THESIS

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New energy vehicles (electric vehicles) industry development analysis:

Consumer Behavior of New Energy Vehicles.

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1. Introduction

Europe is the birthplace of the traditional automobile and the birthplace of the electric car. The world's 1st electric car is usually considered to have been invented by Englishman Robert Anderson around 1832, half a century before the fuel car (Lalu & Loison, 2018; Avere France, 2021). In Europe and the United States, electric vehicles were at their peak in the late 19th century.

In 1900, 15,755 electric cars, 1,684 steam-engine cars, and only 936 fuel-fired cars were manufactured in the U.S. At the end of the 20th century, with dwindling petroleum resources and increasing atmospheric pollution, there was a renewed interest in electric vehicles. In 1990, the California government was the first to establish the Zero Emission Vehicle program, which mandated manufacturers in the U.S. to produce at least 2% zero-emission vehicles starting in 1998. In 1990, the California government first established the Zero Emission Vehicle program, which mandated manufacturers in the United States to produce at least 2% zero-emission vehicles from 1998 onwards (Lalu & Loison , 2018; Avere France, 2021). Some European countries have set similar goals, for example, France set a target of 5% of cars in cities to be electric by 1999 (Avere France, 2021).

At the beginning of the 21st century, the world's new energy vehicles ushered in a golden age of vigorous development, stimulated by government policy subsidies. 2012 saw Tesla begin mass production of the Model S. The car's novel design, stylish smart devices, and superb acceleration (100km in 2.7s) have pushed the development of pure electric vehicles to a new climax.

At the beginning of the 21st century, the Chinese government chose to revitalize the automotive industry with new energy vehicles, and from 2009-2012, with the establishment of the EV development strategy, the Chinese government introduced new energy vehicle pilot projects on a large scale in several cities across the country and prioritized their deployment in the public sector through R&D investments and direct subsidies. Incentivized by government policies, China's EV industry and market have grown rapidly, and many new energy vehicle start-ups have been born. Beginning in 2016, China became the world's largest EV market. By 2019, China will account for half of global sales of electric passenger cars (Jin et al., 2021).

China has been instrumental in the global development of new energy vehicles.

As the birthplace of automobiles, European car companies have been occupying a special position in the automotive field for more than a hundred years, leading the world trend in many aspects. Their long history and strong technology have given European automakers a great advantage in all aspects of the automotive field. At the same time, the European people generally have a strong sense of environmental protection, the European government's environmental policy often play a leading role in the world. 2015 in Paris, the United Nations Climate Change Conference reached a historic agreement to reduce emissions (Mock 2014). On the eve of the Paris climate conference, the European Union has set the world's toughest carbon emission standards for automobiles (Dornoff et al., 2018). It can not only protect the environment, but also promote the sustainable development of new energy vehicles from the policy level. Therefore, the development process and trend of new energy vehicles in Europe is a great reference for the future development of new energy vehicles in China.

New energy vehicles include pure electric vehicles, rechargeable hybrid vehicles and hydrogen vehicles. Although hydrogen energy is regarded as the clean energy with the most development potential in the 21st century, hydrogen fuel cell vehicles have never taken off in Europe due to high costs, immature technology, and other challenges. In 2019, the total sales of hydrogen fuel cell vehicles in Europe were only 526 units (Wikipedia, 2023). In a large automobile market with annual sales volume higher than 15 million units, it is almost negligible.

The automobile market is now at an important stage of overshooting from traditional oil vehicles to new energy vehicles, so new energy vehicles will have an increasing market share in the future. I chose this topic to find out what consumers think about the new energy vehicle market and to make relevant suggestions.

2. Literature Review

2.1. New Energy Vehicle Development History

In the middle of the 19th century, there appeared the world's first electric car, which was largely the work of 2 generations. The first was the electric transmission device completed in the laboratory of the Hungarian engineer Ányos Jedlik in 1828. Then it was improved by the British Robert Anderson and the first electric car was officially launched between 1832 and 1839. The batteries used in this electric car were relatively simple and were non-rechargeable (Shahan 2015). By 1899, Ferdinand Anton Ernst Porsche invented a hub motor to replace the chain drive that was commonly used in automobiles at the time. This was followed by the development of the Lohner-Porsche electric car, which used lead-acid batteries as a power source and was driven directly by a hub motor inside the front wheels - the first automobile to bear the Porsche name. The car made a sensational debut at the 1900 Paris World's Fair under the name Toujours-Contente. Purely electric cars were used long before the advent of fuel cars. of the 4,200 cars sold in Europe and the United States in 1900, 40% were steam locomotives, 38% were electric, and the remaining 22% were fuel cars. At that time, fuel cars were still using external combustion engine technology, which drove noisily and emitted black smoke (Yakovlev 2019). For the European upper-class consumers, automobile should be a product to enjoy and symbolize their status, however, the loud noise and the emission of black smoke do not meet the consumption standard of the European upper-class consumers, so the fuel car was not the first choice at that time.

In the early 20th century with the development of engine technology, the invention of the internal combustion engine as well as the improvement of production technology, fuel vehicles formed an absolute advantage at this stage. Advantage points are mainly manifested in that, although the internal combustion engine is relatively large, exhaust gas, will pollute the environment, noise is also very large, but its fuel is easy to carry, used in transportation, can carry enough fuel to drive a long distance itself. The electric motor is small in size, does not pollute the environment, does not emit exhaust fumes, and the noise is very small, but it needs electricity to work, and electricity is not easy to carry, unless it carries a battery, and at that time there was no major breakthrough in battery technology, the capacity of the battery is limited, so the traveling distance is limited. If it is used in fixed occasions, it can use electric motors, which are relatively more suitable. In this period of electric vehicles compared to the fuel car charging inconvenience and range distance limitations, so this stage of pure electric vehicles out of the automobile market. With the stagnation of the electric vehicle industry, the development and exploitation of electric vehicles also basically came to a standstill.

In the late 1950s, Henney Coachworks formed a joint venture with Exceed battery manufacturer Federal Electric to develop and produce a new electric vehicle called the Henney Kilowatt. The car was available in both 36-volt and 72-volt configurations, and the 72-volt Henney Kilowatt could reach a top speed of 96 kilometers per hour and was capable of driving for one hour continuously on a single charge mode. Although the Henney Kilowatt was a major milestone in that the new technology allowed for a significant increase in speed and range for electric cars, it still had significant disadvantages compared to its gasoline contemporaries, and production of the Henney Kilowatt was officially discontinued in 1961 after a lackluster market response.

In the 1960s, the oil crisis made people pay attention to the pure electric car again, this stage of the European continent has entered the mid-industrialization, the problem of the oil crisis has appeared and become a problem that human beings cannot be ignored, people have realized that they need to find a new way to replace the fuel cars that have been relying on, and began to reflect on the increasingly serious environment will bring great disasters to human beings, and the advantages of electric motors, which are small in size, do not pollute the environment, do not emit exhaust gases, and have very little noise, have brought pure electric vehicles back into people's view. Electric cars were driven by capital, and in the following decade or so, the drive technology of electric cars had a greater development, pure electric cars received more and more attention, and small electric cars began to occupy a fixed market, such as golf course mobility scooters. In 1966, Ford demonstrated a laboratory model of a sodium-sulfur battery, which was 15 times lighter than ordinary lead batteries. The company's engineers said they needed at least two more years to develop a prototype (Li 2013).

The renaissance of electric vehicles in the 1990s was a result of the energy crisis that began in the 1970s and 1980s, which rekindled interest in the new energy vehicle market. before 1990, the promotion of the use of electric vehicles was still largely private. For example, the World Electric Vehicle Association (WIVA), a private academic organization established in 1969, organized Electric Vehicle Symposium and Exposition (EVS) every year and a half in different countries and regions of the world. The World Electric Vehicle Association organizes Electric Vehicle Symposium and Exposition (EVS) in different countries and regions of the world every year and a half. The biggest problem hindering the development of EVs in this era is the lagging development of battery technology. The lack of major breakthroughs in batteries has led to no breakthroughs in charging box range, which has posed a huge challenge to EV makers and caused them to change their direction of development. Traditional automakers, under market pressure, began to develop hybrid vehicles to overcome the problems of batteries and short range. This time is best represented by PHEV plug-in hybrids and HEV hybrids (Li 2013).

At the beginning of the 21st century, the global economic recession led to automakers having to give up less fuel-efficient off-road vehicles, providing a broader space for the development of small-displacement, new-energy vehicles. And there was a breakthrough in battery technology, and countries began to apply electric vehicles on a large scale. This stage of the battery density increases, the range level of electric vehicles also increased at a rate of 50 kilometers per year, the power performance of the motor has been no weaker than some low-displacement fuel vehicles. In 2004, Tesla Motors, a California-based electric car manufacturer, began developing the Roadster, an all-electric sports car, and mass production began in 2008, the world's first mass-produced all-electric sports car. More than 2,000 units of the Roadster have been sold to date, with plans to launch the next generation of all-electric sports cars in 2014. Top leaders at several major automakers, including Nissan and General Motors, have said the Tesla Roadster is a catalyst, and that the car represents a pent-up demand for greater efficiency. GM released the Chevrolet Volt in 2010, which represents the highest technology in plug-in hybrids, and other companies have since released models such as the Opel Ampera, the leaf (Li 2013). The Chinese government is vigorously promoting the development of new energy vehicle technology and product landing, Chinese automobile enterprise BYD independently developed BYD E6 pure electric car model, in 2011 10 began to sell in Shenzhen, China. And after 2014, several excellent new energy vehicle manufacturers emerged in China under the support of policies and market promotion, and up to now China has become the world's new energy vehicle ownership and production of the highest number of countries.

Since the nineteenth century since the introduction of new energy vehicles, new energy vehicles because of technology, environment, policy, and other reasons continue to stop the development and thus withdraw from the market, but with the solution of these problems one by one, new energy vehicles will once again appear in people's vision. Therefore, I think that the new energy vehicles will be the mainstream choice of people before the emergence of the next generation of alternatives.

2.2. The current classification of new energy vehicles

As the current new energy vehicles are not fully popularized, so many people have a wrong perception of the classification of new energy vehicles, thinking that new energy vehicles are pure electric vehicles. The so-called new energy vehicles refer to the main source of power does not rely on the internal combustion engine models, the most important feature is the use of electric motors to provide power, to the electric motor power supply equipment is the battery, to charge the battery can be built-in engine, external charging ports, solar energy, chemical energy, and even hydrogen energy. In his book, Wang (2020) categorizes new energy vehicles into Battery Electric Vehicle, Hybrid Electric Vehicle, Plug-in Hybrid Electric Vehicle, Range-Extended Electric Vehicle, Fuel Cell Electric Vehicle, Hydrogen Electric Vehicle, and Hybrid Electric Vehicle. Cell Electric Vehicle Hydrogen Internal Combustion Engine Vehicle six types:

- **Battery Electric Vehicle** (BEV) for short, is a vehicle that uses on-board rechargeable batteries as power and an electric motor to drive the wheels. The operation of an electric vehicle relies on the output of electrical energy from the power battery, which drives the motor through the motor controller to generate power, and then through the deceleration mechanism, the power is transmitted to the driving wheels to make the electric vehicle move. And it is a vehicle that complies with road traffic, safety regulations and various requirements. A typical pure electric vehicle mainly includes power supply system, drive motor system, vehicle controller and auxiliary system. The rechargeable batteries of pure electric vehicles mainly include lead-acid batteries, nickel-cadmium batteries, nickel-metal hydride batteries and lithium-ion batteries, etc. These batteries can provide the power for pure electric vehicles, and at present there are also pure electric vehicles that can store electricity by directly replacing the batteries so as to replenish the energy faster, and this type of vehicle is exemplified by the NIO automobile, which can replace its batteries by replacing the batteries in the brand's special exchange station, which is a much quicker way than the normal recharging. The battery can be replaced at the brand's dedicated power stations. From the overall technical point of view, BEV can be regarded as a series hybrid structure with the engine removed, and its technical difficulty is much lower than that of HEV technology. Due to the elimination of power systems such as the engine and transmission, it can even be said that BEVs are lower than the technology of ordinary fuel vehicles, and they have once again come onto the stage of history and the market field of vision, on the one hand, it is a change in the energy structure, and on the other hand, it is the guidance of policies of various countries. Now the market of pure electric vehicles is developing very fast, and the prospect is very good (Wang & Li 2020; EVgo Services LLC, 2024).

- **Hybrid Electric Vehicle** (HEV) for short, utilizes both the internal combustion engine of a conventional vehicle and the electric motor of a pure electric vehicle for hybrid drive, and its main drive system consists of at least two individual drive systems that can operate simultaneously in a combination of vehicles, and the driving power of a hybrid electric vehicle is mainly dependent on the state of the hybrid vehicle's vehicular operation: one is provided by a single drive system alone; the second is provided by multiple drive systems together. alone, the second is provided by multiple drive systems working together. It reduces the demand for fossil fuels and improves fuel economy, thus achieving energy saving and emission reduction and mitigating the greenhouse effect. Hybrid vehicles can be categorized into micro hybrid system, medium hybrid system and full hybrid system according to the degree of mixing. In micro hybrid system, the electrical components (starter motor/generator) are only used for starting and stopping functions. During braking, part of the kinetic energy can be converted into electrical energy for reuse (energy regeneration). The vehicle cannot be driven by pure electric power. In a medium hybrid system, the electric drive is used to supplement the internal combustion engine to drive the vehicle. The electric motor drives the wheels in conjunction with the engine, helping to "push" the vehicle when it needs more power, thus improving start-up and acceleration. The electric motor in this type of hybrid powertrain is usually located between the engine and the transmission, rather than independently. The vehicle cannot be driven by pure electric power. With a moderate hybrid system, more kinetic energy can be recovered during braking and stored as electrical energy in a high-voltage battery. High-voltage batteries and electrical components have higher voltage and power ratings. Due to the assistance of the electric motor, the internal combustion engine can be started in the optimum efficiency range, which is known as load point nudging. In a full hybrid system, the system combines a more powerful electric motor with the internal combustion engine, allowing for purely electric drive. The electric motor can assist the operation of the combustion engine once defined conditions are reached. At low speeds, the vehicle is driven exclusively by electric power. The internal combustion engine has start and stop functions. The recovered braking energy recharges the high-voltage battery. A clutch between the combustion engine and the electric motor disconnects the two systems. The internal combustion engine intervenes only when required (Wang & Li 2020; EVgo Services LLC, 2024).

