

A Study on the Current Status and Future Prospects of EV Automotive Market

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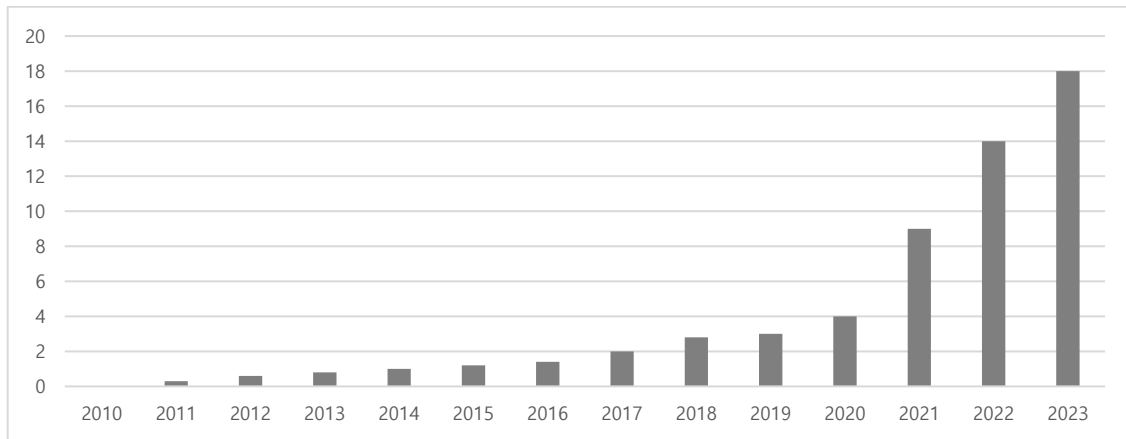
Abstract: According to the International Energy Agency (IEA) projections, the total number of electric vehicles in the world is expected to reach 250 million in 2030 and 525 million in 2035. As a result, more than one in four cars running on the streets is expected to be electric by 2035. In addition, annual sales of electric vehicles are expected to reach about 45 million in 2030 and close to 65 million in 2035. The penetration rate of electric vehicles is expected to exceed about 40% in 2030 and 50% in 2035. In addition, the number of EV chargers in the world is expected to exceed 15 million by 2030, which is four times the current number. With the spread of electric vehicles worldwide, the need for public EV chargers in each country is increasing. As of 2023, there are 3.9 million public EV chargers worldwide. The country with the highest number of installations is China, with 1.5 million regular chargers and 1.2 million high-speed chargers installed as of 2023. China is leading the introduction of EV chargers, accounting for more than 85% of the world's high-speed chargers and about 60% of ordinary chargers. In Europe, 590,000 regular chargers and 110,000 high-speed chargers are installed as of 2023. In the second half of 2023, the European Union adopted the Alternative Fuel Infrastructure Regulation (AFIR), making it mandatory to install public high-speed chargers every 60 km along the EU's major transport corridors. Through this, EV charging infrastructure in Europe is expected to expand rapidly in the future. This EV evolution can be said to be a big inflection point for transportation due to climate change. At this point, it can be said that it is very important to accurately recognize the current status and future of EVs. This paper aims to examine the current status of electric vehicles and forecast the future from this perspective.

Keywords: International Energy Agency, EVs, climate change, Tesla, BYD, overproduction

1. Introduction

According to the International Energy Agency (IEA= International Energy Agency), the penetration rate of the world's electric vehicles (the ratio of EVs to PHEVs) is 18% as of 2023. The growth rate has expanded since 2020, continuing to rise to 4.2% in 2020, 9% in 2021, 14% in 2022, and 18% in 2023. The country with the highest penetration rate is Norway, with 93%, followed by Iceland 71%, Sweden 60%, Finland 54%, Denmark 46%, and Belgium 41%. The overall penetration rate in Europe is 21%, with more than one in five vehicles sold in 2023(Figure1). China has the highest penetration rate of 38% outside of Europe, followed by Israel 19%, and New Zealand 14%. Japan's penetration rate is 3.6%, which is low worldwide. Europe is the top, but China is leading the world in the electric vehicle market, so both sales and total number of vehicles are ranked first. In 2023, global electric vehicle sales were about 14 million, of which 60% were sold in China, 25% in Europe, and 10% in the United States. The total number of electric vehicles in the world reaches 40 million, and China, Europe, and the United States account for about 65% of the total number of global automobile sales. China, the No. 1 market player, sold 8.1 million electric vehicles in 2023, accounting for about 60% of the world. The total number of electric vehicles is 21.9 million, and more than half of the world's electric vehicles exist in China. The second-largest market is Europe, with 3.3 million electric vehicles sold in 2023, accounting for about 25% of the world. The total number of electric vehicles is 11.2 million, and about 28% of the world's electric vehicles exist in Europe. Germany has the largest market in Europe.

Figure1. Trends in BEV-PHEV Ratio in Global New Vehicle Sales (2021-2023)



Date: Global EV Outlook 2024

EV subsidies stopped in Germany in 2023 and electric vehicle sales decreased from 830,000 in 2022 to 700,000 in 2023, but they still remain at the top. France followed with 470,000 units and the UK with 450,000 units. The third-largest market is the United States, with 1.39 million electric vehicles sold in 2022, accounting for about 10% of the world. The total number of electric vehicles is 4.8 million, accounting for about 12% of the world in the United States. Japan's electric vehicle sales in 2023 are 140,000 units, accounting for about 1% of the world. The total number is 540,000, with about 1% of the world's electric vehicles in Japan.

