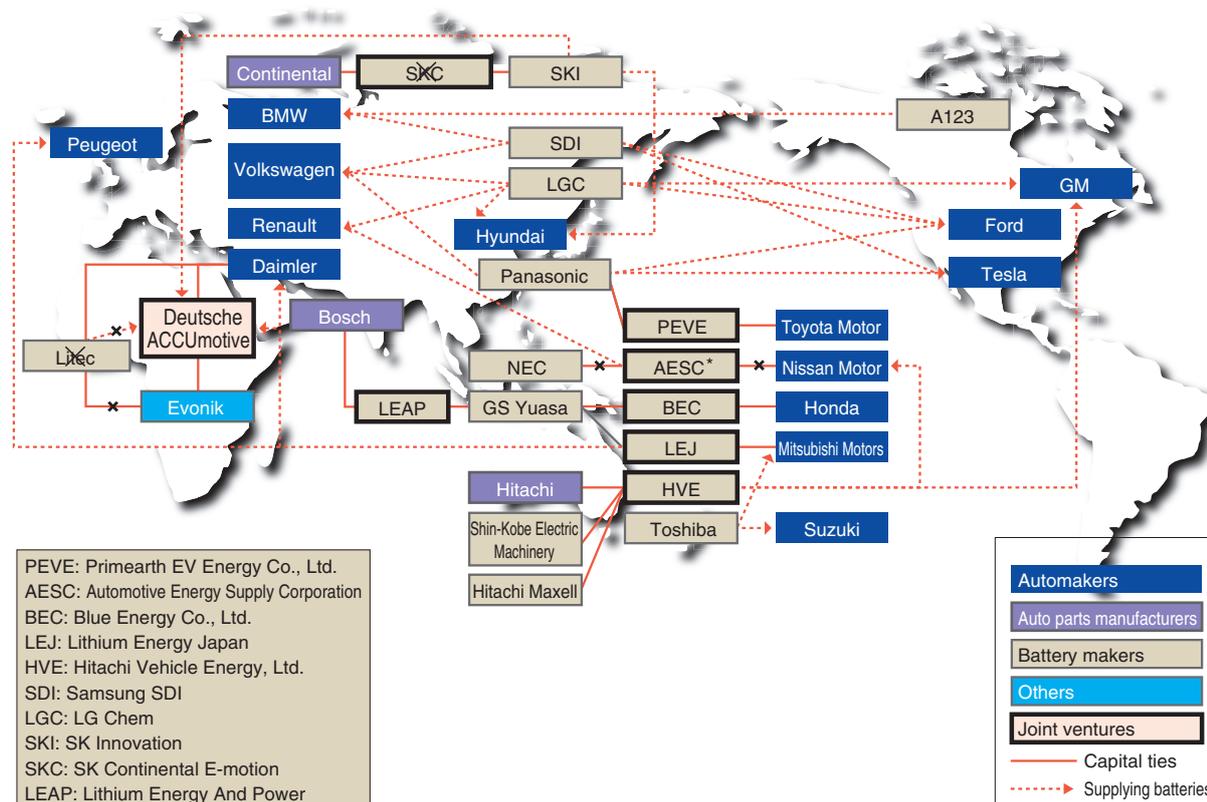


Figure 4. Relationships between automakers and battery makers



Note: "x" indicates the possibility of the end of capital ties through selling a company.

Dow Chemical Company announced the formation of a joint venture called "Advanced Electrolyte Technologies." (In January 2015, Ube Industries acquired a majority stake in this joint venture, making it a subsidiary of Ube Industries). Through collaboration and partnerships between major materials manufacturers and LIB materials manufacturers as in the cases discussed above, the industry seems to be getting reorganized.

### III Impact of Electrification on Relevant Industries

As described thus far, rapidly progressing vehicle electrification is exerting various impacts on relevant industries.