- **Plug-in Hybrid Electric Vehicle** (PHEV) for short, is a new energy vehicle between pure electric vehicles and fuel vehicles, which has the engine, transmission, drive system, fuel circuit and fuel tank of a traditional vehicle. It also has the battery, electric motor and control circuit of a pure electric vehicle, and the battery capacity is relatively large, with a charging interface; it integrates the advantages of pure electric vehicles and hybrid vehicles, which can realize pure electric and zero-emission driving, and also increase the vehicle's driving range through hybrid mode. During daily use, it can also be used as a pure electric vehicle, as long as the single use does not exceed the range that the battery can provide, it can achieve zero emission and zero fuel consumption. Due to the high cost of batteries, it is difficult to realize that this type of vehicle can enter the family at a lower price in the short term, however, due to the influence of the development trend of new energy vehicles and the increase of corresponding subsidies due to the government's attention, plug-in hybrid models are gradually becoming one of the main products of new energy vehicles. (Wang & Li 2020; EVgo Services LLC, 2024).
- **Range-Extended Electric Vehicle** (REEV) is a hybrid vehicle that uses a mixture of fuel and electricity. It is similar to an electric vehicle in that it uses an engine to generate electricity and an electric motor to drive the vehicle. When the battery pack is fully charged, the vehicle is driven in pure electric mode, and when the battery is low, the engine in the vehicle starts, driving the generator to charge the power battery and provide electricity for the electric motor to run (i.e., extended-range mode), and the driver can utilize this engine to replenish the power for the extended-range electric vehicle. (Wang & Li 2020).
- **Fuel Cell Electric Vehicle** (FCEV) for short, is a fuel cell electric vehicle that uses hydrogen, methanol, natural gas, and gasoline as reactants to be combusted with oxygen in the air in a battery under the action of a catalyst, which in turn provides electric energy as a

power source for the vehicle. Essentially, fuel cell electric vehicles are also one of the electric vehicles and have many similarities with electric vehicles in terms of performance and design. The reason for dividing them into two categories is that fuel cell electric vehicles convert hydrogen, methanol, natural gas, gasoline, and so on, into electric energy through a chemical reaction, whereas pure electric vehicles rely on recharging to replenish the electric energy. (Wang & Li 2020).

- **Hydrogen Internal Combustion Engine Vehicle** (HICEV) is a hydrogen vehicle that uses an internal combustion engine. HICEVs are different from hydrogen fuel cell vehicles (which utilize hydrogen electrochemically instead of burning it). Instead, a hydrogen internal combustion engine is simply a modified version of the traditional gasoline-powered internal combustion engine. Being carbon-free means that no carbon dioxide is produced, thus eliminating the major greenhouse gas emissions of conventional petroleum engines. However, the cost of batteries for hydrogen-powered vehicles is very high, and storage and transportation conditions make it difficult to practically apply them in actual production, making it difficult for hydrogen-powered vehicles to become a mainstream model of energy vehicles as of yet (Wang & Li 2020).

As far as the current market is concerned, the main new energy vehicles for sale and use are pure electric vehicles, hybrid vehicles, plug-in hybrid vehicles and programmable electric vehicles, while fuel cell electric vehicles and hydrogen-powered vehicles cannot be mass-produced and used as the main sales models due to cost and technical reasons.

2.3. The social background of NEV on areas such as environment and energy

In recent years, due to the increasing emergence of climate and environmental issues, countries have begun to gradually face the issue of environmental and ecological sustainability. In 2015, 195 member states of the United Nations, in order to achieve environmental and ecological sustainability and prevent climate warming and other climate issues, signed the Paris Agreement, which sets three clear goals and targets investment in renewable energy, while bringing the world's Most developing countries and regions of the world are included in the scope of the Agreement (United Nations, 2016).

In this global context, researchers and scholars believe that reducing greenhouse gas (GHG) emissions is one of the most effective ways to address global warming. Among greenhouse gas emissions, transportation emissions, as a major pathway that can directly affect the environment and biological health, have been a hot topic of major concern and discussion, so improving travel patterns and using environmentally friendly means of transportation have become an important way to achieve emission reductions. Currently, the transportation sector is almost entirely dependent on fossil fuels. The sector accounts for about a quarter of total energy-related

CO_2 emissions. Walking, cycling and public transportation help reduce air pollution and greenhouse gas emissions. However, only half of the global urban population has easy access to public transportation. With the number of cars worldwide set to triple by 2050, greenhouse gas emissions from the transportation sector are growing faster than from any other sector. New energy vehicles are therefore coming into the limelight, and they have become one of the popular options for consumers (United Nations, 2023). In order to promote the sustainable development of the environment for this purpose, the governments of various countries have increased the support policies for the new energy automobile industry, and gradually improve the related infrastructure of new energy automobile, at the same time, for the purchase of new energy automobile consumers also provide the corresponding preferential policies, it is also because of these reasons like new energy automobile manufacturing enterprises have appeared in recent years and rapid development. Now on the market for consumers to choose the type of new energy vehicles are more and more, consumer demand for cars is also undergoing a huge change, the original consumer for the car's safety, comfort, performance and other needs have higher requirements, and due to the diversification of new energy vehicles, the emergence of smart cars, consumers for the car machine Internet of Things, automatic driving and other needs are also gradually appearing, we have ushered in an era of change in transportation. The era of transportation change.

According to the U.S. Environmental Protection Agency, the transportation sector produces 24% of the world's greenhouse gases, and 29% of U.S. greenhouse gases come from transportation, making it the largest single source of U.S. emissions. In addition to carbon emissions, fuel-efficient vehicles produce fine particulate matter, volatile organic compounds, carbon monoxide, nitrogen oxides and sulfur oxides. Their adverse health effects - from asthma and heart disease to cancer and pregnancy disorders - have been well documented to disproportionately affect low-income and communities of color. Electric cars won't solve all these problems, but they can make our world a more livable place (Environmental Protection Agency, 2023; Teter 2020).

In the U.S., the grid is becoming less and less dependent on coal, and to quote the aforementioned Reichmuth of the Union of Concerned Scientists' recent Lifecycle Analysis, "Driving an electric car, no matter where you are in the U.S., emits fewer emissions and has less of an impact on global warming than a fuel-guzzling car" (Nealer et al., 2015). As Nikolas Hill, co-author of a major 2020 study for the European Commission, said in the podcast HOW TO SAVE A PLANET: "The same conclusion has been drawn from our study, and indeed a range of other studies in the field, that electric vehicles, whether they are all-electric, hybrid, plug-in hybrids, and fuel cell vehicles are undoubtedly better suited to our climate than conventional vehicles. There should be no doubt about that from a full life cycle analysis" (Nikolas 2020).

The current manufacture of electric vehicles has a greater environmental impact than the manufacture of gasoline-powered vehicles. This is largely due to battery manufacturing, which requires the mining, transportation and processing of raw materials that are often extracted in unsustainable and polluting ways. Battery manufacturing also consumes more energy, which can lead to increased greenhouse gas emissions. In China, for example, the raw materials and manufacturing process for a gasoline car produces 10.5 tons of carbon dioxide, while producing an electric car produces 13 tons of carbon dioxide. Similarly, a recent Vancouver study comparing electric and gasoline-powered cars found that it takes almost twice as much energy to make an electric car as it does to make a gasoline-powered car. Most of the emissions from gasoline-powered cars come not from the manufacturing process, but from the cumulative time the vehicle spends on the road. In contrast electric cars emit more throughout their life cycle in raw materials and manufacturing processes. On average about one-third of total emissions from electric vehicles come from the manufacturing process, three times as much as from fuel-powered vehicles. However, in countries with predominantly clean energy sources for electricity generation, such as France, the vehicle manufacturing process can account for 75% to nearly 100% of an EV's lifecycle GHG emissions. Once an electric vehicle is manufactured, emissions drop dramatically later in the process. Thus, while the manufacturing of electric vehicles generates higher emissions than the production of gasoline-powered vehicles, the low- to zero-emission driving life makes electric vehicles more environmentally beneficial. The same conclusions are found in China and Canada (Dale Hall & Lutsey 2018).

When it comes to driving, the longer an electric vehicle is on the road, the less environmental impact it produces. However driving conditions and driving habits do affect vehicle emissions. Across all vehicle types, auxiliary energy consumption (energy not used to drive the vehicle, such as heating and cooling) accounts for about one third of vehicle emissions (Rangaraju, et al., 2015). While gasoline-powered vehicles are heated by engine waste heat, electric vehicles require cabin heat to be generated using battery energy, which increases their environmental impact. Driving habits and patterns are less quantifiable but important (Weldon et al., 2016; Brand et al., 2018).

With regard to environmental pollution, while most of the research on the benefits of electric vehicles relates to greenhouse gas emissions, it is understandable that the broader environmental impacts of non-tailpipe emissions are also a consideration in life cycle analysis. The negative health impacts of particulate matter (PM) from road traffic are well documented. Fine particles from road dust and wear and tear on tires and brake pads are swept up in the vehicle's motion and cause "re-suspension," which accounts for 60% of all non-tailpipe emissions. Electric vehicles, due to the weight of their batteries, are on average 17 to 24 percent heavier than comparable gasoline-powered vehicles, resulting in even higher particulate emissions from resuspension and tire wear (Timmers & Achten 2016). However, one of the more favorable aspects of electric vehicles is brake braking. About 20% of traffic-related fine particle pollution, PM 2.5, comes from brakes. While fuel vehicles rely on the friction of disc brakes to slow and stop, the energy recovery (or regenerative braking) used in electric vehicles utilizes the braking power of the electric motor to slow the vehicle. Energy recovery can reduce brake wear by 50% and 95%.

Fuel differences are "one of the main drivers of the life-cycle environmental impacts of electric vehicles". Some of these impacts are determined by the fuel efficiency of the vehicle itself. The average efficiency of an electric vehicle is about 77 percent, meaning that 77 percent of the electrical energy stored in the battery is converted to power, while a gasoline vehicle converts between 12 and 30 percent of the chemical energy of the fuel to power; most of the rest is consumed as heat. (U.S. Department of Energy, 2023). The efficiency of battery storage and discharge is also a factor. Both gasoline-powered and electric vehicles lose efficiency as their lifespan increases. For gasoline-powered cars, this means that the longer they are on the road, the more gasoline they consume per kilometer and the more pollutants they emit. Electric cars consume more electricity when their batteries become less efficient at charging and discharging. The fuel efficiency of fuel engines declines faster than the efficiency of electric motors, so the efficiency gap between electric and fuel vehicles increases over time. The aforementioned Consumer Reports study found that after five to seven years of use, fuel cost savings for electric vehicles are still two to three times higher than gasoline vehicle fuel costs, and higher for newer EVs (Harto, 2020). So will the significant increase in ownership of new energy vehicles reduce the demand for oil? Electric vehicle ownership growth is expected to have a negligible impact on oil demand over the next 10 to 15 years. Since 2005, the fuel efficiency of conventional vehicles has improved by nearly 2% per year. Fuel efficiency is expected to continue to improve by more than 2.5% per year between now and 2025. However, global demand for crude oil will continue to grow even as fuel-efficient vehicles become more efficient and their market share is impacted by electric vehicles. The proliferation of electric vehicles could significantly affect demand for another fossil fuel: natural gas. The increase in electric vehicles means that more electricity needs to be produced (Hensley et al., 2009).

The more environmental benefits of electric vehicles depend on a factor over which the vehicle has no control: the source of the electricity. Electric vehicles get their power from the grid, so their emission levels depend on how clean the grid power is. As the grid becomes cleaner, the cleanliness gap between electric and combustion engine vehicles will only widen. For example, in China and the U.S. greenhouse gas emissions have decreased dramatically due to the power sector, depending on the source of electricity on the grid. The cleaner the grid, the cleaner the car. On a grid powered entirely by coal, electric cars produce more greenhouse gases than fuel cars (Ministry of Ecology and Environment of the Chinese Government, 2021; Rupp et al., 2019). In Denmark, it was found that purely electric vehicles were "ineffective in reducing environmental impacts", in part because of the large amount of coal consumed by the Danish power grid (Bohnes et al., 2017). In contrast, in Belgium, where a large part of the electricity mix comes from nuclear power, electric vehicles have lower whole-life emissions than gasoline or diesel vehicles (Rangaraju et al., 2015). In contrast, in Belgium, where a large part of the electricity mix comes from nuclear power, electric vehicles have lower whole-life emissions than gasoline or diesel vehicles (Tong & Azevedo 2020).

Currently electric vehicle owners have little control over the energy mix of their grids, and their charging behavior does affect the environmental impact of electric vehicles, with most electric vehicle owners charging their vehicles at night, leading to higher greenhouse gas emissions (Garcia & Freire 2016). In countries with a high reliance on solar energy, such as Germany, charging at midday has the greatest environmental benefits, while charging at times of peak demand (usually in the evening) draws energy from the more fossil-fuel-dependent sources of electricity generation in the grid (Rupp et al., 2019). As David Reichmuth told Treehugger, changing EV charging behavior means that "using electric vehicles can benefit the grid." "EVs can be part of a smart grid," where EV owners can work with utilities to charge their vehicles when grid demand is low and power sources are cleaner. Charging their batteries with solar power and discharging them during peak demand times allows charging stations to consume more solar energy and support electric vehicles with energy storage even when the sun is not shining. (Reichmuth 2021).

Some retail giants have begun to consider offering customers the convenience of shopping while charging, hoping to turn the charging experience to their advantage. Just as mega-malls have long portrayed themselves as leading retailers centered on the shopping experience, retail-oriented mega-charging stations could be a new star in the commercial landscape. (Hensley et al., 2009).

For the end-of-life treatment of new energy vehicle cars, as with gasoline-powered cars, metals, e-waste, tires and other components of electric vehicles can be recycled or resold. The main difference between new energy vehicles is the battery. In fuel-powered vehicles, more than 98 percent of the material in lead-acid batteries is successfully recycled. (Gaines 2014). EV battery recycling is still in its infancy, and a viable battery recycling program is needed to avoid reducing the relative advantages of EVs.

By contrast, electric vehicles are still an emerging technology, and their efficiency and range continue to improve. On a global scale, dramatic changes in the way electricity is produced will further make electric cars cleaner. In an interview with Treehugger, David Reichmuth of the Union of Concerned Scientists said, "We've got a long way to go, and we don't have the luxury of waiting" (Reichmuth 2021). The founders of UCS, including Henry Kendall and Kurt Gottfried, drafted a statement calling for a shift in scientific research away from military technology and toward solving pressing environmental and social problems (MIT faculty 1968).

For the time being, new energy vehicles is undoubtedly a solution that can alleviate the environment, non-renewable energy, but for society, the environment and resource consumption, the rapid development of the new energy automobile industry is bound to have an impact on society, energy and traditional automobile and other industries and even impact, but this is the inevitable result of social and technological progress. New energy vehicles are not perfect, but it will become close to perfect with the passage of time and the development of technology.

2.4. Policies related to NEV in some countries and regions

- As the second largest economy in the world, China's manufacturing industry is the largest in the world. At present, in the new energy automobile industry, China's new energy automobile enterprises have a huge market group and perfect manufacturing system, so China's new energy automobile industry is developing rapidly and gradually become the main force of the global new energy automobile enterprises. From 2009 to 2014, the Chinese government promoted the industrialization of new energy vehicles through measures such as the "Ten Cities, One Thousand Vehicles" demonstration project. From 2015 to 2020, China's new energy vehicle market share reached 1.3% in 2015, breaking the 1% mark for the first time, marking the beginning of China's new energy vehicle industry. During this period China's new energy vehicle sales had ups and downs but maintained a steady development trend with the support of financial subsidies and other policies. From 2021 onwards, China's new energy vehicle market share will reach 13.4%, and new energy vehicles will shift from being driven mainly by policy support to being driven mainly by market demand (Jin et al., 2021).

  According to the China Association of Automobile Manufacturers (CAAM), China's new energy vehicle sales from January to September 2022 amounted to 4.567 million units, increasing its market share to 23.5%. In terms of ownership, according to data from the Ministry of Public Security, as of the end of September 2022, the country's new energy vehicle ownership amounted to 11.49 million vehicles, accounting for 3.65% of vehicle ownership, leading the world. It is worth noting that compared to developed countries, Chinese consumers are more favorable to technologies such as electrification, providing an important impetus for the development of the new energy vehicle industry (China Association of Automobile Manufacturers, 2022).