With the spread of electric vehicles worldwide, the need for public EV chargers in each country is increasing. As of 2023, there are 3.9 million public EV chargers worldwide. The country with the highest number of installations is China, with 1.5 million regular chargers and 1.2 million high-speed chargers installed as of 2023. China is leading the introduction of EV chargers, accounting for more than 85% of the world's high-speed chargers and about 60% of ordinary chargers. In Europe, 590,000 regular chargers and 110,000 high-speed chargers are installed as of 2023. In the second half of 2023, the European Union adopted the Alternative Fuel Infrastructure Regulation (AFIR), making it mandatory to install public high-speed chargers every 60 km along the EU's major transport corridors. Through this, Europe's EV charging infrastructure is expected to expand rapidly in the future. In the United States, 140,000 regular chargers and 43,000 high-speed chargers are installed as of 2023. In the United States, as well as increasing the number of EV chargers, the movement to unify the specifications of EV chargers to Tesla's North American Charging Standard (NACS) is underway. In December 2023, the Association of Automotive Engineers (SAE International) announced that Tesla's charging connector (J3400), based on the North American Charging Standard (NACS), will be used as a standard across North America. With the unification of EV charging standards, the interoperability of charging infrastructure and the charging environment of EV drivers across the United States will be improved. In Japan, as of 2023, there are usually 22,000 chargers and 9,600 high-speed chargers installed. The Japanese government aims to overhaul the charging infrastructure of 300,000 units, including 30,000 high-speed chargers for public use, by 2030.^[1]

The Chinese government aims to raise the proportion of new energy vehicles (NEVs) in new car sales to 45% by 2027. It originally aimed to raise it to more than 20% by 2025, more than 40% by 2030, and more than 50% by 2035, but because it met this goal early, the target was raised in 2023. Moreover, in 2035, all gasoline cars in new car sales are aiming to be produced as hybrid vehicles (HVs), so gasoline cars will be excluded from the market. The term "new energy vehicle (=NEV)" means an electric vehicle (BEV) or a plug-in hybrid (PHEV) fuel cell vehicle (FCV). The Chinese government ended the subsidies for the purchase of electric vehicles, which had been introduced since 2010, at the end of 2022 after a gradual reduction, but sales have continued to increase steadily. Although 2023 was the first year without subsidies, sales of low-end models continue to rise.

The European Union plans to ban the sale of new cars by 2035 using gasoline and diesel engine vehicles, except for synthetic fuel vehicles. In Europe, subsidies and tax incentives have been taken early on when purchasing electric vehicles. Countries that have recently spread electric vehicles, such as Sweden, the Netherlands, Germany, the United Kingdom, and France, have begun to focus on next-stage policies, such as gradually reducing or phasing out subsidies and tax incentives, and expanding charging infrastructure. The U.S. government is setting a goal of making more than 50% of new car sales electric

and fuel cell vehicles by 2030. Part of the Inflation Control Act (IRA), which was passed in August 2022, focused on accelerating the introduction of EVs. You can receive a tax credit of up to \$7,500 per vehicle for electric vehicles that meet certain requirements, such as final assembly of the vehicle in North America. Based on the latest data from the U.S. media "Clean Technica", which informs EV sales in countries around the world, let's look at the world's top-selling electric car makers and models.

The world's best-selling electric vehicle manufacturer in 2023 is BYD of China. BYD entered the automobile industry in 2003 from the battery manufacturing business and has been selling electric vehicles since 2008. As affordability gained popularity, it overtook Tesla, the United States, which has been the world's No. 1 for many years. The second place is Tesla of the United States. Tesla's electric cars have a very long mileage and excellent acceleration performance. It also has the world's largest fast charging network. BMW of Germany is in third place. BMW's electric car history is long, and the 1972 Summer Olympics unveiled its first model, the BMW 1602 Electric. It has been developing new models or technologies that are tailored to the evolution of electric vehicle technology for more than 50 years to date. In fourth place, it beat Volkswagen and entered China's GAC AION. It is an electric car brand of Chinese car maker and GAC that has rapidly increased sales in recent years. GAC, established in 1954, is a Chinese state-owned automobile company that has joint ventures with Toyota, Honda, and Mitsubishi, respectively. The spotlight is on China's Li Auto, which is ranked 7th. It has risen sharply from 19th in 2022. Li Auto is an emerging Chinese company that has been selling electric vehicles since 2015 and 2019. Among Japanese makers, Toyota is ranked 19th. Popular models abroad are 'bZ4X', 'bZ3', and 'RZ'.^[2]