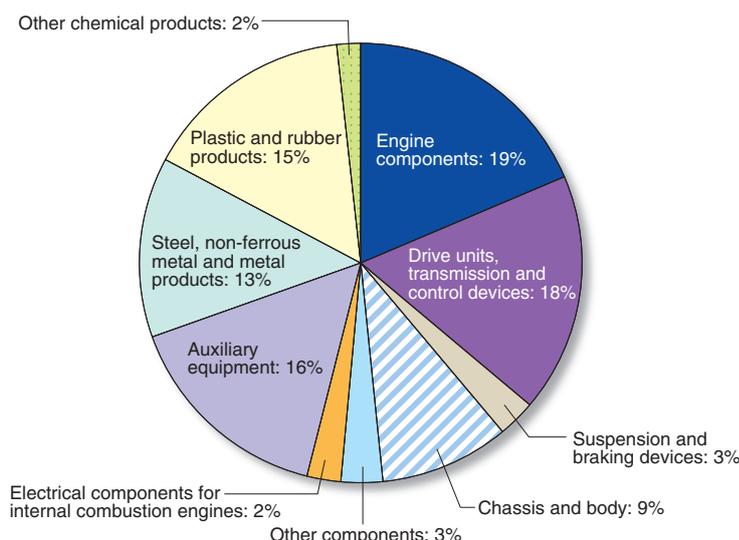
While the automotive parts and materials industries will obviously be influenced, the use of alternative energy sources will also have a great impact on the energy industry. Furthermore, the emergence of new businesses such as car sharing, which will gain popularity with the spread of electric drive vehicles, will also involve other industries such as the communications industry. This chapter looks at such impacts on relevant industries.

#### 1 Impact on the automotive parts industry

Several years ago, hybrid electric vehicles (HEVs) were mainstream electric drive vehicles. Because HEVs use

both an internal combustion engine and an electric motor, the impact on existing parts makers was limited. However, the focus is now on a transition to all-electric vehicles, which involves removing the entire internal combustion engine and eliminating the need for a traditional transmission. Such a change leads to the possibility that existing parts makers may lose their businesses entirely. For example, parts designed for internal combustion engines such as hydraulic systems must be modified for electrification. Figure 5 shows parts and equipment that are affected by vehicle electrification. As indicated in this pie chart, such a shift will have a massive impact on the auto parts industry.

With vehicle electrification, the industry structure will also change from vertical integration to horizontal specialization. In the same way as with gasoline-powered cars, coordination and adjustment are necessary in the development process of electric vehicles. However, the complexity involved in such a process differs largely. So the degree to which automakers can take the initiative will decline. It is easily conceivable that a greater proportion of electronic components in a car brought about through electrification will cause the automotive industry to shift to horizontal specialization, which is a common industry structure in the electrical industry. Through these changes, the role played by automakers in the manufacturing process is expected to diminish, and a greater proportion of added value will shift from automakers to suppliers.

**Figure 5. Proportions of individual parts in Japan's auto parts industry and impact of vehicle electrification**

Note: Parts and components largely influenced by electrification are shaded; the degree of shading indicates the degree of impact.  
 Source: Compiled by the authors based on "Nihon no jidousha buhin sangyuu 2016 (Japan's Auto Parts Industry 2016)."

## 2 Impact on the energy industry

As vehicle electrification progresses, the demand for fuels will change from traditional petroleum fuels to electricity, bringing about a major impact on the energy industry. This section looks at the electric power industry, which is particularly required to change even within the energy industry.

Currently, the electric power industry faces instability in the power grid due to increasing renewable energy, which generates power in an inconstant manner. Because of this, power supply-demand adjustments have become essential. An energy storage system (stationary, large storage batteries) can be effective for this purpose. The energy industry expects electric vehicles, which are projected to become popular and are what might be called "running storage batteries," to play a role in adjusting power supply and demand.

### (1) Challenges facing the electric power industry in introducing renewable energy sources

Today, many countries, especially advanced countries, have been promoting the introduction and spread of renewable energy as clean energy that can replace fossil fuel energy. The same applies to Japan. According to the "Long-term Energy Supply and Demand Outlook" announced by Japan's Ministry of Economy, Trade and Industry, the government set a target that renewable energy sources account for about 20 percent of total power generation by 2030.

However, the introduction of renewable energy sources, which are unstable sources of power, faces various problems such as a shortfall of frequency regulation capacity, generation of surplus power, grid voltage rise and a shortage of transmission capacity. To overcome these challenges, specific measures are

necessary to maintain the quality (voltage and frequency) of the power supply by securing needed regulation capacity and providing backup power sources.