  Since September 1, 2014, the acquisition of new energy vehicles has been exempted from vehicle purchase tax, and the policy has been extended to December 31, 2023 in 2017, 2020 and 2022 three times successively. By the end of 2022, the cumulative tax exemption scale of the above policy exceeded 200 billion yuan, and it is expected that the tax exemption in 2023 will exceed 115 billion yuan. And the vehicle purchase tax exemption policy for new energy vehicles was extended from implementation until December 31, 2023 to December 31, 2027, for four years. Among them, from January 1, 2024, to December 31, 2025, the vehicle purchase tax will be exempted; from January 1, 2026 to December 31, 2027, the vehicle purchase tax will be reduced by half. The Chinese government's adoption of the vehicle purchase tax reduction and exemption policy will not only bring benefits to consumers, but also have an obvious pulling effect on promoting the development of the new energy vehicle industry and expanding consumption.

In addition to the tax reduction, the government is also strengthening the construction of infrastructure related to new energy vehicles. First, it is building a convenient and efficient intercity charging network and improving charging infrastructure services along highways. The second is to build an interconnected charging network in urban agglomerations, focusing on the Beijing-Tianjin-Hebei, Yangtze River Delta, Guangdong-Hong Kong-Macao Bay Area, and Chengdu-Chongqing Twin Cities Economic Circle, and to create a fast-charging network connecting major cities in the region, and striving to bring charging technology, standards, and services up to the world's advanced level. Thirdly, we will improve the comprehensive coverage of charging facilities in cities. The fourth construction of charging facilities in rural areas to cover and realize the integration of rural and urban areas (Liu 2023).

- October 28, 2022, the European Commission welcomes the agreement reached by the European Parliament and the European Council which will ensure that by 2035 all new cars and vans registered in Europe will have zero emissions. As an intermediate step towards zero emissions, the new CO2 standards will also require average emissions to be reduced by 55% for new cars and 50% for vans by 2030. This will mean that the EU will ban the production of new fuel-efficient vehicles from 2035 (European Commission, 2019).

  To this end, European governments have given corresponding incentives, for example: Hungary from 2016, the Hungarian government has formulated an electric vehicle development plan, put forward to significantly increase the production of electric vehicles, require the installation of charging ports in large parking lots with conditions, and promote the expansion of the charging infrastructure through the enactment of laws and regulations. For example, new residential buildings and shopping centers must provide reserved parking spaces with charging ports. To encourage more residents to purchase and use electric vehicles, the Hungarian government offers significant tax breaks to the electric vehicle industry and lowers the purchase price for consumers, for example, by subsidizing the purchase of a purely electric vehicle by up to 21% of the purchase price of the entire vehicle. Hungary also stipulates that electric vehicles with green license plates enjoy exemption from many motor vehicle taxes, exemption from highway tolls, free parking in Budapest and other cities, and many other benefits. Italy will increase subsidies for new energy vehicles from 2023 (International Energy Agency, 2023).

  The Italian government, in order to promote the development of electric vehicles, has increased the subsidy to €3,000 to €4,500 for individuals with incomes of less than €30,000 from 2023; for end-of-life vehicles and people with incomes of more than €30,000, the purchase of a pure-electric/plug-in will be subsidized by €4,000 to €5,000, respectively. In Spain, in April 2021, the MOVES III program was introduced to allocate subsidies for the purchase of electric vehicles. The program includes subsidies for the purchase of electric cars (up to €7,000), electric motorcycles (up to €1,300) and electric vans (up to €9,000). The old car needs to be scrapped to receive the full subsidy and the Spanish government bears the cost of the charging infrastructure for electric cars (International Energy Agency, 2023).

New energy vehicles in Portugal enjoy tax breaks. Portuguese companies are exempt from corporate income tax on pure electric vehicles and enjoy reduced corporate income tax on plug-in hybrid vehicles (International Energy Agency, 2023).

France is currently able to subsidize electric cars produced in any country and by any manufacturer with a subsidy of 5,000 euros per vehicle from Paris, with the only restriction being that the price of the vehicle must not exceed 47,000 euros. Under Macron's new bill, future subsidies of 5,000 euros will be directly linked to the amount of carbon dioxide emitted during the production of electric cars, a move that could affect sales of non-EU carmakers and exempt them from weight penalties (International Energy Agency, 2023).

Finland will receive a subsidy of EUR 2,000 per vehicle for the purchase of all-electric cars from the beginning of 2018, and EV buyers will only have to pay a CO2 registration tax at a minimum rate of 5% (International Energy Agency, 2023).

Belgium has introduced incentives for company cars, which account for the majority of its new car sales and serve as a conduit into the second-hand market, making them more affordable. Belgium has introduced incentives for company cars, which account for the majority of its new car sales and serve as a conduit to the second-hand market, making them more affordable (International Energy Agency, 2023).

- On June 14, 2022, the UK announced a policy of removing the £1,500 subsidy for pure or plug-in hybrid cars. Previously, the UK had been gradually rolling back subsidies. It went from £2,500 to £1,500, and the maximum selling price of models that could benefit from the subsidy dropped from £35,000 to £32,000. The UK will shift the existing subsidy allocation to the construction of infrastructure such as charging networks and the electrification transformation of other types of vehicles, which are still eligible for subsidies, including cabs, motorcycles, vans, wheelchair vans and other models, and need to meet certain conditions (International Energy Agency, 2023).
- In August 2022, in the Inflation Reduction Act (IRA) signed by President Joe Biden, after January 1, 2023, subsidies will be available for consumers to purchase electric vehicles assembled in the United States. There are two localization conditions required for electric vehicles to receive the tax credit: first the electric vehicle power battery plant contains key metal raw materials extracted and processed in the United States or in any country with which the United States has an FTA in force; or recycled to at least 40% by January 1, 2024, can receive a $3,750 tax credit. Another tax credit of $3,750 is available for a second new energy vehicle power cell that is manufactured and assembled in North America at a percentage of localized value of 50% or more. This policy lasts for 10 years, from

December 31, 2022 to December 31, 2032. The U.S. also offers a tax credit of up to $4,000 for used EVs, plus a tax credit of up to $7,500 per EV for leasing purposes. The policy also introduces new caps on the retail price of eligible vehicles. Sedans will not exceed $55,000, and other models such as vans, sport utility vehicles and pickup trucks will not be sold for more than $80,000. The U.S. has also placed limits on the income of purchasers, capped at $150,000 per year for a single person (or $300,000 for a couple) buying a new EV, and $75,000 per year for a single person (or $150,000 for a couple) buying a used EV (International Energy Agency, 2023).

- In March 2022, the Canadian federal government announced the Zero Carbon Emission Vehicle Subsidy Policy, which means that electric models selling for less than $45,000 are eligible for a $5,000 subsidy. In addition to direct incentives for EVs, the related budget includes other initiatives such as investments in charging infrastructure.2022 In December 2022, the Canadian government announced its plan to go all-electric for vehicles, under which one-fifth of passenger cars sold in Canada will need to be electric in 2026, increasing to 60% by 2030, and by 2035, 100% of all passenger cars will need to be electric. At the same time, the Canadian federal government is proposing to track sales by issuing automobile sales credit scores (credits). All-electric cars and pickup trucks would have higher credits than plug-in hybrids (International Energy Agency, 2023).
- In order to increase the market share of electric vehicles, in 2022 the Japanese government has increased the subsidies for the purchase of pure electric vehicles and plug-in hybrids up to two and two and a half times the original amount, respectively, with a maximum subsidy of up to 800,000 yen for pure electric models. The subsidy for new energy vehicles will be extended until the end of 2023, while the Eco-vehicle tax break, which provides incentives for models with good fuel efficiency, will also be extended, from before it expires at the end of April 2023 to the end of 2023. The "environmental performance discount" paid at the time of purchase will be extended from the end of March 2023 to the end of the same year. In order to popularize pure electric vehicles, the two tax exemptions for the vehicle weight tax levied at the time of purchase and at the time of vehicle inspection will be maintained until the end of April 2026 (International Energy Agency, 2023).
- In January 2023, South Korea introduced a new subsidy policy for new energy vehicles, changing from a greater emphasis on performance and range to a greater focus on maintenance, safety and charging infrastructure. The maximum state subsidy amount will be reduced to 6.8 million won from the current 7 million won. The threshold for 100% subsidy will be adjusted to 57 million won from less than 55 million won in the past. The new subsidies also include a cap of 5 million won for fuel efficiency and mileage, down 1 million won from the current level, and subsidies based on the operation of customer service centers, after-sales service centers, and parts management centers. If it does not, it will only receive half of the fuel efficiency and mileage subsidies. The new subsidies also include an additional 150,000 won for electric vehicles, provided that the vehicle is

equipped with "V2L (vehicle-to-load)" technology. In addition, the new subsidy rate includes a program that pays an additional 150,000 won in subsidies for electric vehicles from automakers that have installed more than 100 fast-charging piles in the last three years. According to the new subsidy standard, the subsidy for domestic EVs will be at least 2.5 million won more than that of imported EVs, which may make customers more willing to buy pure EVs made in Korea (International Energy Agency, 2023).

From the above national and regional policies on new energy vehicles, new energy vehicles have become the next development direction of each country and region. In order to promote this development direction, each country and region has implemented different support policies. Therefore, new energy vehicles will usher in the peak of development.

2.5. The development of NEV by various automobile companies

Currently in the new energy vehicle market competition is fierce, the traditional automobile enterprises gradually in the transition to new energy vehicles, at the same time new energy vehicle emerging enterprises also joined the competition track, each enterprise in this competitive global market environment continue to innovate and develop.

- **Toyota,** a Japanese automobile company, developed the Hybrid system for hybrid vehicles and launched the first model equipped with the system, the Toyota Prius, in 1997 in Japan, which was the world's first mass-produced product of this type. It has been exported to more than 40 countries and regions around the world since 2000, with the largest markets being Japan and North America. But a few visionaries believe that hybrids are just a transition, and that the future is all about electric cars. Toyota may be able to get Nissan to use the technology in its Altima model. Toyota's supplier Aisin Seiki also offers similar hybrid transmission technology to other car brands and companies such as Lexus, Honda, and Nissan, all of which have models equipped with Hybrid systems. At the same time, as countries for new energy vehicles increased research and development and investment, electric vehicles dedicated lead-acid batteries in the technology has also made significant breakthroughs, the battery also evolved from a single lead-acid batteries out of multiple types of high-performance batteries, but also the emergence of lithium batteries, which allows the electric vehicle industry plagued with a long time range problem has been solved, greatly facilitating the development of electric vehicles. Toyota's goal is to have a new energy version of every model by around 2025, and to increase the sales share of new energy vehicles to more than 50% by around 2030, with electric vehicles and hydrogen fuel cell vehicles, two types of zero-emission vehicles, accounting for more than 10% of sales to more than 1 million units. In order to realize this strategic plan, Toyota established the "EV

Business Planning Office", and personally led by Toyoda Akio, began to accelerate the layout of the pure electric field. It can be seen that Toyota's determination and strength to promote the development of electric vehicles. Toyota CTO Shigeki Terashi said: the world tailpipe emissions and other related regulations are becoming increasingly stringent, relying only on fuel cell vehicles and hybrids are unable to seize the opportunity, Europe is constantly strengthening environmental regulations, to 2030 point in time Toyota Prius fear that it will not be able to meet the emission control standards, so it is necessary to develop pure electric vehicles and fuel cell vehicles at the same time. Toyota's plan is to promote small electric cars in the European market, promote large electric cars in the U.S. market, and Suzuki in the Indian market and Suzuki hand in hand to develop small electric cars. In order to avoid affecting the valuation when depreciation occurs at a later stage, Toyota plans to develop a battery that can guarantee a capacity of 90% or more after 10 years of use. Demonstrating cars equipped with solid-state batteries at the 2020 Tokyo Olympics. Shigeki Terashi said Toyota plans to completely ban gasoline vehicles by 2030 or 2035, and with Japan's Ministry of Economy, Trade and Industry planning to stop sales of conventional cars powered solely by internal combustion engines from 2035, Toyota will have to accept the reality of the situation, which is, of course, in the Japanese market as well as in Europe and the United States (Toyota Motor Corporation, 2023).

- Tesla, On July 1, 2003, Martin Eberhard and Marc Tarpenning co-founded **Tesla,** and in February 2004, Elon Musk decided to invest $6.3 million in Tesla, becoming Chairman of the Board of Tesla and having the final say in all company matters. The year after Elon Musk joined Tesla, Tesla's first electric roadster was released and deliveries began in 2008. This was followed by the release of the Model S in 2012; Tesla opened up more than 300 patents to the entire industry from 2014, the same year Elon Musk first proposed to build an automobile production plant in China. 2015 saw the birth of the third automobile product, the Model X; and 2016 saw the launch of the Model 3. And for the whole of 2016, Tesla's sales in the U.S. market amounted to 4 70,000 units, already well ahead of the Chevrolet, Ford and Nissan brands. In 2019, construction began on the Shanghai Super factory, with deliveries in 2020 and the launch of the Chinese-made Model Y. On October 26, 2020, Tesla's Shanghai Super factory began exporting electric cars to Europe. As of January 2021, the annual production capacity of the plant was 250,000 vehicles, with plans to increase it to 450,000. In August 2022, the 1 millionth vehicle rolled off the production line at the Shanghai Super Works, a milestone achieved in less than three years from the delivery of the first China-made model, making it a phenomenal record in the history of the automotive industry. Super high production efficiency, so that the Shanghai Super Factory in less than 40 seconds can come off the line a Model Y white body, the speed is far more than the fuel car companies. 2022 put into operation in the United States, Texas Super Factory, Berlin Super Factory, Germany, is also in the global scope of the production efficiency and industrial impact of the "replica" of the Shanghai Super Factory, at present, the two factories Model Y single-unit production efficiency and industrial impact, the two factories, the Model Y single-unit production efficiency and industrial impact. At present, the production of Model Y in both factories has exceeded 3,000 units per week (TESLA Group, 2023).