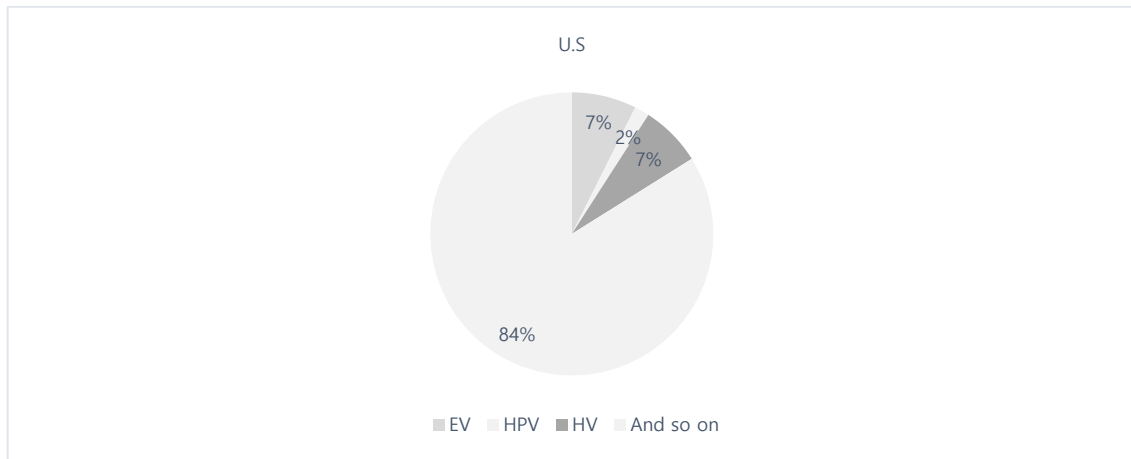
The International Energy Agency (IEA) predicts that the total number of global electric vehicles will reach 250 million in 2030 and 525 million in 2035. As a result, more than one in four cars running on the streets is expected to be electric by 2035. In addition, annual sales of electric vehicles are expected to reach about 45 million in 2030 and nearly 65 million in 2035. The penetration rate of electric vehicles is expected to exceed about 40% in 2030 and 50% in 2035. In addition, the number of EV chargers in the world is expected to exceed 15 million by 2030, which is four times the current number.

2. BYD, Tesla and EV Markets

Leading the EV automobile market are China's BYD and Tesla in the United States. What these companies have in common is that their main business is not the automobile industry, and they are dominating the global EV automobile market in a very short period of time. First of all, BYD briefly entered the automobile industry, but ended gasoline car production early in 2022 and quickly shifted its production system to EV and PHV. As a result, it has established a competitive advantage in the Tesla and global EV markets, regardless of whether it is unique in the global electric vehicle market. For example, in terms of electric vehicle sales (2023), BYD has an advantage of 1.04 million units and Tesla has an advantage of 1.32 million units, but there are currently no companies to compete between the two in major electric vehicle markets such as Europe and China. Market research company MarkLines said that Tesla (2023) is the highest in terms of global electric vehicle sales by vehicle type with 840,000 units, Model 3 with 37.6 million units, BYD's Qin Plus with 320,000 units, and Song Plus with 320,000 units. Even in terms of sales vehicles, BYD and Tesla are highly satisfied with consumers.

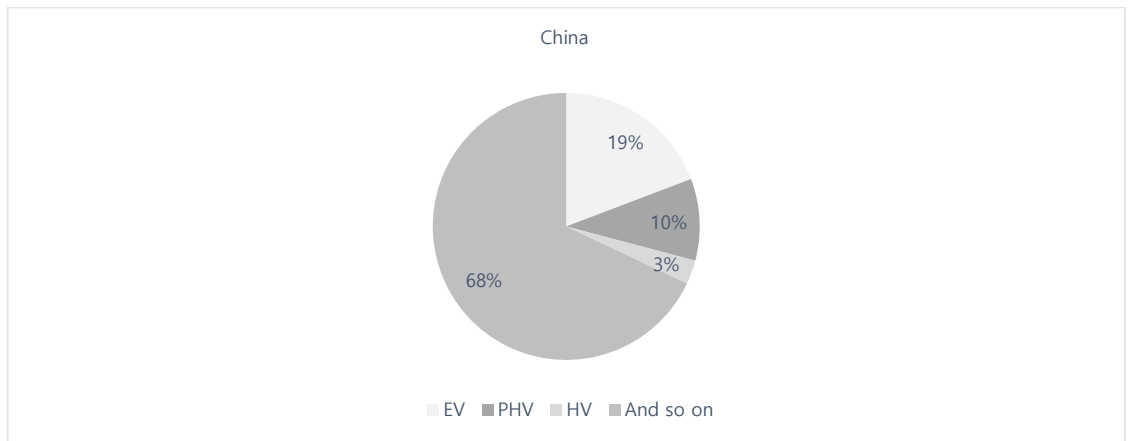
BYD and Tesla also attracted attention at the "IAA Transportation 2023" held in Germany in 2023. It has been 10 years since 2013, and BYD participated for the first time, but the consumer response was high. The Japan Trade Promotion Corporation (JETRO) had a strong presence as BYD introduced multiple models at an IAA event, although there was no increase in sales in Europe. BYD and Tesla are the result of increasing cost competitiveness through production rationalization by establishing a specialized development and production system for EVs. In addition, the design is advanced and software is faithful, so it is more competitive than existing automobile products. In other words, it is the result of quickly detecting and responding to the EV flow of consumers sensitive to trends or technology. Of course, government and regional EV support played an important role in the background of the development of these two companies. It was an investment in the future. For example, the EU plans to support EV purchases and ban the sale of internal combustion engine (ICE) cars from 2035. (Easy conversion of e-fuel cars using synthetic fuels that do not emit greenhouse gases). It also stipulates targets such as greenhouse-effect gas emissions, recycling resource conversion ratio by raw material, and battery recovery rate throughout the life cycle from procurement of raw materials to design, production, and reuse of batteries(Figure2).