### (2) Use of vehicle-mounted batteries for supply-demand adjustment

"Vehicle-to-grid (V2G)" technology, whereby power is supplied from batteries mounted on EVs and PHEVs to the grid, could be a solution for supply-demand adjustment in order to introduce renewable energy. If group control of batteries installed on EVs and PHEVs becomes possible, the number of large-scale storage batteries to be deployed for the adjustment purpose will be reduced, raising the possibility of reducing the cost of developing grid networks. Nissan, a leading EV company, is taking an active approach to V2G projects. In 2016, Nissan and Enel announced a pilot program of installing and connecting 100 V2G units that transmit power from electric vehicles to the grid at the locations of Nissan LEAF and e-NV200 owners.

Let's take Japan as an example to examine the extent of impact when EVs become much more common. Based on the estimate described in Chapter I, the number of EVs and PHEVs owned in Japan in 2020 will be about 600,000 units. If a regular battery charger for a LEAF (200V/15A) is used for calculation, the amount of stored power would be equivalent to that generated by about two nuclear reactors.

In actuality, the impact could be even more substantial. The fact behind this speculation is that in pursuit of extending the driving range of EVs and PHEVs, automakers are endeavoring to increase the capacity of on-board batteries. Discussions are now ongoing regarding fast chargers to feed electricity into such large-capacity batteries.

However, looking at the other side of the coin, these

discussions are nothing more than those regarding the maximum increase in demand for power when EVs and PHEVs are introduced. In any case, the growing popularity of EVs and PHEVs will definitely have a major impact on the electric power industry. The key issues that the industry must deal with include the development of charging/discharging control techniques and customer service models.

### **(3) Reuse of on-board storage batteries**

A glimpse into the future when EVs are widely popular leads us to consider the recovery of the large number of batteries installed on discarded electric vehicles. The first company that was established to promote the second-life use of on-board batteries and reuse them for the supply-demand adjustment with power grid networks is 4R Energy, a joint venture between Nissan and Sumitomo. In recent years, Daimler and BMW have been actively testing ways to reuse batteries.

Daimler has constructed a 13 MWh stationary, large-scale storage battery using a total of 1,000 battery systems from compact “Smart Fortwo” electric drive cars and installed it in Lunen, Nordrhein-Westfalen, West Germany. In consideration of commercialization, Daimler entered into partnership with The Mobility House, which is offering smart home solutions, GETEC, an energy service provider, and REMONDIS, a service provider for recycling and water management.

If a market for used, retired EV/PHEV batteries could be established, automakers would be able to offer practical discounts for the buyers of new EVs and PHEVs. The benefit to the electric power industry is that the industry would be able to develop power grid systems at a lower cost by using low-cost batteries.

### **(4) Establishing a relationship between the automotive industry and the electric power industry**

On a path towards achieving vehicle electrification, automakers face the challenges of developing a charging infrastructure and reducing battery cost, which leads to a need for a new business model. In addressing these needs, automakers must consider the extent of involvement in the electric power business as part of the expansion of their business areas and select appropriate power companies as their partners. For new power producers and suppliers (PPS), these moves could open the way for expanding their businesses. Consequently, they keep abreast of trends in the automotive industry.

## **3 Impact on the communications industry**

The growing popularity of electric drive vehicles could also benefit the communications industry in the form of creating new business opportunities. The following paragraphs describe these new opportunities from two perspectives: vehicle bodies and charging services.

As for vehicle bodies, services that can be assumed when the Internet of Things (IoT) is applied to electric vehicles are discussed. Regarding charging services, services assumed when charging services are combined with IoT are described with a look at the situation in China.

### **(1) Service opportunities created when IoT is applied to electric vehicle bodies**

Nissan and other EV manufacturers have already been offering services in which IoT is applied to electric vehicle bodies. For example, the Nissan LEAF uses IoT to visualize the driving status. By installing a dedicated app on a smartphone, a driver can check various driving conditions on a real-time basis such as residual battery capacity, time needed to complete charging and drivable distance.

With the expansion of the types and amount of data that can be acquired and stored, new service opportunities will be further created. Specifically, service opportunities that are expected to be created in the three areas of maintenance, leasing and company-owned cars/vehicles used in logistics operations are described in the following paragraphs.