- China's own brands, in 2001, China's "Tenth Five-Year Plan" launched the "863 Automobile" major project, and in 2007, China officially designated new energy vehicles as an independent category to regulate production. Only during this period, China's new energy market is still mainly concentrated in the public sector to promote some demonstration projects, such as the 2008 Olympic Games to transport athletes of electric buses, electric cabs in some cities, electric buses and so on. However, China's own brands such as **BYD, BAIC, Changan Automobile and SAIC** have been involved in the research and development of new energy vehicles, with BYD taking the lead among these brands and eventually developing into a leading company in this field. In 2013, Tesla officially entered the Chinese market with its brand-new Model S. And by April 22, 2014, the first batch of Tesla models in China was officially delivered. The arrival of Tesla can be said to have activated China's new energy market, which not only promotes the transformation of Chinese traditional car enterprises, but also drives the development of new car-making enterprises. In 2014-2015, inspired by Tesla and with the help of capital, new car-making enterprises such as NIO, XPeng Motors, Li Auto, etc. were born (Jin et al., 2021).
- NIO, founded on November 25, 2014, NIO signed an OEM contract with JAC Motor in April 2016 to start a deep cooperation with JAC due to its lack of car-making qualifications. After assembling capital, team, technology and factory, NIO launched NIO's first electric supercar EP9.In 2017, NIO launched its own first mass-produced pure electric product, ES8.Immediately after, NIO's first power exchange station was officially put into operation on May 20, 2018.NIO's first power exchange station is now in operation. And just on the eve of the launch of NIO's second product ES6, on September 12, 2018, NIO successfully landed on the New York Stock Exchange in the United States, becoming the first Chinese company listed on the U.S. stock market (NIO Group, 2023).
- The Mercedes-Benz Group has put forward its "Vision 2039", which aims to completely phase out fuel-efficient vehicles by 2039. In July 2021, it was proposed that Mercedes-Benz would be ready to go all-electric by the end of the century, market conditions permitting. From 2025 onwards, all newly launched vehicle architectures will be purely electric, and customers will be able to choose an all-electric alternative for every model the company produces. Mercedes-Benz intends to manage this accelerated transformation while adhering to its profitability targets. To facilitate this transformation, Mercedes-Benz has launched a comprehensive program that includes a significant acceleration of research and development. Between 2022 and 2030, investments in pure electric vehicles will total more than €40 billion. The acceleration and advancement of the EV portfolio program will mark

a turning point in the adoption of electric vehicles. Mercedes-Benz plans to increase the share of global sales of purely electric models to more than 25% by 2025, and plug-in hybrid and pure electric models to account for more than 50% of global sales by 2030 (Mercedes-Benz Group, 2021).

- BMW will make new energy vehicles the focus of its product lineup starting in 2025 and make EV production 50% of total production by 2030. Another goal of the BMW Group is to reduce carbon emissions per vehicle in the production chain by 80% by 2030 compared to 2019. In 2022, the BMW Group delivered a total of 433,792 4 units to customers, i.e., significantly more electrified vehicles than in the previous year. On this basis, the share of electrified vehicles had also increased significantly to 18.1% by the end of the year under report. To date, the BMW Group has therefore handed over a total of more than 1.4 million vehicles with either all-electric or plug-in hybrid drive systems to customers. The share of electrified vehicles in total deliveries might exceed 30% by as early as 2025. In our view, the NEUE KLASSE has the potential to additionally accelerate the market penetration of electric mobility, and thus a 50% share of all-electric vehicles in the BMW Group's global unit sales could be achieved even earlier than 2030. Under these conditions, the BMW Group aims to surpass the mark of ten million all-electric vehicles delivered to customers in total by 2030. This positive expectation for future sales will also play a key role in the review of our carbon emissions reduction targets scheduled to take place in 2023.Both the MINI and the Rolls-Royce brands are also firmly on track towards an electrified future. Based on their respective typical user profiles, the model ranges of the two brands are set to be exclusively all-electric by the early 2030s (BMW Group, 2023).
- The Volkswagen Group plans to achieve its goal of having 70% of the vehicles it sells in Europe be new energy vehicles by 2030, double the original target. To this end, VW 2021 announced plans to invest around €46 billion in electric vehicles and hybrids over the next five years. In 2022, the Volkswagen Group will offer additional new all-electric vehicles to its customers as part of its electric offensive. Based on the Modular Electric Drive Toolkit (MEB), the Volkswagen brand is planning to launch the dynamic SUV coupés ID.501 and ID.5 GTX02, which it has already unveiled, as well as the iconic ID. Buzz03. Also based on the MEB, ŠKODA will roll out the sporty Enyaq iV Coupé03 and CUPRA expands the range of the Born04 with additional battery capacities and a more powerful e-Boost version. Audi will introduce the upgraded e-tron and new versions of the Porsche Taycan and Taycan Sport Turismo will be available for the first time. By 2040, VW plans to sell only zero-emission vehicles in its major markets. In addition to the increased investment, the VW Group plans to launch at least one pure electric model every year in the future to capture the increasingly competitive market. The Group aims to become the leading provider of electric vehicles worldwide by 2025. In the period from 2022 to 2026, around €52 billions of investments are therefore planned in e-mobility and another amount of around €8 billion

in the hybridization of the model portfolio. Volkswagen is the first automotive group to commit to the Paris Climate Agreement and intends to become net climate neutral by 2050, which is why the Group is systematically driving forward decarbonization even beyond its vehicles. The power plant in Wolfsburg, which produces electricity for the plant and district heating for the city, was recently converted from coal to gas. That will save 1.5 million tons of CO2 per year, equivalent to the annual emissions of 870,000 cars (Volkswagen Group, 2022).

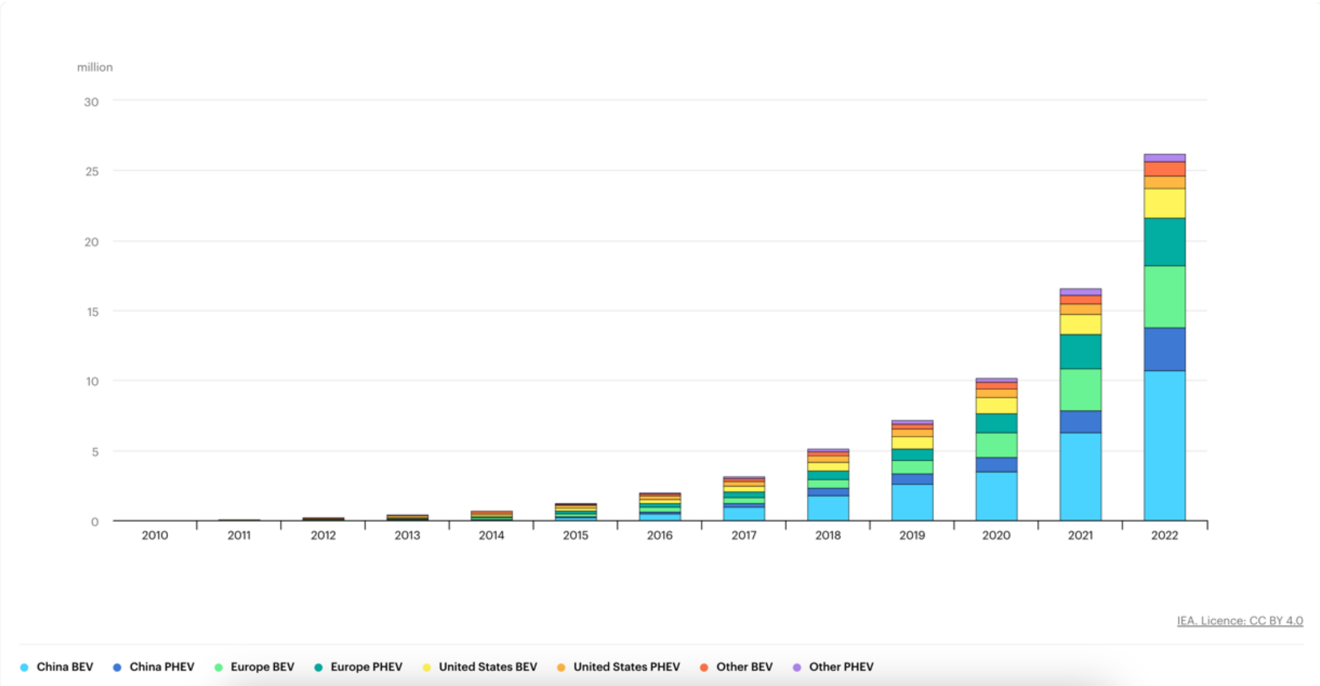
Combined with the above development plans of automobile companies for new energy vehicles, the new energy vehicle industry will usher in a period of rapid development. Competition in this industry will also be more intense, so automotive companies also need to strengthen their own competitiveness, improve the core technology of their products, cater to the needs of the consumer market, and strengthen the diversification of the new energy vehicle sector.

2.6. Market share of NEV in selected countries and regions

Total auto sales in 2022 are down 3% from 2021. New energy vehicle sales topped 10 million last year, up 55% from 2021. This figure exceeds the total number of cars sold in the entire European Union (about 9.5 million) and is close to half of the total number of cars sold in China in 2022. In just five years from 2017 to 2022, electric vehicle sales jumped from around 1 million to over 10 million. Previously, it took five years from 2012 to 2017 for EV sales to grow from 100,000 to 1 million units, underscoring the exponential nature of EV sales growth. The share of electric vehicles in total vehicle sales jumps from 9% in 2021 to 14% in 2022, more than 10 times the 2017 share (International Energy Agency, 2023).

From Figure 1-1, it can be seen that the stock of new energy vehicles has realized explosive growth in the past 20 years, of which, the stock of BEVs in China has grown most significantly, while the stock of PHEVs in China has grown less compared to the stock of BEVs. In Europe and the United States, the fastest-growing stock is also for BEVs.

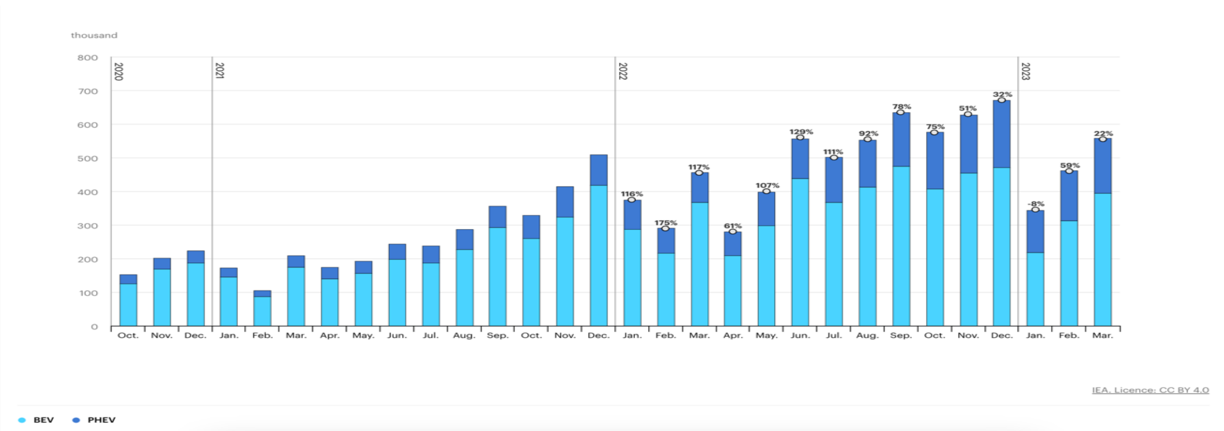
Figure 1-1: Global electric car stock, 2010-2022



(Source: IEA analysis based on country submissions, ACEA, EAFO, EV Volumes and Marklines.)

The increase in sales brings the total number of electric vehicles on the world's roads to 26 million, a 60% increase from 2021, with pure electric vehicles accounting for more than 70% of the total annual growth, as in previous years. As a result, by 2022, about 70% of global EV ownership will be pure EVs. In the same year, China's pure electric vehicle sales grew 60% from 2021 to 4.4 million units, and plug-in hybrid sales nearly tripled to 1.5 million units. And for the first time, they accounted for more than 50% of the total number of electric vehicles on the world's roads, totaling 13.8 million vehicles (International Energy Agency, 2023).

Figure 1-2: Monthly new electric car registrations in China, 2020-2023

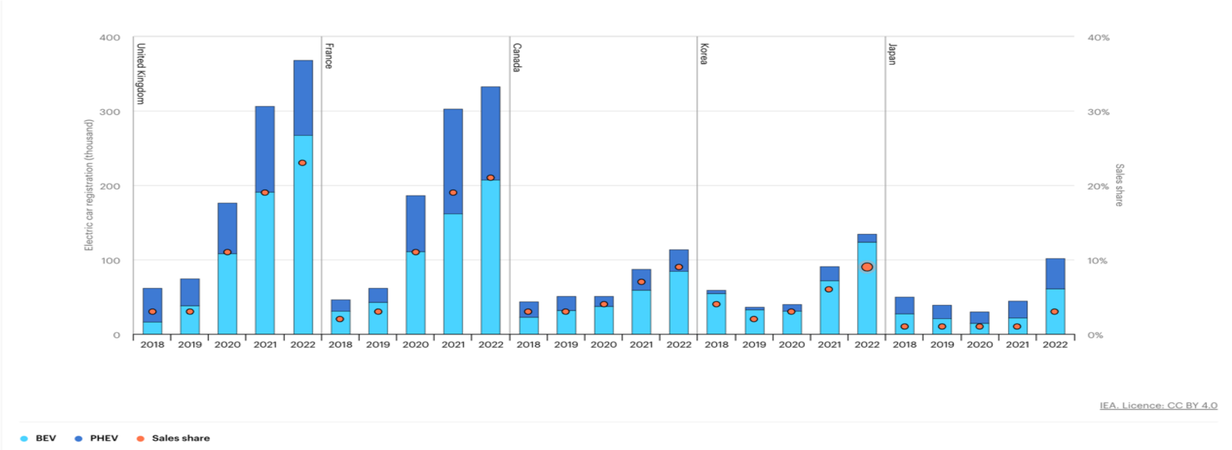


(Source: IEA analysis based on EV Volumes (2023), https://www.ev-volumes.com/datacenter/.)

China aims to achieve a 50% share of sales in the so-called "key air pollution control areas" by 2030 and a 40% share of sales nationwide by 2030 to support the national Peak Carbon Action Plan. If recent market trends continue, China's 2030 target could also be met ahead of schedule. Provincial governments are also supporting the adoption of new energy vehicles, with 18 provinces having set new energy vehicle targets to date (State Council of China, 2021).

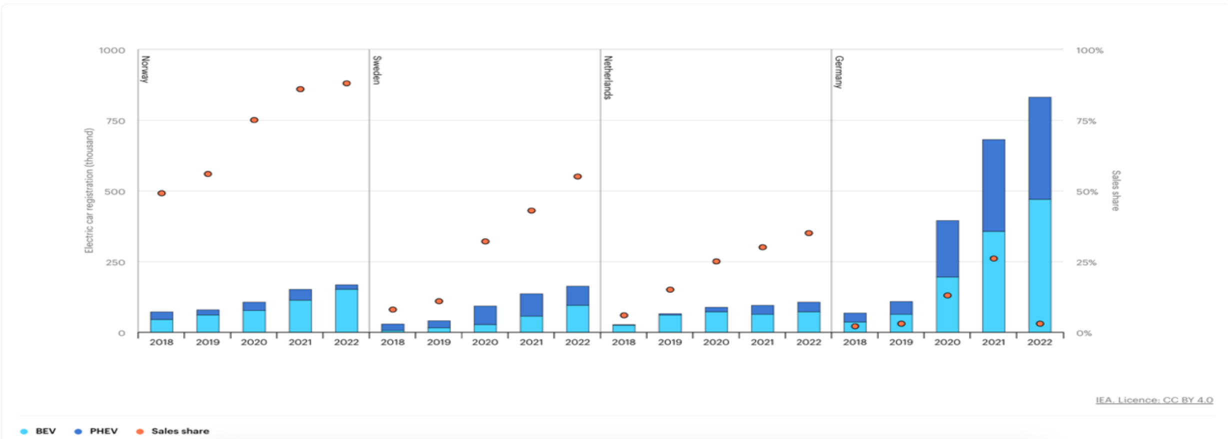
In Europe, electric vehicle sales grow by more than 15% in 2022 relative to 2021 to reach 2.7 million units. Sales have grown even faster in previous years: more than 65% annually in 2021 and an average of 40% in 2017-2019. in 2022, pure EV sales grow by 30% relative to 2021, while plug-in hybrid sales decline by about 3%. Europe accounts for 10% of global growth in new EV sales (International Energy Agency, 2023).