Figure2. China, U.S., Europe's EV Sales Share



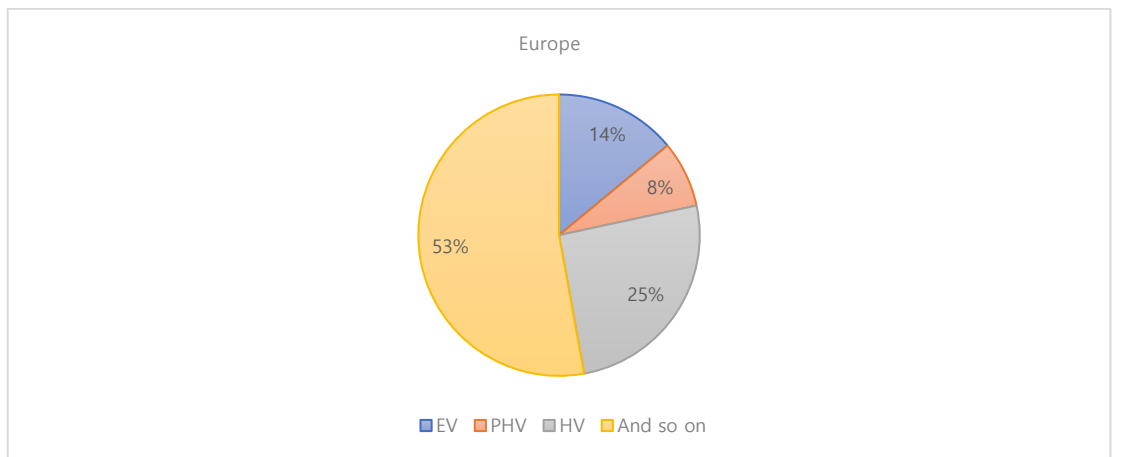
Data: U.S., China, MARKTLINES , Europe: European Automotive Industry Association (ACEA)

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Following Europe, the United States has also announced a presidential decree that aims to spend more than half of new vehicle sales by 2030 EVs, PHVs, and FCVs (fuel cell vehicles). The Inflation Control Act (IRA) established in 2022 stipulates in detail the place of production or procurement network for EVs and batteries, and EVs that do not reach this cannot receive up to \$7500 in tax support. While China also strictly regulates the issuance of vehicle numbers for gasoline cars, there are several support measures for EVs, such as purchase subsidies and vehicle acquisition tax reductions. As a result, the EV market has grown rapidly in recent years. In China, the EV ratio (2023) due to the expansion of EV

investment by Chinese companies other than Tesla and BYD reaches 19%. Europe, such as Germany and VW, is very interested in EVs, reaching 14%. Tesla's US market is 7%. On the other hand, Japan is only 2%, so Japan is a special market globally.

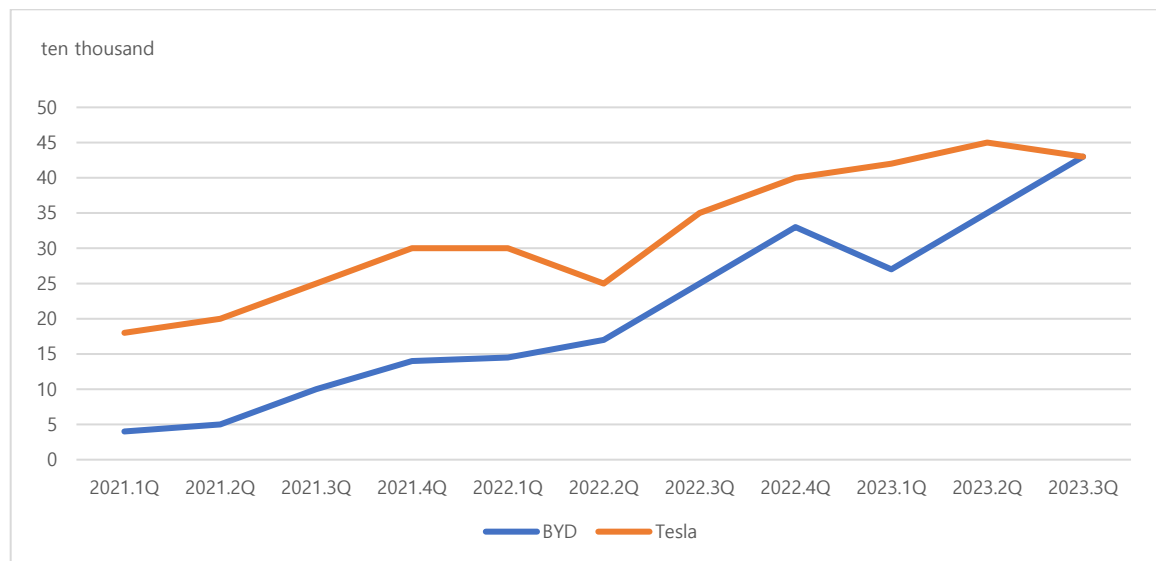
On the other hand, EVs are not just intended for exhaust engines. The essence of deoxygenation is a means of creating jobs in the country through industry. EVs should be understood as a means to achieve that. The IRA or European Battery Regulations aim to induce industries to the United States. It is intended to attract all investment, including not only EV and battery production plants but also raw material supply chains, including recycling. What's more complicated is each country's trend toward ensuring economic stability. Battery parts made or processed by companies in certain countries, including China, will be excluded from tax support from 2024 and important minerals will be excluded from the IRA. France revised its EV purchase support system in 2023 to exclude EVs imported from outside Europe from subsidies. Italy is also moving to agree.^[3]