Services assumed in the area of maintenance include performing maintenance based on cumulative hours of driving and selecting an optimal maintenance center by using GPS. By using these services, users will benefit from reduced maintenance costs.

In the area of leasing, expected services include charging lease fees based on cumulative hours of driving and selling data to insurance companies. With a “pay-as-you-go” method, user satisfaction will increase.

Regarding company-owned cars and vehicles used in logistics operations, providing a platform for dispatching cars will contribute to the reduced number of cars in stock as well as to an increase in vehicle utilization rate.

The use of IoT-enabled services is predicted to further increase transport vehicles other than passenger cars such as motorcycles and buses.

In 2016, PS Solutions, a member of SoftBank Group, launched an electric scooter rental service using IoT in Teshima Island, Kagawa Prefecture by. The company rents Honda EV-neo scooters to tourists visiting the island, and offers IoT-enabled “loosely watching” services through which visitors can check the residual battery capacity and current location of each scooter. Visitors are also notified of the departure time of their return ship.

Hitachi developed an electric bus operation management system to support the formulation of plans to purchase electric buses, determination of bus routes and operation management. Specific activities include estimating power consumption based on route conditions, vehicle specifications and bus schedule, and remote monitoring of current location of each electric bus and residual battery capacity.

**(2) Service opportunities created when IoT is applied to a charging service**

China’s charging service business now faces challenges in three aspects: user satisfaction, effective use of time during charging and establishing a revenue model.

Problems related to user satisfaction include difficulties in finding a charging station, long waiting times at charging stations and unclear user authentication procedures. The issue regarding the effective use of time during charging is that the user must park a car for about 30 minutes at a specific location (charging station), but service providers are not able to use that time effectively. The problem involved in establishing a revenue model is that the price of electric power is set low in China, and it is difficult to secure adequate revenue by only selling electricity.

The use of IoT could solve all of these three challenges simultaneously. During the time users are charging their cars, IoT could be used to collect and analyze data regarding the use of a car, driving and charging. These data could be used to create new value, which will benefit stakeholders such as battery manufacturers, electric vehicle manufacturers, dealers and users.

Actually, BMW has built about 1,500 charging stations in China, and the company offers services to reduce the burdens of users by supporting them in many aspects from finding the closest station to actual charging. In October 2016, BMW began this service in

Japan as well.

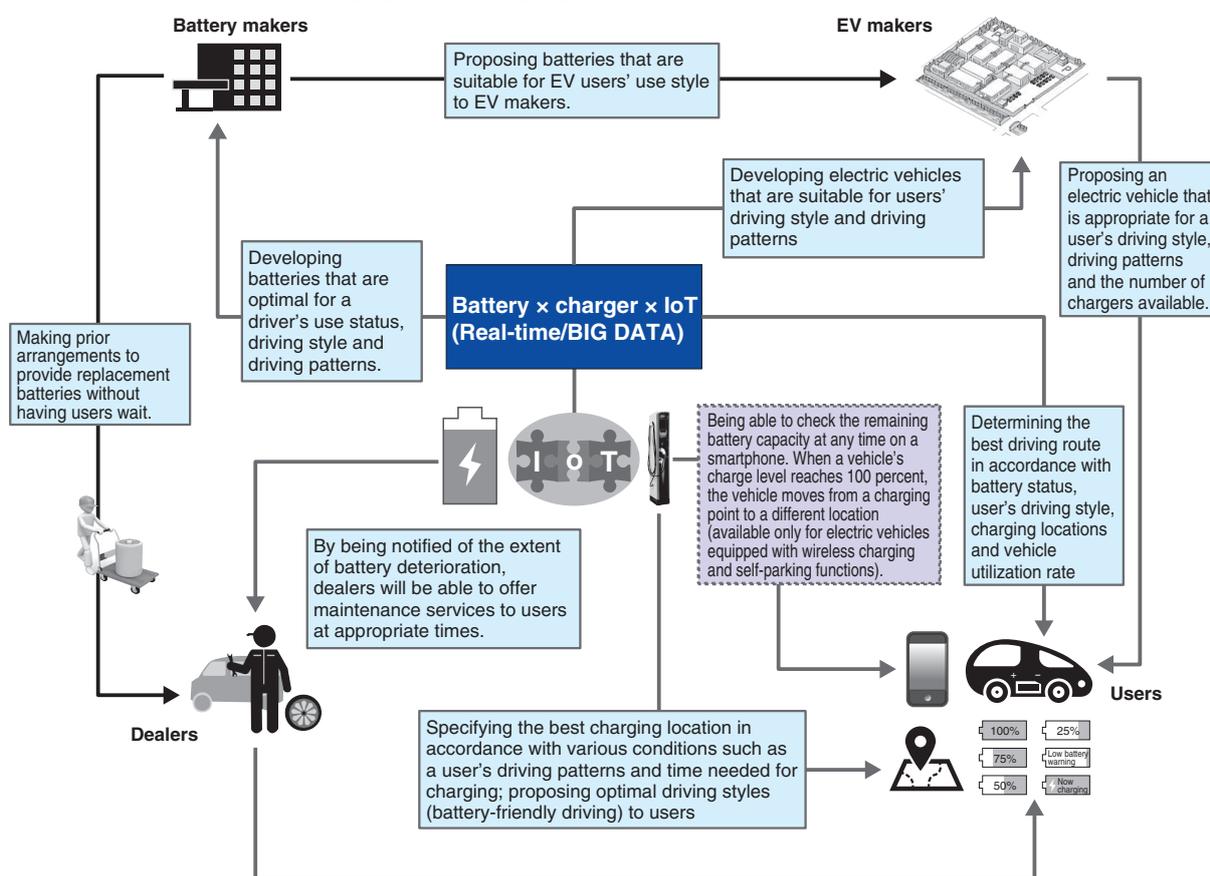
This service, called “ChargeNow,” indicates the locations of partner charging stations throughout the country on a map by using an onboard navigation system or a free smartphone app, “ChargeNow App.” The service also provides details of each charging station and real-time, full/empty information of each charger, and helps drivers check on the availability of a charger at the nearest charging station.