Figure 1-3: Electric car registrations and sales share in selected countries, 2018-2022



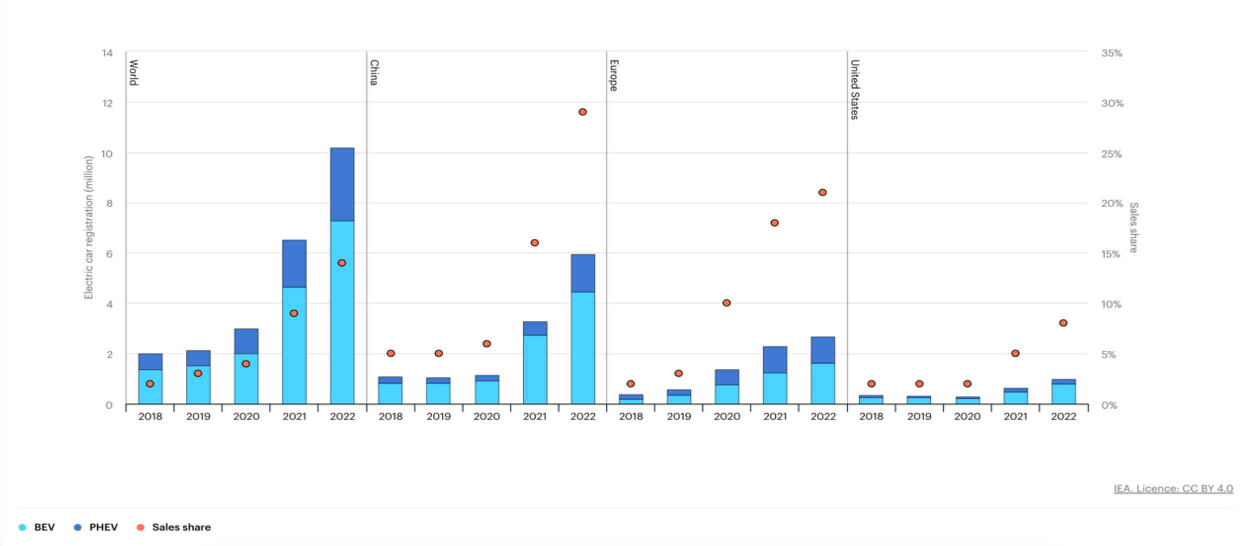
(Source: IEA analysis based on country submissions, ACEA, EAFO, EV Volumes and Marklines.)

Figure 1-4: Electric car registrations and sales share in selected European countries, 2018-2022



(Source: IEA analysis based on country submissions, ACEA, EAFO and EV Volumes.)

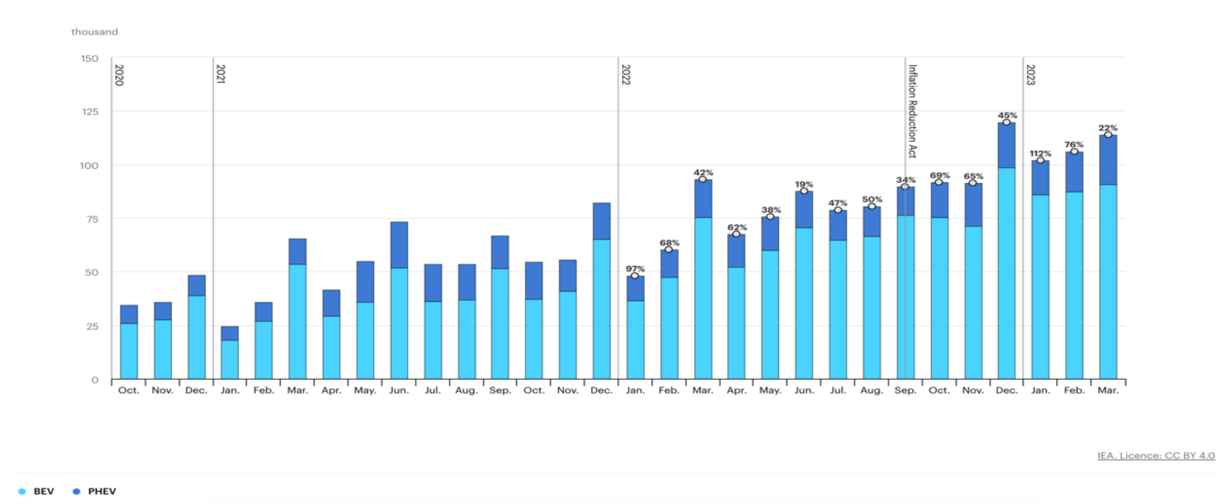
Figure 1-5: Electric car registrations and sales share in China, United States and Europe, 2018-2022



(Source: IEA analysis based on country submissions, ACEA, EAFO, EV Volumes and Marklines.)

In the U.S., electric vehicle sales grow 55% in 2022 over 2021, led by pure electric vehicles. The U.S. accounts for 10% of global sales growth. Total electric vehicle ownership reaches 3 million units, up 40% from 2021. EV share of total vehicle sales reaches nearly 8%, up from just over 5% in 2021 and around 2% from 2018 to 2020 (International Energy Agency, 2023).

Figure 1-6: Monthly new electric car registrations in the United States, 2020-2023



(Source: IEA analysis based on EV Volumes (2023).)

Inflation Reduction Act (Internal Revenue Service, 2023) triggered a flurry of global electric vehicle companies to expand their manufacturing operations in the U.S. Between August 2022 and March 2023, major electric vehicle and battery makers announced cumulative investments of $52 billion in the North American EV supply chain, with 50% of that amount going to battery manufacturing, and about 20% each to battery parts and EV manufacturing. Tesla plans to relocate its lithium-ion battery Super factory in Berlin to Texas, where it is partnering with China's Ningde Times, and to produce its next-generation electric vehicles in Mexico. Ford announced an agreement with Ningde Times to build a battery plant in Michigan and plans to increase EV production six-fold from 2022 to 600,000 vehicles per year by the end of 2023, rising to 2 million by 2026. BMW is looking to expand EV manufacturing at its plant in South Carolina following an IRA. Volkswagen chose Canada for its first battery plant outside of Europe to begin operations in 2027 and is investing $2 billion in the South Carolina plant. (Coppola 2022).

Overall, the market share of new energy vehicles is increasing year by year, which means that the consumer market is becoming more and more receptive to new energy vehicles. The increase in consumer demand for new energy vehicles will stimulate the supply side of the automotive industry, such a virtuous cycle for the new energy vehicle industry to provide a favorable environment for development.

3. My Research

3.1. Place of the research

China's consumer market for new energy vehicles has grown rapidly in recent years and has become the world's largest market for new energy vehicles. The rapid growth of this market is attributed to the government's strong support for the new energy vehicle industry, including a variety of policies such as providing subsidies for vehicle purchases and building charging infrastructure. With technological advances and cost reductions, the range, performance and comfort of new energy vehicles have improved significantly, further stimulating consumers' willingness to buy.

China's new energy vehicle consumer base is wide-ranging, encompassing everything from young technology enthusiasts to middle-aged and elderly people who are highly cognizant of environmental protection. These consumers are interested in new energy vehicles not only because of the environmental protection concept, but also because of their advanced technological features, low cost and government incentives. With the growing awareness of green mobility in society and the increasing abundance of new energy vehicle brands, consumers are becoming more and more receptive to new energy vehicles, and they are paying more attention to the quality, performance, and level of intelligence of the vehicles.

3.2. Method of the research

This paper adopts the methods of literature review and data research.

In the literature review, this paper introduces the history of the development of new energy vehicles, the market share and the policies of some countries on new energy vehicles, etc., and analyzes the relevant data of new energy vehicles in some countries.

Using the method of data research, combined with the method of questionnaire survey, it is found that there are factors affecting the purchase intention in the consumer market of new energy vehicles in China.

The questionnaire has 43 questions. The content of the questionnaire covers generalized basic information, product factors and psychological factors. I believe that these product and psychological factors may influence Chinese consumers' willingness to purchase new energy vehicles.

In this paper, the questionnaire was distributed to consumers in the Chinese market through an online questionnaire platform. The collected data were then processed and analyzed using SPSS. The data analysis methods used in this paper include descriptive statistics, reliability and validity test, correlation analysis and regression analysis. The analysis methods I plan to use are moderated models (H1a and H2a, H1b and H2b), mediation models (H1c and H2c), and regression models (H1d).

3.3. Hypothesis

Hypothesis 1: Product factors have a positive effect on consumers' willingness to purchase.

a. The price of new energy vehicles has a positive effect on consumers' willingness to buy.
b. The configuration of new energy vehicles has a positive effect on consumers' willingness to buy.
c. The convenience of charging facilities has a positive effect on consumers' willingness to buy.
d. The economy of new energy vehicles has a positive effect on consumers' willingness to purchase.

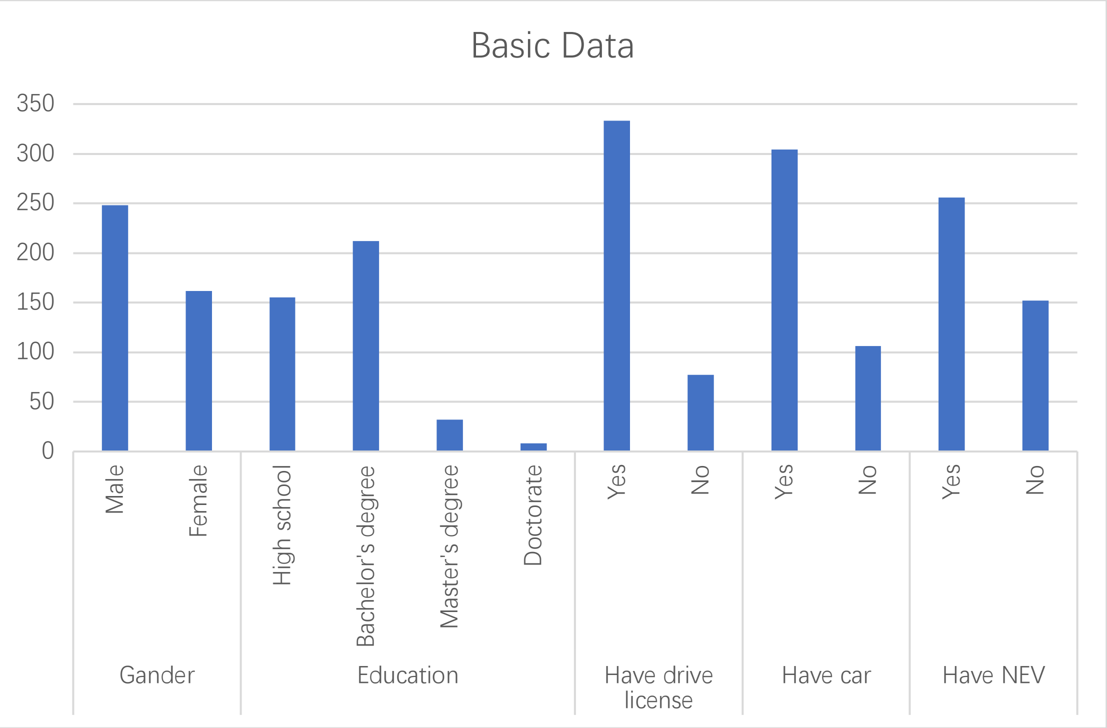
Hypothesis 2: Psychological factors moderate or mediate the relationship between product factors and purchase factors.

a. Brand premium moderates the relationship between price and consumer purchase intention.
b. Driving sensation moderates the relationship between configuration and consumer purchase intention.
c. Range anxiety mediates the relationship between ease of access to charging facilities and consumer purchase intentions.

3.4. Demographic data

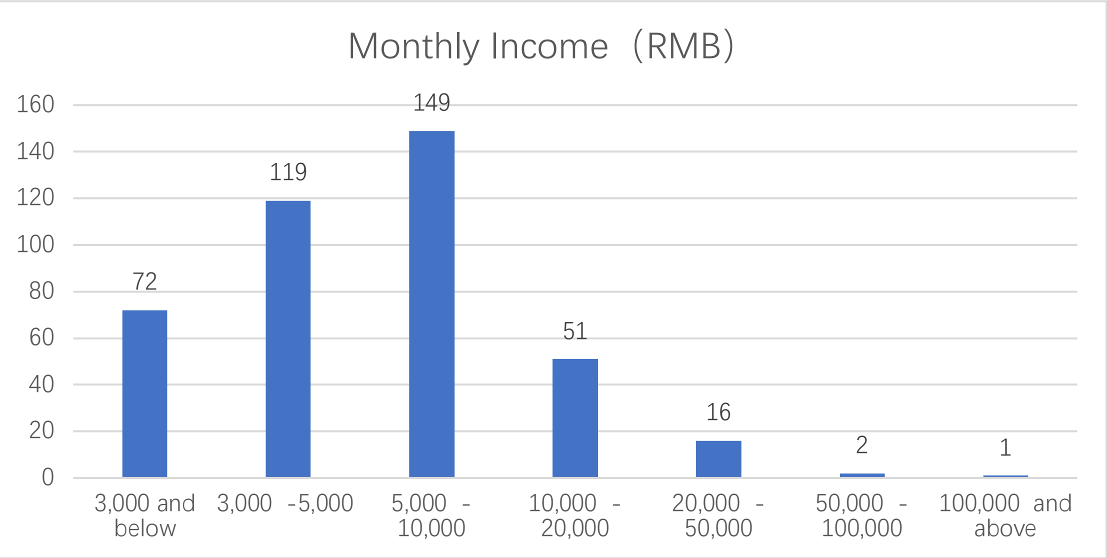
A total of 410 valid questionnaires were collected, and 410 questionnaires were collected exclusively from China.

Figure 2-1: Data description



(Source: questionnaire data.)

Figure 2-2: Monthly Income description



(Source: questionnaire data.)

In terms of gender, the number of male respondents was 248 and the number of female respondents was 162, accounting for 60.5% and 39.5% respectively.
The vast majority of the respondents have bachelor's degree or below, among which the number of people with high school or below education is 155 accounting for 37.8%, and the number of people with bachelor's degree is 212 accounting for 51.7% of the total number of respondents. The remaining 35 people with Master's degree and 8 people with PhD accounted for 8.5% and 2% respectively.
Most of the respondents have a monthly income between 3,000RMB and 10,000RMB, of which 72 people accounted for 17.6% of the total below 3,000RMB, 119 people accounted for 29% of the total between 3,000RMB and 5,000RMB, 149 people accounted for 36.3% of the total between 5,000RMB and 10,000RMB, and the monthly income between 10,000RMB to 20,000RMB, 20,000RMB to 50,000RMB, 50,000RMB to 100,000RMB and over 100,000RMB were 51, 16, 2 and 1 respectively, accounting for 12.4%, 3.9%, 0.5% and 0.2% respectively.
Among the respondents, 333 of them have driver's licenses accounting for 81.2%, of which 304 own cars accounting for 74.1% of the total. There are 256 people have new energy vehicles accounted for 62.4% of the total number of people, taking into account the current development of new energy vehicles, I think this data is normal, in China due to the preferential policies for consumers to buy new energy vehicles and new energy vehicles use the characteristics of the low cost, most of the people are more willing to buy new energy vehicles.