3. Sources of BYD and Tesla's Competitiveness

3.1 Tesla's Sources of Competitiveness

Originally, EVs are difficult to generate profits due to production costs and profit correlations, but BYD and Tesla have established sources of competitiveness, respectively. First of all, Tesla specializes in EVs thoroughly, so the production and sales system is the source of competitiveness. For production, it employs a giant aluminum die casting facility called GIGA Press from IDRA, Italy. Conventionally, efforts were made to rationalize production in a line that is automated by aggregating more than 150 parts into two(Figure3).

Figure3. EV Global Market Sales Trends In BYD And Tesla



Date: BYD, Tesla's IR Data (2023), Note: BYD's EV sales do not include PHV

In addition, development costs were suppressed by reducing the number of vehicles. In addition, intermediate costs were reduced by selling them directly without going through an intermediate dealer. The consumer goods industry is expensive to advertise, and Tesla is increasing profitability in a different way than conventional automakers, such as relying on the CEO's own SNS.

Additionally, software is a must-see point of Tesla's competitiveness. For instance, a car icon represented by Rudolph looks like Santa will be riding. The icon that runs around it has also been changed to a reindeer. This entertainment component has become something that appeals to Tesla's consumers.

In the automobile industry, the term SDV (a car in which software defines value) frequently appears. In SDV, software is one of the major factors that increase the value of the vehicle by increasing the function or performance of the vehicle purchased. Accordingly, companies are paying attention to software development as a new revenue source for EVs by reducing production costs. In other words, this is why automobiles become smartphones.

Tesla has a production capacity of 2 million units at factories in Texas in the United States and Berlin,

Germany. In addition to this, factories are also being built in Mexico. In particular, old, US, and China, which have a lot of support for EV purchase, are becoming major markets. In particular, sales of the Model Y in 2023 in Europe increased 2.4 times from the same year last year. It is the most sold in Europe, including engine cars, and remains the top in 2023. In addition, the Shanghai plant in China, with an annual production capacity of about 1 million units, is functioning as an export base in Europe and North America. Although the plan to expand the production capacity of the Shanghai plant has been temporarily suspended, it is striving to maintain its top position in the world with the goal of 2 million units.

3.2 BYD's source of competitiveness

Unlike Tesla, BYD is highly competitive with the public as a practical vehicle. SUVs such as the AT 3 and DOLPHIN can be purchased for about 130,000 yuan to 190,000 yuan. BYD also has strong proper layout and is currently building factories in emerging countries such as Thailand and Brazil. It is also planning to expand production in Hungary from 2023, establishing a stable regional strategy.^[4]

The source of competitiveness of EV cars is, above all, batteries. BYD has the competitiveness of batteries. The inherent square power battery is a type of iriyumnion battery called the LFP battery. LFP batteries are cheaper than ternary systems (nickel, cobalt, and manganese), which use a lot of expensive materials. Although it has a disadvantage in capacity than the ternary system, it has high heat stability and is excellent in stability. BYD simplified the configuration of the battery and increased the quality of the battery with a battery capacity that can be mounted in a limited space, which is only in the form of a thin rectangle. This has secured a mileage that is comparable to that of other EVs using the ternary system.

BYD and Tesla are pursuing a vertically integrated model without sticking to their own development in areas that determine the competitiveness of EVs such as batteries, semiconductors, and software. Despite the difficulties of many automakers due to the shortage of semiconductors, BYD and Tesla's sales increased. Moreover, Tesla is directly dealing with mining companies to stably procure richium, the raw material for batteries. Meanwhile, BYD has created its own semiconductor manufacturing subsidiary and is reducing costs through mass production effects.

Since 2021, when the EV market expanded, BYD and Tesla have increased their profit margins, reaching 8%. Usually, an operating margin of 5% or higher can be considered a successful company. However, these companies were not successful in a short period of time. Tesla's operating profit was safely achieved after 2021, and previously, it faced a crisis of bankruptcy due to difficulties in mass production or financing.

Meanwhile, BYD initially produced gasoline cars, but it was only recently that it decided to weaken its competitiveness early and ended production in 2022, and later emerged as an EV. PHV sales are also growing rapidly, forming a production system of 3 million units per year along with EVs.

In addition, software improvements made by over the air (OTA) to enhance the multifunctionality of vehicles and stay true to trendsetters are the biggest attractions of BYD and Tesla to raise the interest of young people. In addition, the EV business, which includes a power base business that combines renewable energy with EVs and electronic systems for home appliances, is far beyond the framework of existing automakers.

However, existing companies are facing difficulties in the EV business. Volkswagen of Germany is showing signs of running counter to the trend of automobiles, such as cutting EVs and reducing the number of people developing software. Ford Motor of the U.S. has an unexpected loss of \$1.3 billion in EBITDA for its EV-related business in 2023. Given the trend of the EV environment, these difficulties are expected to lead to perceptual changes in the global automobile industry.