The expansion of these services will bring about service opportunities for stakeholders such as battery manufacturers, electric vehicle manufacturers, dealers and users. The projected services are introduced in the following paragraphs (Figure 6).

Service opportunities that will be available to battery makers include being able to make prior arrangements to provide replacement batteries without having users wait, and developing optimal batteries that are suitable for a driver’s use status, driving style and driving patterns.

Electric vehicle manufacturers will be able to propose electric vehicles that are suitable for a user’s driving style, driving patterns and the number of chargers available. They will be able to propose optimal driving styles (battery-friendly driving) to users by specifying the best charging stations for each user in consideration of the user’s driving patterns and time needed for charging.

**Figure 6. Projected services by applying IoT to charging service in China**



Batteries deteriorate over time. By being notified of the extent of such deterioration, dealers will be able to offer maintenance services at appropriate times.

Users will be able to check the remaining battery capacity at any time on a smartphone. When the charge level reaches 100 percent, a vehicle moves from a charging point to a different location (this service is available only for electric vehicles equipped with wireless charging and self-parking functions). In addition, users will be able to determine the best driving route in accordance with the battery status, user's driving style, charging locations and vehicle utilization rate.

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**Tomohide KAZAMA** is Group Manager at NRI's Global Manufacturing Industry Consulting Department. His specialties include business strategy focusing on the automotive, battery and materials industries, technology marketing and rulemaking strategy in emerging economies.

**Kazunori SUZUKI** is Senior Consultant at NRI's Global Manufacturing Industry Consulting Department. His specialties include planning business strategy for the manufacturing industry, particularly for the automotive industry, energy-saving measures, and support for entry into overseas markets.

**Dinghui, ZHANG** is Consultant at NRI's Global Manufacturing Industry Consulting Department. His specialties include formulating management strategy and business strategy, creating a strategy map and business transformation in the fields of automobiles, automotive parts/components, natural resources/energy and materials.

**Shotaro YOSHIHASHI** is Consultant at NRI's Global Manufacturing Industry Consulting Department. His specialties include planning business strategy regarding onboard batteries, lightweight vehicle development and next-generation automobiles.

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Inquiries to: Corporate Communications Department  
Nomura Research Institute, Ltd.  
E-mail: [nri-papers@nri.co.jp](mailto:nri-papers@nri.co.jp)