3.5. Results

Reliability and validity analysis

Based on the hypothesis I have categorized the questionnaire into eight latitudes which are Willingness, Price, Brand, Configuration, Driving Feeling, Charging Facilities, Endurance anxiety, Economy.
Before proving the Hypothesis, I will analyze the reliability of the eight latitudes.
Table 1-1: Reliability test 1.1

Case Processing Summary			
		N	%
Cases	Valid	410	100.0
	Excluded[a]	0	.0
	Total	410	100.0
a. Listwise deletion based on all variables in the procedure.			

(Source: questionnaire data analyse by SPSS).

As can be seen from Table 1-1, there are 410 items with no missing samples.

In Reliability Statistics you can see that Willingness has a Cronbach's Alpha coefficient of 0.895, Price has a Cronbach's Alpha coefficient of 0.773, Brand has a Cronbach's Alpha coefficient for Brand is 0.79, Cronbach's Alpha coefficient for Configuration is 0.789, Cronbach's Alpha coefficient for Driving Feeling is 0.776, Charging Facilities has a Cronbach's Alpha coefficient of 0.762, Endurance anxiety has a Cronbach's Alpha coefficient of 0.794, and Economy has a Cronbach's Alpha coefficient of 0.794. 's Alpha coefficient is 0.817. if the coefficient is greater than 0.7, it is usually considered to pass the reliability test. This means that the data I have collected is reliable.

Table 1-2: Reliability test 1.2

	Reliability Statistics	
	Cronbach's Alpha	N of Items
Willingness	0.895	3
Price	0.773	4
Brand	0.79	4
Configuration	0.789	4
Driving Feeling	0.776	4
Charging Facilities	0.762	4
Endurance anxiety	0.794	4
Economy	0.817	4

(Source: questionnaire data analyse by SPSS.)

Table 1-3: Validity test 1.1

KMO and Bartlett's Test		
Kaiser-Meyer-Olkin Measure of Sampling Adequacy.		.880
Bartlett's Test of Sphericity	Approx. Chi-Square	5231.016
	df	465
	Sig.	<.001

(Source: questionnaire data analyse by SPSS.)

From the table, it can be seen that the Kaiser-Meyer-Olkin Measure of Sampling Adequacy is 0.880, which is greater than 0.7 and the closer it is to 1, the better the structural validity of the questionnaire is. The significance of the Bartlett's Test of Sphericity is less than 0.001, which suggests that there is a strong correlation between the variables within the questionnaire. There is a strong correlation between the variables.

According to Table 1-4 we can see that only 8 principal components have eigenvalues greater than 1, so the first 8 principal components are extracted and the cumulative variance contribution ratio of the first 8 principal components reaches 64.798%, which is greater than 60% therefore the first 8 principal components are acceptable. According to Figure 3 again it can be seen that the scatters of the first 8 factors are located on steep slopes while the scatters of the rest of the factors after that form gentle slopes with eigenvalues less than 1, so it is sufficient to consider the first 8 public factors. This corresponds to the 8 latitudes divided earlier.

Table 1-4 Validity test 1.2

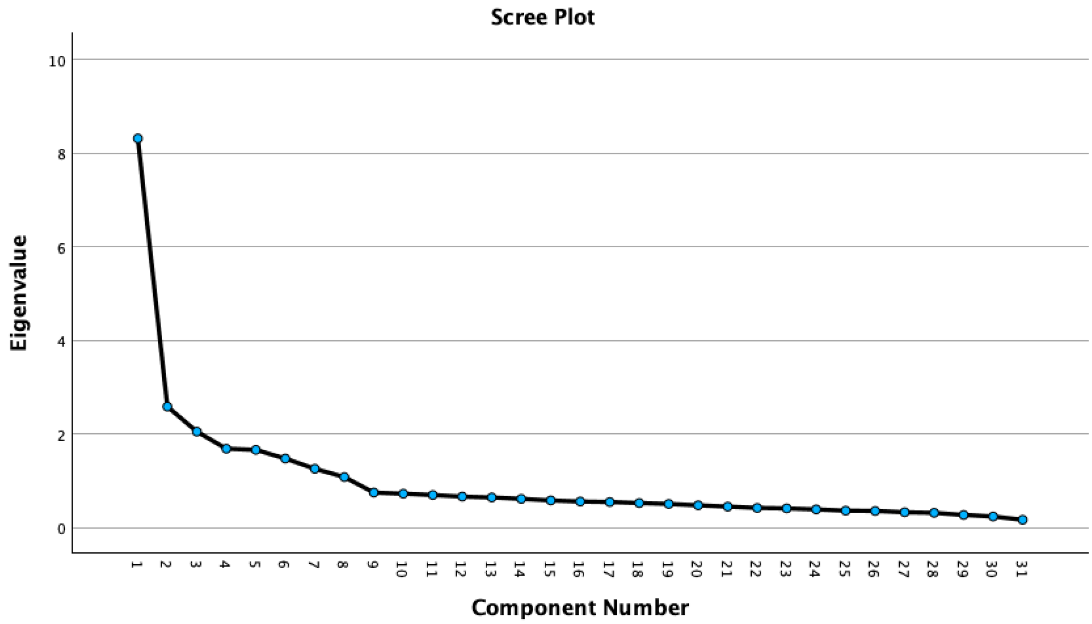
Total Variance Explained

	Initial Eigenvalues			Extraction Sums of Squared Loadings			Rotation Sums of Squared Loadings		
Component	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %
1	8.313	26.815	26.815	8.313	26.815	26.815	2.696	8.697	8.697
2	2.582	8.329	35.144	2.582	8.329	35.144	2.614	8.432	17.129
3	2.048	6.605	41.749	2.048	6.605	41.749	2.575	8.308	25.437
4	1.683	5.428	47.177	1.683	5.428	47.177	2.546	8.212	33.649
5	1.658	5.349	52.526	1.658	5.349	52.526	2.487	8.024	41.673
6	1.472	4.749	57.275	1.472	4.749	57.275	2.460	7.936	49.609
7	1.254	4.046	61.321	1.254	4.046	61.321	2.425	7.823	57.432
8	1.078	3.477	64.798	1.078	3.477	64.798	2.283	7.366	64.798
9	.745	2.405	67.202						
10	.721	2.326	69.528						
11	.693	2.235	71.763						
12	.659	2.127	73.890						
13	.641	2.067	75.957						
14	.611	1.971	77.927						
15	.577	1.862	79.789						
16	.554	1.788	81.577						
17	.543	1.752	83.329						
18	.522	1.683	85.012						
19	.502	1.620	86.633						
20	.474	1.528	88.160						
21	.445	1.437	89.597						
22	.417	1.346	90.944						
23	.408	1.315	92.259						
24	.386	1.246	93.504						
25	.359	1.157	94.661						
26	.352	1.136	95.798						
27	.325	1.048	96.845						
28	.312	1.008	97.853						
29	.267	.863	98.716						
30	.234	.755	99.471						
31	.164	.529	100.000						

Extraction Method: Principal Component Analysis.

(Source: questionnaire data analyse by SPSS.)

Figure 3: Validity test 1.3



(Source: questionnaire data analyse by SPSS.)

At the same time, I calculated the average scores of all the variables, in 410 questionnaires we can see that all the variables are above 4, which means that the respondents do not agree with these variables completely, the highest average score is 4.5073, which means that there is the phenomenon that the respondents have range anxiety for the new energy vehicles. The lowest mean score is 4.4006, which means that the respondents believe that the luxury brand of new energy vehicles accounts for a certain portion of the consideration factors for purchasing a vehicle.

Table 1-5: Average Report

Descriptive Statistics			
	Mean	Std. Deviation	N
Price	4.4585	.71214	410
Brand	4.4006	.75053	410
Configuration	4.4463	.70723	410
Driving Feeling	4.4811	.66989	410
Charging Facilities	4.4134	.73972	410
Endurance anxiety	4.5073	.66749	410
Economy	4.4610	.71677	410
Willingness	4.4805	.80866	410

(Source: questionnaire data analyse by SPSS.)

Hypothetical results

H1a. The price of new energy vehicles has a positive effect on consumers' willingness to buy.

Table 2-1: Analysis of Correlation between Willingness and Price

Correlations			
		Willingness	Price
Willingness	Pearson Correlation	1	.427**
	Sig. (2-tailed)		<.001
	N	410	410
Price	Pearson Correlation	.427**	1
	Sig. (2-tailed)	<.001	
	N	410	410
**. Correlation is significant at the 0.01 level (2-tailed).			

(Source: questionnaire data analyse by SPSS.)

From Table 2-1, we can see that the correlation coefficient between the price factor and willingness to buy is 0.427, and the two-sided P-value of the test of the correlation coefficient is less than 0.001, so it can be considered that the positive correlation between the two variables is statistically significant.

As shown in Table 2-2, R is 0.427, which is greater than 0.4, which indicates that the relationship between price and willingness to buy is positive. Normally we consider the ideal interval of Durbin-Watson coefficient is between 1.5 and 2.5, in the table Durbin- Watson coefficient is 2.142 which is within the ideal interval and we consider it ideal for this analysis.

Table 2-2: Analysis of regression with Willingness and Price 1.1

Model Summary[b]										
					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.427[a]	.182	.180	.73224	.182	90.822	1	408	<.001	2.142
a. Predictors: (Constant), Price										
b. Dependent Variable: Willingness										

(Source: questionnaire data analyse by SPSS.)

Table 2-3: Analysis of regression with Willingness and Price 1.2

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	48.696	1	48.696	90.822	<.001[b]
	Residual	218.759	408	.536		
	Total	267.455	409			
a. Dependent Variable: Willingness						
b. Predictors: (Constant), Price						

(Source: questionnaire data analyse by SPSS.)

In Table 2-3 ANOVA, the sig. value is less than 0.001, and we believe that the sig. value should be less than 0.005. therefore, we believe that the regression equation is valid.

Table 2-4: Analysis of regression with Willingness and Price 1.3

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.320	.230		10.108	<.001		
	Price	.485	.051	.427	9.530	<.001	1.000	1.000
a. Dependent Variable: Willingness								

(Source: questionnaire data analyse by SPSS.)

In Table 2-4 Coefficients, it can be concluded that y=0.485x+2.320, which can be interpreted as the willingness to buy increases by 0.485 times for every unit increase in price. Therefore, we believe that the price of new energy vehicles has a positive effect on consumers' willingness to buy.

H1b. The configuration of new energy vehicles has a positive effect on consumers' willingness to buy.

From Table 3-1, we can see that the correlation coefficient between price factor and purchase intention is 0.444, which is positive. And the test of correlation coefficient two-sided p-value is less than 0.001, which can be statistically significant positive correlation between artificial configuration and consumer's willingness to buy.

Table 3-1: Analysis of Correlation between Willingness and Configuration

Correlations			
		Willingness	Configuration
Willingness	Pearson Correlation	1	.444**
	Sig. (2-tailed)		<.001
	N	410	410
Configuration	Pearson Correlation	.444**	1
	Sig. (2-tailed)	<.001	
	N	410	410
**. Correlation is significant at the 0.01 level (2-tailed).			

(Source: questionnaire data analyse by SPSS.)

Table 3-2: Analysis of regression with Willingness and Configuration 1.1

Model Summary[b]										
					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.444[a]	.197	.195	.72552	.197	100.098	1	408	<.001	2.132
a. Predictors: (Constant), Configuration										
b. Dependent Variable: Willingness										

(Source: questionnaire data analyse by SPSS.)

According to Table 3-2 the R-value is 0.444, so there is a positive correlation between the two variables. And the Durbin-Waston coefficient is 2.132 is within the ideal range of 1.5 to 2.5, so this analysis is more desirable.

Table 3-3: Analysis of regression with Willingness and Configuration 1.2

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	52.690	1	52.690	100.098	<.001[b]
	Residual	214.765	408	.526		
	Total	267.455	409			
a. Dependent Variable: Willingness						
b. Predictors: (Constant), Configuration						

(Source: questionnaire data analyse by SPSS.)

From Table 3-3 ANOVA, we can see that the Sig. value is less than 0.01, so we think that the regression equation is valid.

In Table 3-4, it can be seen that y=0.508x+2.224, which can be expressed as every unit increase in configuration consumers' willingness to buy will increase by 0.508 times. Therefore the hypothesis that the configuration of new energy vehicles has a positive effect on consumers' willingness to buy is valid.

Table 3-4: Analysis of regression with Willingness and Configuration 1.3

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.224	.228		9.738	<.001		
	Configuration	.508	.051	.444	10.005	<.001	1.000	1.000
a. Dependent Variable: Willingness								

(Source: questionnaire data analyse by SPSS.)

H1c. The convenience of charging facilities has a positive effect on consumers' willingness to buy.

Table 4-1: Analysis of Correlation between Willingness and Charging Facilities

Correlations			
		Willingness	Charging Facilities
Willingness	Pearson Correlation	1	.457**
	Sig. (2-tailed)		<.001
	N	410	410
Charging Facilities	Pearson Correlation	.457**	1
	Sig. (2-tailed)	<.001	
	N	410	410
**. Correlation is significant at the 0.01 level (2-tailed).			

(Source: questionnaire data analyse by SPSS.)

According to Table 4-1 Correlation in shows that the p-value is less than 0.001, so there is a statistically significant relationship between these two variables and the Pearson Correlation coefficient is 0.457, so it can be assumed that there is a positive correlation between the accessibility of the charging facilities and the consumer's willingness to buy.

Table 4-2: Analysis of regression with Willingness and Charging Facilities 1.1

Model Summary[b]										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics					Durbin-Watson
					R Square Change	F Change	df1	df2	Sig. F Change	
1	.457[a]	.209	.207	.72015	.209	107.703	1	408	<.001	2.282
a. Predictors: (Constant), Charging Facilities										
b. Dependent Variable: Willingness										

(Source: questionnaire data analyse by SPSS.)

From Table 4-2, we can see that the R value is 0.457, so there is a positive correlation between the two variables and the Durin- Watson coefficient is 2.282 in the ideal interval. So we can consider this analysis as more desirable.

Table 4-3: Analysis of regression with Willingness and Charging Facilities 1.2

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	55.857	1	55.857	107.703	<.001[b]
	Residual	211.598	408	.519		
	Total	267.455	409			
a. Dependent Variable: Willingness						
b. Predictors: (Constant), Charging Facilities						

(Source: questionnaire data analyse by SPSS.)

In Table 4-3 it shows that the sig. value is less than 0.01, so we can assume that the regression equation is valid.

Table 4-4: Analysis of regression with Willingness and Charging Facilities 1.3

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.276	.215		10.564	<.001		
	Charging Facilities	.500	.048	.457	10.378	<.001	1.000	1.000
a. Dependent Variable: Willingness								

(Source: questionnaire data analyse by SPSS.)

In Table 4-4 it can be seen that y = 0.5x + 2.276, according to the formula we can interpret that for every unit increase in the convenience of charging facilities, the consumer's willingness to buy increases by a factor of 0.5, so the hypothesis is valid.

H1d. The economy of new energy vehicles has a positive effect on consumers' willingness to purchase.