4. PHV and NEV Markets

The PHV market has grown significantly due to BYD's driving. PHV sales have increased since the second half of 2021, and the NEV market share has risen from 19% in 2019 to 31% in 2023. EV sales in 2023 are showing a slowdown in the previous year's growth rate to about 20%, while PHV's growth rate reaches about 80%.

In China, many cities give preference to NEVs over engine cars in terms of issuing vehicle numbers and acquiring vehicles. NEV sales in these cities account for about half of all NEV sales in China. Among NEVs, the background of the increase in PHV is due to changes in the mid-priced market. EVs capable of long-term driving are expensive and use large-capacity batteries, so the vehicle price is high. Therefore,

the attractiveness of EVs in terms of price has decreased due to the reduction and termination of EV deposits. In addition, as charging infrastructure maintenance is underway, consumers have moved to PHVs with longer mileage and cheaper prices than EVs.

The strength of BYD, which has increased its PHV presence, is its high performance and price competitiveness. PHV is equipped with both sides such as a drive motor and battery, and the cost is generally about \$4100 to \$5500, but BYD targeted the engine market with PHV by taking advantage of the advantages (electricity and engine car are the same price).

BYD's PHV system (DM-i) is combined with a high-efficiency engine and has greatly improved fuel efficiency. The (QIAN PLUS DM-i) equipped with this system has realized fuel efficiency of more than 26km per liter of gasoline. Although BYD's PHV with a high-performance drive device is not easy to respond to engine cars with cost, the low price of (QIAN PLUS DM-i) is about 100,000 yuan, which is the price range of Toyota's engine car. In addition, the mid-sized sedan (SEAL DM-i) is the first to be equipped with a vehicle stability control system developed by its own company, and it achieved a driving speed range of 200km in the form of a battery car for the first time as a medium-sized PHV.^[5]

BYD's high price competitiveness is because it is a company that makes batteries. BYD can develop its own lithium ion battery independently. By establishing a vertically integrated production system including not only batteries but also power trains and internal and external parts, a common platform for each vehicle size was used to reduce large costs.

BYD is the first global automobile company to stop producing engine cars. Currently, a total of 20 models, including NEVs, are being produced to meet various demands ranging from medium and large EVs in the high-end price range to PGVs in the mid-end price range and small EVs in the low price range. BYD has a 35% share and an overwhelming advantage in the NEV market in 2023. In the entire passenger car market, it has become a leader, beating YIQI VW, a 2022 VW China merger. It is building its power to maintain cost competitiveness through mass production effects.

5. China's EV Automotive Surge

Meanwhile, there are many NEV competitors in China other than BYD. Due to the continuous limitations of gasoline car development, Chinese state-owned automobile companies promoted the fostering of new EV brands with the focus on electricity and connected. There are guangzhou qiche under guangagqi Aion, changanqiche under (abata-), beijingqiche under borderless, jiliqiche under (ZEEKR), and dongfengqiche under (VOYAH). Among them, guangzhouqiche's flagship model (Aion Y) (Aion S) is popular with consumers and is the third largest in the Chinese NEV market.

In addition, about 50 IT and electronics companies in China have entered the EV development market since 2014 after seeing Tesla's success stories, but most are now struggling. Emerging companies such as hengda new energy vehicles, weimaqiche, and qidianqiche, which are affiliated with the real estate giant hengda Group, are also experiencing business difficulties in 2023.

Among emerging companies, only five companies sell 100,000 units in 2023. Among them, lixiangqiche and NIO are producing luxury cars like Tesla. Lingpaoqiche and nataqiche produce low-priced EVs, and xiaopengqiche produce mid- and high-end EVs through connected car production. Other companies are pursuing differentiation strategies by providing automatic driving assistance functions in addition to AI, automatic voice, and entertainment apps. In particular, lixiangqiche recorded a surplus in 2023, making it really difficult to make a surplus due to electric vehicle production. Lixiangqiche is a type of PHV equipped with a power generation engine, whose mileage has raised consumer expectations. In addition, the production efficiency was increased by using the Matryoshka design that commonizes the parts and technologies of each model. This strategy to have various services or prices increases profitability by increasing customers. In addition, lixiangqiche is responding to EVs that shorten charging time. The (MEGA) of the EV luxury minivan, which went on sale in 2023, can drive 500 km on a 12-minute charge. In the future, performance is expected to improve further. The company plans to sell 1.6 million units of the lixiangqiche and guangzhouqiche Alon in 2025 and 1 million units, respectively. Although the unit is different from BYD's 4 million units, chances are high that it will compete with Tesla for the second place in China. From now on, emerging companies that use SDV or automated driving technology may become a strong competition for BYD in the mid- and high-end vehicles.

6. Advancement of EV Cars

The public opinion that next-generation cars are EVs is growing. The source is environmental performance as well. In other words, it is a green car that generates no CO₂. Driving is quiet, especially with less vibration is touching, and there is less fatigue when traveling long distances. Although it may have low hobbies due to the lack of engine sound, it is perfect for practical waves and is excellent for the surrounding environment. However, due to the short mileage, charging time, and lack of infrastructure, many people still have a lot of anxiety about purchasing EVs. There are not many model or grade options, and although there are subsidies, the price is high.

Many people are interested in EVs, but many are hesitant to buy them because they think they don't fit the usage environment yet. Hybrid cars or engine cars are definitely the most likely candidates to buy yet.

Whether the purchase choice is HV or the engine, the meaning of choosing it is not clear. For example, if it is an electric car, you want to receive new value or joy, but if you want to use it with confidence even when traveling long distances, HV would be a good option. Or, if the electricity of the passenger car progresses in the future, there will be fewer engine cars to choose from, but rather an engine car may be an option now.^[6]

A sports car is typical of an engine car. The engine itself feels good, which is also a big reason. The EV somehow has a large battery and a heavy weight, and at this point, the running side and design are not satisfactory enough. It is still a long way off from being able to realize a lightweight sports car as an EV.

However, the strengthening of vehicle roar regulations is getting higher. In the future, there is a high possibility that the option of sports cars with internal combustion engines will disappear. The current choice may not be wrong. You may be able to choose an engine car due to cost issues. Compared to EV cars, they are cheaper and even considering the long-term cost of holding, engine cars are still the best option in many cases. These were taken into account by HV. It is not as expensive as EVs and has excellent fuel, so long-distance driving can be used at will.

7. Types of EV cars

7.1 Basic form of EV

Electric cars basically move by rotating tires, and they use motors as driving power. In the broad sense, it means electric vehicles (EVs). An EV is a vehicle that moves by converting electricity into power. It is a vehicle that drives a motor from electricity. EVs are divided into four types: BEV (Battery EV), HEV (Hybrid EV), PHEV (Plug-in-Hybrid EV), and FCEV (Fuel Cell EV).

In general, an EV often means a BEV. The BEV charges outside the mounted battery and moves the motor with that electricity. Since no engine is required, the number of parts reaches about 30,000 for gasoline cars, but the number of parts for BEV can be greatly reduced to about 20,000.

The HEV runs in combination with a motor and an engine that uses gasoline or diesel fuel. It does not have an external charging function, and it is obtained by charging the basic engine used in the motor. Therefore, there is no place to charge the car.

Combinations of HEVs can be classified into three main categories. An example is a structure represented by the primus, which is divided using power and gears in the engine and connected by the driving of wheels and generators.

PHEV can be charged externally as well as powered by an engine like HEV. FCEV generates electricity through a chemical reaction between hydrogen and oxygen and drives a motor. It is charged at a hydrogen charging station to cause a chemical reaction in a system called a fuel cell.^[7]

7.2 The pros and cons of EVs

EVs also have their own advantages and disadvantages. In theory, BEV emits zero CO₂ (carbon dioxide) while driving. However, in order to increase the mileage, it is difficult to increase the amount of batteries loaded, eventually increasing the price of vehicles and lengthening the charging time.

HEV can lower body cost due to its small battery size, but CO₂ is emitted from the engine. PHEV

has only the advantages of BEV and HEV, but the price of new cars also increases due to the high battery cost. FCEV does not emit CO2 and has a long mileage. Hydrogen charging time is also short, but the problem is that the price of new cars is high and hydrogen charging facilities are low.

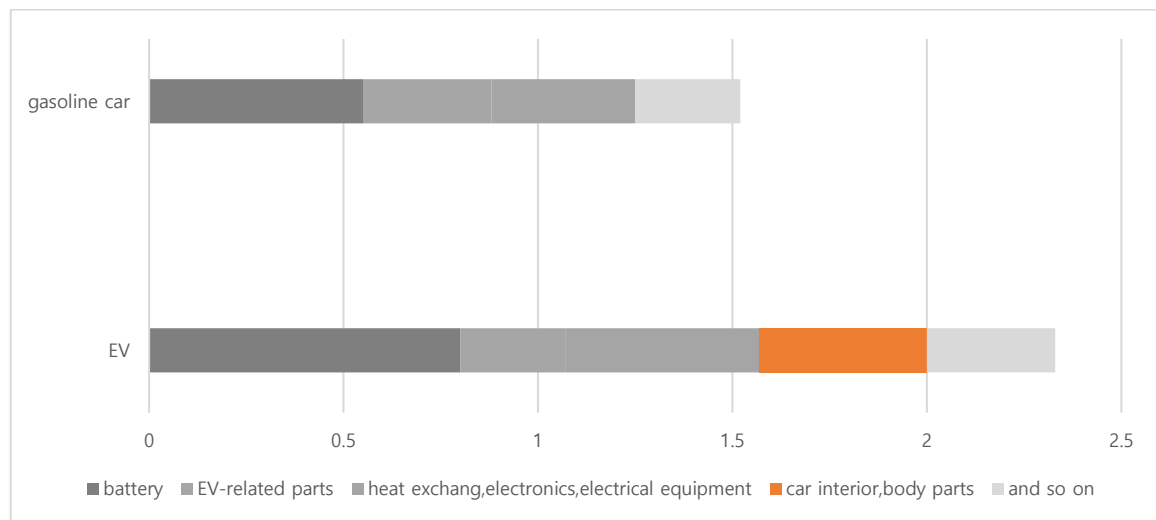
7.3 High cost of EVs

The difficulty of EVs to profit is due to high battery costs. The battery cost, which accounts for the average cost of one EV part, reaches 30%. Figure 4 shows that EV cars do not have high returns in the same way as engine cars.