Table 5-1: Analysis of Correlation between Willingness and Economy

Correlations			
		Willingness	Economy
Willingness	Pearson Correlation	1	.466**
	Sig. (2-tailed)		<.001
	N	410	410
Economy	Pearson Correlation	.466**	1
	Sig. (2-tailed)	<.001	
	N	410	410
**. Correlation is significant at the 0.01 level (2-tailed).			

(Source: questionnaire data analyse by SPSS.)

From Table 5-1, we can see that the correlation coefficient between the economy of use of new energy vehicles and consumers' willingness to buy is 0.466, and the p-value is less than 0.001. Therefore, we can consider that there is a statistically significant positive correlation between the economy of use of new energy vehicles and consumers' willingness to buy.

Table 5-2: Analysis of regression with Willingness and Economy 1.1

Model Summary[b]										
					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.466[a]	.217	.215	.71657	.217	112.870	1	408	<.001	2.207
a. Predictors: (Constant), Economy										
b. Dependent Variable: Willingness										

(Source: questionnaire data analyse by SPSS.)

In Table 5-2 Model Summary, we can see that there is a positive correlation between Economy and willingness to buy, and the Durbin-Watson coefficient is 2.207 which is within the ideal range of 1.5 to 2.5, so we think that this analysis is more ideal.

Table 5-3: Analysis of regression with Willingness and Economy 1.2

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	57.956	1	57.956	112.870	<.001[b]
	Residual	209.499	408	.513		
	Total	267.455	409			
a. Dependent Variable: Willingness						
b. Predictors: (Constant), Economy						

(Source: questionnaire data analyse by SPSS.)

From the ANOVA table I a see that the Sig. value is less than 0.001, so it can be determined that the regression equation is valid.

Table 5-4: Analysis of regression with Willingness and Economy 1.3

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.138	.223		9.571	<.001		
	Economy	.525	.049	.466	10.624	<.001	1.000	1.000
a. Dependent Variable: Willingness								

(Source: questionnaire data analyse by SPSS.)

In the above table, we can derive the equation y=0.525x+2.138, so we can interpret it as the consumer's willingness to buy increases by 0.525 times when the economy of use of new energy vehicles increases by one unit. So the hypothesis that the economy of use of new energy vehicles has a positive effect on consumers' willingness to buy is valid.

H2a. Brand premium moderates the relationship between price and consumer purchase intention.

In order to investigate whether Brand plays a moderating role in the effect of Willingness, this study uses hierarchical regression to test the moderating effect. Hierarchical regression is based on the regression analysis method, and the basic idea is to place the different types of variables under study inside the model in order to examine the contribution of the variable to the regression equation when the contribution of other variables is excluded. If the variable still has a significant contribution, then we can make the conclusion that the variable does have a unique role that cannot be replaced by other variables. The main purpose of this method is to get whether the newly added variable has an effect on the dependent variable after excluding the effect of the previous independent variable on the dependent variable.

From the theory of moderated variable analysis, it can be seen that when the moderating variable and the independent variable are continuous variables, the moderating variable and the continuous variable should be centered first, and then the product of the two should be used as the new variable, and the independent variable should be X, and the moderating variable should be M. Then the centered data should be $X-\overline{X}$ and $M-\overline{M}$, and the product of the two should be $(X-\overline{X})\times(M-\overline{M})$, which is called the cross term, and the cross term should be used as an independent variable, and the cross term should be used as a cross term for the dependent variable, and the cross term for the dependent variable. term as an independent variable to regress the dependent variable, if the standardized regression coefficient is significant, it indicates moderation.

Table 6-1: Analysis of regression with Willingness, Price, Brand and cross term Price×Brand 1.1

Model Summary[d]										
					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.427[a]	.182	.180	.73224	.182	90.822	1	408	<.001	
2	.489[b]	.239	.235	.70729	.057	30.296	1	407	<.001	
3	.532[c]	.283	.278	.68712	.045	25.238	1	406	<.001	2.212
a. Predictors: (Constant), Price										
b. Predictors: (Constant), Price, Brand										
c. Predictors: (Constant), Price, Brand, Price×Brand										
d. Dependent Variable: Willingness										

(Source: questionnaire data analyse by SPSS.)

From Taable 6-1 Model Summary, we mainly look at the three values of "R square", "Sig. F Change" and "Durbin-Watson". " three values, R square represents the explanatory rate of the independent variable to the dependent variable, in model 1, the explanatory rate of the independent variable Price to the dependent variable Willingness is 18.2%, while in model 2, the explanatory rate of the independent variable Price with the moderator variable Brand to the dependent variable Willingness is 23.9%%, in Model 3, the explanatory rate of the dependent variable willingness by the independent variable Price, moderator variable Brand with the cross term Price×Brand is 28.3%%. "Sig. F Change" reflects whether the change of R-square is significant or not, and the value of "Sig. F Change" in the model is less than 0.001 and less than 0.05, which means that the moderating effect is significant. The Durbin-Watson value of 2.212 is within the ideal range of 1.5 to 2.5, so we think this analysis is more satisfactory.

Table 6-2: Analysis of regression with Willingness, Price, Brand and cross term Price×Brand 1.2

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	48.696	1	48.696	90.822	<.001[b]
	Residual	218.759	408	.536		
	Total	267.455	409			
2	Regression	63.852	2	31.926	63.820	<.001[c]
	Residual	203.603	407	.500		
	Total	267.455	409			
3	Regression	75.768	3	25.256	53.493	<.001[d]
	Residual	191.687	406	.472		
	Total	267.455	409			
a. Dependent Variable: Willingness						
b. Predictors: (Constant), Price						
c. Predictors: (Constant), Price, Brand						
d. Predictors: (Constant), Price, Brand, Price×Brand						

(Source: questionnaire data analyse by SPSS.)

According to Table 6-2 ANOVA it can be seen that the Sig. value is less than 0.001 and less than 0.05, so it can be determined that the analysis is valid.

From Table 6-3 Coefficients, it can be seen that in Model 1, the Beta value of Price is 0.427 is greater than 0 and the Sig. value is less than 0.001, so Price has a significant positive effect on willingness. In model 2, adding the moderating variable Brand, the Beta value of Price is 0.340 is greater than 0 and the Sig. value is less than 0.001, and the Beta value of Brand is 0.253 is greater than 0 and the Sig. value is less than 0.001, so we believe that Brand has a significant positive effect on Willingness. In model 3, adding the moderating effect Price × Brand, its Beta value is 0.225 is greater than 0, Sig. value is less than 0.001, and finally we believe that brand premium increases the positive effect of price on purchase intention, so the hypothesis is valid.

Table 6-3: Analysis of regression with Willingness, Price, Brand and cross term Price×Brand 1.3

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.320	.230		10.108	<.001		
	Price	.485	.051	.427	9.530	<.001	1.000	1.000
2	(Constant)	1.558	.261		5.958	<.001		
	Price	.386	.052	.340	7.389	<.001	.883	1.132
	Brand	.273	.050	.253	5.504	<.001	.883	1.132
3	(Constant)	1.036	.274		3.777	<.001		
	Price	.440	.052	.388	8.485	<.001	.845	1.184
	Brand	.323	.049	.300	6.565	<.001	.847	1.181
	Price×Brand	.326	.065	.225	5.024	<.001	.882	1.134
a. Dependent Variable: Willingness								

(Source: questionnaire data analyse by SPSS.)

H2b. Driving sensation moderates the relationship between configuration and consumer purchase intention.

Hierarchical regression was also used to test for moderating effects in the study of driving perception as a moderator between configuration and consumers' purchase intentions. In this model, we use configuration as the independent variable, driving sense as the moderator variable, and the dependent variable is purchase intention. From the theory of moderating variable analysis, when the moderating variable and the independent variable are continuous variables, the moderating variable and the continuous variable should be centered first, and then the product of the two should be used as a new variable, so we introduce a new variable Configuration×Charging Facilities, which is also called the cross-term, and use the cross-term as an independent variable, regress the dependent variable and if the standardized regression coefficients are significant, it indicates a moderating effect.

According to Table 7-1, we can see that Configuration explains 19.7% of Willingness in Model 1, in Model 2 Configuration and the moderator variable Driving Feeling explain 26.8% of Willingness, and in Model 3. Configuration, the moderator variable Driving Feeling and the cross-term Configuration × Charging Facilities explain 29.7% of Willingness. We can see that the value of "Sig. F Change" in the model is less than 0.001 and less than 0.05, which indicates that the moderating effect in the model is statistically significant. Moreover, the Durbin-Watson value is 2.147, which is within the ideal range of 1.5 to 2.5, so we can consider this analysis is more satisfactory.

Table 7-1: Analysis of regression with Willingness, Configuration, Driving Feeling and cross-term Configuration×Charging_Facilities 1.1

Model Summary[d]										
					Change Statistics					
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.444[a]	.197	.195	.72552	.197	100.098	1	408	<.001	
2	.518[b]	.268	.265	.69334	.071	39.761	1	407	<.001	
3	.545[c]	.297	.292	.68033	.029	16.711	1	406	<.001	2.147
a. Predictors: (Constant), Configuration										
b. Predictors: (Constant), Configuration, Driving Feeling										
c. Predictors: (Constant), Configuration, Driving Feeling, Configuration×Charging_Facilities										
d. Dependent Variable: Willingness										

(Source: questionnaire data analyse by SPSS.)

Table 7-2: Analysis of regression with Willingness, Configuration, Driving Feeling and cross-term Configuration×Charging_Facilities 1.2

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	52.690	1	52.690	100.098	<.001[b]
	Residual	214.765	408	.526		
	Total	267.455	409			
2	Regression	71.804	2	35.902	74.684	<.001[c]
	Residual	195.651	407	.481		
	Total	267.455	409			
3	Regression	79.538	3	26.513	57.282	<.001[d]
	Residual	187.917	406	.463		
	Total	267.455	409			
a. Dependent Variable: Willingness						
b. Predictors: (Constant), Configuration						
c. Predictors: (Constant), Configuration, Driving Feeling						
d. Predictors: (Constant), Configuration, Driving Feeling, Configuration×Charging_Facilities						

(Source: questionnaire data analyse by SPSS.)

According to the ANOVA table it can be seen that the Sig. value is less than 0.001 and less than 0.05, so it can be decided that the analysis is valid.

Table 7-3: Analysis of regression with Willingness, Configuration, Driving Feeling and cross-term Configuration×Charging_Facilities 1.3

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.224	.228		9.738	<.001		
	Configuration	.508	.051	.444	10.005	<.001	1.000	1.000
2	(Constant)	1.111	.281		3.956	<.001		
	Configuration	.419	.050	.367	8.314	<.001	.923	1.083
	Driving Feeling	.336	.053	.278	6.306	<.001	.923	1.083
3	(Constant)	.804	.285		2.817	.005		
	Configuration	.424	.050	.371	8.563	<.001	.923	1.084
	Driving Feeling	.391	.054	.324	7.242	<.001	.866	1.155
	Configuration×Charging_Facilities	.305	.075	.176	4.088	<.001	.930	1.076
a. Dependent Variable: Willingness								

(Source: questionnaire data analyse by SPSS.)

From Table 7-3, we can see that in Model 1, the Beta value of Configuration is 0.444 is greater than 0 is positive, and the Sig. value is less than 0.001, so we can assume that Configuration has a significant positive effect on willingness. In model 2, by adding the moderator variable Driving Feeling, the Beta value of Configuration is 0.367 is greater than 0 is positive and Sig. value is less than 0.001, and the Beta value of Driving Feeling is 0.278 is greater than 0 is positive and Sig. value is less than 0.001, so we can assume that Driving Feeling has a significant positive effect on Willingness. In model 3, adding the moderating effect Configuration × Charging Facilities, its Beta value is 0.176 is greater than 0 is positive, Sig. value is less than 0.001, and finally we think that Driving Feeling will increase the positive effect of Configuration on Willingness Therefore, the hypothesis that Driving Feeling has a moderating effect between Configuration and consumer's willingness to buy is valid.

H2c. Range anxiety mediates the relationship between ease of access to charging facilities and consumer purchase intentions.

In order to test that range anxiety has a mediating effect between the convenience of charging facilities and consumers' willingness to purchase, we therefore set the convenience of charging facilities as the independent variable, consumers' willingness to purchase as the dependent variable, and range anxiety as the mediating variable, and the following mediation effect test is conducted to verify the hypotheses.

If we want to prove the mediating effect, first prove that the independent variable has an effect on the dependent variable. Secondly prove that the independent variable has an effect on the mediating variable. Finally after adding the mediator variable, if the independent variable becomes no effect on the dependent variable then we determine that there is a full mediating effect, if the independent variable still has an effect on the dependent variable, but the influence coefficient becomes smaller then there is a partial mediating effect.

Table 8-1: Analysis of regression with Willingness, Charging facilities, Endurance anxiety 1.1

Model Summary[c]										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.457[a]	.209	.207	.72015	.209	107.703	1	408	<.001	
2	.478[b]	.229	.225	.71197	.020	10.437	1	407	.001	2.269
a. Predictors: (Constant), Charging Facilities										
b. Predictors: (Constant), Charging Facilities, Endurance anxiety										
c. Dependent Variable: Willingness										

(Source: questionnaire data analyse by SPSS.)

From Table 8-1, we can see that the explanatory rate of the independent variable Charging Facilities on the dependent variable Willingness is 20.9% and the Sig. F Change value is less than 0.001 and less than 0.05. With the addition of the terminal variable Endurance anxiety, the explanatory rate of the independent variable Charging Facilities explains 22.9% of the dependent variable Willingness with Sig. F Change value of 0.001 less than 0.05.Durbin-Watson value of 2.269 is within the desirable interval between 1.5 and 2.5. We can consider this analysis as statistically significant and satisfactory.

Table 8-2: Analysis of regression with Charging facilities, Endurance anxiety 1.1

Model Summary[b]										
Model	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics: R Square Change	F Change	df1	df2	Sig. F Change	Durbin-Watson
1	.494[a]	.244	.242	.58119	.244	131.482	1	408	<.001	2.038
a. Predictors: (Constant), Charging Facilities										
b. Dependent Variable: Endurance anxiety										

(Source: questionnaire data analyse by SPSS.)

From Table 8-2, we can see that the explanatory rate of independent variable Charging Facilities on the mediator variable Endurance anxiety is 24.4%, Sig. F Change value is less than 0.001 and less than 0.05, so we can think that the results of this analysis are statistically significant and the Durbin- Watson value of 2.038 is within the ideal interval, so the results of this analysis are more satisfactory.

Table 8-3: Analysis of regression with Willingness, Charging facilities, Endurance anxiety 1.2

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	55.857	1	55.857	107.703	<.001[b]
	Residual	211.598	408	.519		
	Total	267.455	409			
2	Regression	61.147	2	30.574	60.315	<.001[c]
	Residual	206.308	407	.507		
	Total	267.455	409			
a. Dependent Variable: Willingness						
b. Predictors: (Constant), Charging Facilities						
c. Predictors: (Constant), Charging Facilities, Endurance anxiety						

(Source: questionnaire data analyse by SPSS.)

Table 8-4: Analysis of regression with Charging facilities, Endurance anxiety 1.2

ANOVA[a]						
Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	44.412	1	44.412	131.482	<.001[b]
	Residual	137.816	408	.338		
	Total	182.228	409			
a. Dependent Variable: Endurance anxiety						
b. Predictors: (Constant), Charging Facilities						

(Source: questionnaire data analyse by SPSS.)