Automobile batteries are expensive because they use rare metals such as lithium as materials. The supply of what is known as rare metals is limited, which confuses expectations for increased demand. More and more companies are investing in resource rights and interests by automakers themselves.

For automobile companies that develop and manufacture engines, batteries are based on external procurement, and in order to expand EV production, automobile companies have a sales advantage through cooperation with large battery makers in China and Korea.

Figure4. Average cost to buy parts per EV and gasoline car



Data: AlixPartners (2024), Survey of Consumer Consciousness About 2024 Electric Vehicles

Meanwhile, efforts are being made to reduce battery costs. For example, a lithium ion battery called iron oxide, which does not use three types of rare metals with high price, is used. Existing Japanese and European automakers, which are difficult to expand battery capacity, are negative to use, but it is a solution to the capacity problem considering the combination of body parts. BYD and Tesla have already introduced this. Battery costs are falling due to efforts to develop batteries by utilizing cheap materials or to improve the battery's production process.

Cost savings other than batteries are also making progress. Giga casting that makes huge aluminum parts is drawing attention. Thousands of parts are replaced into one to significantly reduce the processing process. Aluminum, which is more expensive than iron, is used, and Tesla and Chinese cars are introducing it before other cars because it can reduce costs. In addition to cost reduction, a surplus is possible if attractive EVs are made and many sales are possible at high prices. In addition, it plays an important role in increasing profits by improving software and services. Therefore, it is also important to establish a surplus model for EVs.^[8]

Conclusion

EV development can be said to be a big inflection point for transportation due to climate change. EV development is also rapidly developing accordingly. Companies are also actively working on EV development. In other words, Tesla and BYD are conducting businesses not only for production, but also for resource procurement, battery production, and power business that combines renewable energy. Japan's Itochu Research Institute points out that it is now moving both ways to produce and create value for EV products.

It has only been about 10 years since the EV market was created. So, not only hardware but also software, a new area, is developing as it competes. In the automobile industry, competition rules and opponents change rapidly in connection with political and social issues.

This overheating competition could rather run counter to the big challenge of climate change. For example, it is the problem of excess production capacity. We are facing a new problem due to overheating of production. In particular, the Chinese automobile industry is time to consider the problem of excess production capacity. As of the end of 2022, China's passenger car production capacity is estimated to be 42.89 million units per year, which is 44% overproduction. In addition, there are 54 companies that produce less than 10,000 NEVs, and the problem of over-entry is serious.

Among these, the exemption from vehicle acquisition tax, which promoted NEV sales, will continue until 2025, but will be halved in 26 and 27. Due to fierce competition in the domestic new car market in China, Chinese companies have begun to enter overseas markets in earnest. China's automobile exports reached 5 million units in 2023, overtaking Japan to become the world's largest automobile exporter. However, the European Union is wary of Chinese products with EV competitiveness with the plan to investigate subsidies for Chinese EVs.

Tesla, the No. 1 EV car, is also likely to become the second-largest in China, so it plans to double its EV production capacity to 2 million units per year by expanding its Shanghai plant in the third stage. Currently, the Shanghai factory is producing two models of the (Model Y) and (Model 3), so production exceeded 900,000 units in 2023. Tesla is making its Shanghai factory an export base by taking advantage of China's EV cost advantage.

In 2023, VW also established a merger with CARIAD, a software development company, and an AI semiconductor company in China. In the future, it is planned to cooperate with the development of Connected Car. Stellantis is also investing in Leap motor to aim for EV development know-how or supply-chain.

The Chinese automobile industry, which cannot catch up with advanced cars with engine cars, is building a world-leading high-performance and low-cost supply-chain with EVs or PHVs. In the future, the impact on the global automobile market is expected to be large. Chinese companies emphasize the importance of technology development and speed management. If the competitive advantage is maintained with electricity or smartization technology, it seems that the time will not be long before the Chinese automobile company brand becomes a world famous brand.

Second, in terms of politics, it will be an important point in achieving EV penetration. It will be an important starting point for EV distribution depending on the results of the Harris and Trump elections in the 2024 presidential election. In other words, Trump is criticizing the rationality of Biden's environmental policies and industrial policies such as EVs. Trump is promising to abolish regulations under the Biden administration by abandoning current environmental goals and promoting fossil energy development. Of course, if Harris is elected, it is highly likely to follow Biden's policy as it is. Depending on the election results, changes in the continuation of EVs are expected.

Third, the increase in EV cars in Germany has had a significant impact on the expansion of consumer options through subsidies and diversification of product lines, and the maintenance of charging infrastructure. However, the biggest reason seems to have been the purchase subsidies for EVs, PHVs, and fuel cell vehicles (FCVs). Germany's purchase subsidies were introduced in 2016, but in 2020, subsidies from the German federal government, called (environmental bonuses), were greatly increased.

However, the Olaf Scholz regime decided to reduce and abolish purchase subsidies in 2022, and subsidies for PHV ended in 2022. EV subsidies were also cut in 2023. As a result of this, new EV and PHV registrations increased in 2022, it can be seen that subsidies played a major role in purchases. Therefore, it is expected that it will have some form of impact on EV conversion.

The development of global EV will continue, but we hope that the automobile era will come suitable for the new era by sufficiently collecting opinions from those who are concerned about this.

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