According to Table 8-3 and Table 8-4 it can be seen that the Sig. value is less than 0.001 and less than 0.05, so it can be decided that the analysis is valid.

Table 8-5: Analysis of regression with Willingness, Charging facilities, Endurance anxiety 1.3

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.276	.215		10.564	<.001		
	Charging Facilities	.500	.048	.457	10.378	<.001	1.000	1.000
2	(Constant)	1.778	.263		6.762	<.001		
	Charging Facilities	.412	.055	.377	7.534	<.001	.756	1.322
	Endurance anxiety	.196	.061	.162	3.231	.001	.756	1.322
a. Dependent Variable: Willingness								

(Source: questionnaire data analyse by SPSS.)

Table 8-6: Analysis of regression with Charging facilities, Endurance anxiety 1.3

Coefficients[a]								
Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.	Collinearity Statistics	
		B	Std. Error	Beta			Tolerance	VIF
1	(Constant)	2.541	.174		14.618	<.001		
	Charging Facilities	.445	.039	.494	11.467	<.001	1.000	1.000
a. Dependent Variable: Endurance anxiety								

(Source: questionnaire data analyse by SPSS.)

First of all we can see from Table 8-5 that the Beta value of the independent variable Charging Facilities on the dependent variable Willingness is 0.377 which is positive and the Sig. value is less than 0.001 and less than 0.05. So we can assume that the independent variable Charging Facilities has a positive effect on the dependent variable Willingness has a positive effect. Secondly, from Table 8-6, we can see that the Beta value of independent variable Charging Facilities on mediator variable Endurance anxiety is 0.494 which is positive and Sig. value is less than 0.001 and less than 0.05. So independent variable Charging Facilities has a positive effect on mediator variable Endurance anxiety. Endurance anxiety has positive effect. Finally, from Table 8-5, we can see that after adding the mediator variable Endurance anxiety, the Beta value of the independent variable Charging Facilities on the dependent variable Willingness is 0.162, which is positive but less than 0.377 before adding the mediator variable, and the Sig. value is less than 0.001 and less than 0.05. Therefore, we can judge that the independent variable Charging Facilities has a positive effect on the dependent variable Endurance anxiety. 0.05. Therefore, we can determine that the mediator variable Endurance anxiety has a partial mediating role between the independent variable Charging Facilities and the dependent variable Willingness, so the hypothesis is valid.

3.6. Conclusions and Suggestions

Conclusions

H1. Product factors have a positive effect on consumers' purchase intention.

a. In China's new energy vehicle market, price has a positive influence on consumers' willingness to buy new energy vehicles, as Chinese consumers believe that the price of new energy vehicles is cheaper than that of traditional oil vehicles, and they are more willing to buy new energy vehicles because of the more favorable price.

b. In China's new energy vehicle market, the configuration of new energy vehicles has a positive effect on consumers' willingness to buy, Chinese consumers believe that the configuration of new energy vehicles is more practical and safer than that of traditional oil vehicles, so the stronger the willingness of Chinese consumers to buy new energy vehicles.

c. In China's new energy vehicle market, the convenience of charging facilities for new energy vehicles has a positive impact on consumers' willingness to buy. Chinese consumers generally believe that the convenience of charging is more important, so new energy vehicles with more convenient charging facilities are more likely to be purchased by Chinese consumers.

d. In China's new energy vehicle market, the economy of use of new energy vehicles has a positive impact on consumers' willingness to buy, Chinese consumers also attach great importance to the economy of use of the vehicle, so in China, the lower the cost of daily use of the vehicle, the lower the maintenance cost of new energy vehicles are more favored by Chinese consumers.

H2. Psychological factors moderate or mediate the relationship between product and purchase factors.

a. In the Chinese new energy vehicle market, brand premium has a moderating effect between price and consumers' willingness to buy, and Chinese consumers attach great importance to the recognition and brand reputation of automobile brands. Internationally recognized brands are usually more favored, and China's own brands are also improving their brand image and market share. In recent years, China's own-branded new energy vehicles have gradually become the mainstay of the global new energy vehicle industry, and their brand recognition and brand premium are also gradually increasing. Therefore, Chinese consumers will take brand premium into consideration when purchasing new energy vehicles.

b. In China's new energy vehicle market, driving sensation has a moderating effect between configuration and consumers' purchase intention. Chinese consumers are interested in the power performance and acceleration of new energy vehicles, and the driving stability and maneuverability of new energy vehicles are better than that of traditional oil-fueled vehicles due to the difference in mechanical structure. Chinese consumers are willing to add optional features to improve driving experience if they have sufficient budget, and they are also more willing to choose models with higher features and better driving experience when they choose a vehicle in the spot.

c. In China's new energy vehicle market, range anxiety plays an intermediary role between the convenience of charging facilities and consumers' willingness to buy. Because new energy vehicles differ from traditional oil vehicles in terms of energy supply and the limitations of existing technology, the speed of refueling for traditional oil vehicles is moderately faster than that of charging for new energy vehicles, so when purchasing a new energy vehicle, Chinese consumers will take the convenience of charging into consideration. Therefore, Chinese consumers will take the convenience of charging into consideration when purchasing new energy vehicles, and new energy vehicles with faster charging speeds or exclusive charging facilities, such as Tesla's exclusive super charging piles and NIO's power exchange stations, will sell better. The convenience of charging facilities can effectively alleviate the range anxiety of new energy vehicles, and consumers do not have to worry about not being able to charge in time during long-distance driving. When convenient charging facilities overcome range anxiety, consumers are more willing to buy new energy vehicles.

China's consumer market for new energy vehicles has shown rapid growth in recent years, thanks to government policy support, increased environmental awareness, and consumers' pursuit of advanced technology and energy efficiency. The Chinese government has been committed to promoting the development of the new energy vehicle industry and has adopted a series of incentive policies, including subsidies for vehicle purchases, exemption from vehicle purchase tax, and free license plates, to encourage consumers to purchase new energy vehicles. The implementation of these policies has greatly reduced the purchase cost of new energy vehicles and driven the rapid growth of the market. In the new energy vehicle market, there is fierce competition between internationally recognized auto brands and local Chinese brands. Some local Chinese new energy vehicle brands have been increasing their investment in technology development and product promotion, gradually eating into the market share of international brands. Thanks to China's economic development and economic globalization, Chinese consumers are gradually increasing their consumption power, so when purchasing a car, Chinese consumers will consider the economy of use and at the same time pursue high-end luxury brands. At the same time, the Chinese government is also increasing the construction of charging infrastructure to solve the problem of inconvenient charging of new energy vehicles. The popularity of charging piles plays an important role in consumers' decision to purchase new energy vehicles.

Suggestions

Sales Strategy for New Energy Vehicles

China, as the world's most populous country, has the world's second largest consumer market and a large consumer base, which means that consumers have a wide range of acceptance of prices. As of September 2023, China's motor vehicle ownership reached 430 million, of which 330 million were automobiles and 18.21 million were new energy vehicles; there were 520 million motor vehicle drivers, of which 480 million were automobile drivers. This means that the Chinese market has a huge demand for automobiles. And Chinese consumers on the purchase of automobile consumption concept is the first is a good price, comparison, so Chinese consumers pay more attention to the price of the car for sale. The second is to buy a more luxurious and advanced car within a limited budget, which is also the unique face culture in China. Therefore, I think manufacturers can consider formulating price incentives, such as cash discounts, purchase subsidies or free accessories, to reduce the cost of purchasing cars and attract more consumers to buy new energy vehicles. And to meet the needs of different consumer groups, they can provide diversified price levels and model choices, including high-end, mid-range and entry-level products, so as to meet the budgets and needs of different consumers. For consumers with a certain history of vehicle use, provide favorable new energy vehicle exchange policies to encourage them to upgrade and increase market penetration. Finally, by adding value-added services such as free maintenance, free charging and extended warranty, the overall cost-effectiveness of the products will be improved to attract more consumers to choose new energy vehicles.

Configuration Innovation and Enhanced Driving Experience for New Energy Vehicles

At present, Chinese consumers' requirements for new energy vehicles are safety, comfort, economy, intelligence and personality. I think new energy vehicle manufacturers should continue to strengthen their scientific research efforts in the field of new energy vehicles, and gradually improve the safety configuration of new energy vehicles. Manufacturers should equip their vehicles with advanced safety driving assistance systems, such as automatic emergency braking systems, blind spot monitoring systems, adaptive cruise control, and automatic driving technology, to improve the safety performance of their vehicles. And continue to develop more mature technologies on the basis of the existing ones. In terms of battery technology for new energy vehicles, manufacturers need to further improve battery safety and reduce the risk of battery spontaneous combustion. In terms of comfort, I think China's own brand manufacturers should continue to learn from the traditional oil car manufacturers at the same time combined with the actual situation of the Chinese people, to create their own ergonomic system in line with the Chinese people, and can be practically applied to the product. In terms of intelligence, I think manufacturers can continue to optimize the car system, improve the car system user interface design, so that the user operation is more concise and easy to get started. Enhance human-computer interaction, further strengthen the car in the Internet, better realize the car in the personal intelligent terminal and other intelligent terminal interconnection. Strengthen the system cloud construction, optimize the data update mechanism, realize real-time information push and update, including road condition information, weather forecast, traffic restrictions, etc., to improve the user's driving safety and comfort. Enhance the real-time monitoring and self-diagnosis of the vehicle status by the vehicle system such as tire pressure monitoring, battery status, body structure inspection, etc., and provide timely feedback and maintenance suggestions. Enhance the security measures of the vehicle system itself and the cloud to prevent network attacks and the risk of information leakage and ensure the safety of users' personal information and vehicle data. For personality, as today's consumers prefer unique and unique customized products, I think manufacturers can launch a more diversified personalized private customization service, which can increase personalized body accessories according to consumers' personal preferences, such as customized sports kits, wheel styles, body appearance modifications, etc. For the interior manufacturers can add personalized interior decoration accessories options, such as seat materials, dashboard decoration, steering wheel style, etc., to create a unique interior space. Open up more diversified functional customization, allowing consumers to choose the functional configurations of the vehicle according to their personal needs, such as adding intelligent driver assistance systems, upgrading the audio system, improving seat comfort, adding air suspension, etc., to achieve a personalized driving experience. It also allows consumers to purchase different vehicle accessories according to their personal preferences, such as luggage racks, roof boxes, vehicle refrigerators, etc., to create a unique vehicle appearance and functionality. For pre-sales and after-sales service, I think manufacturers can refine the pre-sales service list and personalized after-sales service and maintenance programs, provide personalized handover ceremonies and customized vehicle delivery processes when the car is delivered to provide consumers with an exclusive service experience and enhance brand identity and satisfaction. It also allows consumers to flexibly choose their own after-sales service programs and flexible scheduling according to their own needs, ensuring the good condition and experience of the vehicle.

Recommendations for range and charging facilities for new energy vehicles

With urbanization and economic development, population movement in China is increasing. In addition to public transportation such as high-speed trains and airplanes, self-driving is also popular. However, China has the third largest land area in the world, with more than 60 degrees of longitude across the east and west, spanning five time zones, and a distance of about 5,200 kilometers from east to west. North and south across the latitude of nearly 50 degrees, the distance between north and south is about 5500 kilometers. For self-driving people on the car's primary consideration is the range, as far as the current technology is concerned, the range of new energy vehicles can not fully support long-distance driving. Although China has built a huge number of charging piles in recent years, covering various areas such as cities, villages and highways. However, as the popularity of new energy vehicles continues to increase, the demand for charging is growing rapidly, and the construction of charging facilities is not keeping up with the growth in market demand. The construction of charging facilities is mainly concentrated in urban centers and economically developed areas, while charging facilities in marginal urban areas and rural areas are relatively insufficient. The current standard of charging facilities is not uniform, and different brands of new energy vehicles need to use different types of charging equipment, increasing the inconvenience for users. These are all issues that will hinder the consumption of new energy vehicles. For this reason, I believe that the government should continue to speed up the construction of charging facilities and increase the number and density of charging piles to meet the growing demand for charging. Adjust resource allocation, increase investment in charging facilities in marginal urban and rural areas, and improve the coverage and balance of charging facilities. Each manufacturer should strengthen the standardization of charging facilities, promote the unification of charging facility standards, improve the interoperability and compatibility of charging facilities, and provide users with more convenient charging services. At the same time, new battery materials and technologies are constantly being developed to improve the energy density of batteries and achieve a higher range. This can be achieved by adopting new materials, optimizing the battery structure and improving the manufacturing process. Accelerate the research and development of fast charging technology to increase charging speed, shorten charging time, and improve the user's charging convenience and experience.

4. Summary

As the world's third largest country in terms of land area and the world's largest population, China has a huge consumer market, and a huge demand for new energy vehicles, but also has higher requirements for new energy vehicles. At present, China's rapid development in the new energy automobile industry has become the backbone of the global new energy automobile industry. Since Tesla entered the Chinese market in 2013, China's new energy automobile market has been activated, and a large number of new energy automobile emerging car-making enterprises have emerged. Such a group of companies continue to plowing in the field of new energy vehicles constantly innovative technology, so that China's new energy vehicle market into a virtuous cycle, consumers for new energy vehicles more and more choices, factors affecting consumers to buy new energy vehicles is also increasing. The government has introduced a series of policies to support the development of new energy vehicles, including purchase subsidies, free parking, free licensing and other incentives to motivate consumers to buy new energy vehicles. Despite the relatively high purchase cost of new energy vehicles, consumers usually consider the economics of long-term use. They believe that although the initial investment in a new energy vehicle is larger, the total cost of a new energy vehicle may be lower in the long run because of the relatively low cost of charging an electric vehicle and the lower cost of maintenance, which becomes a consideration for their purchase. Consumers tend to prefer well-known brands and reputable manufacturers when purchasing new energy vehicles. They believe that these brands have more reliable product quality and better after-sales service, and that they can have a better purchasing and usage experience after purchase, so they are more willing to choose products from these brands. Range anxiety is a hindrance to the promotion and popularization of new energy vehicles, so manufacturers and the government need to take measures to alleviate range anxiety and boost consumer confidence and acceptance of new energy vehicles. This may include measures such as increasing the range of electric vehicles, building more charging facilities, improving charging speeds, enhancing consumer education and publicity, and promoting the popularity of new energy vehicles. When purchasing a new energy vehicle, consumers will consider the availability of charging facilities in their neighborhood, including the number, location and convenience of charging piles, to ensure convenient and reliable charging. Consumers also attach great importance to the driving experience of new energy vehicles. They pay attention to power performance, handling and comfort. A good driving experience can improve user satisfaction and increase recognition of new energy vehicles, so driving experience is an important factor influencing consumers' decision to purchase a vehicle. With the development of society, consumers pay more and more attention to personalized needs. When purchasing a new energy vehicle, consumers will consider whether the appearance, configuration and performance of the model can meet their needs. Some consumers may prefer a stylish exterior design, some may value configuration and features, while others may be more concerned about the performance of the vehicle. Therefore, manufacturers need to take into account consumers' individual needs when designing their products and provide more diversified and personalized choices to meet the needs and preferences of different consumers.

From the perspective of consumer behavior, when studying the consumer behavior of new energy vehicles, it is necessary to look for factors that can influence consumers as much as possible, and to understand how different factors have an impact on consumers in order to study more effectively. This is also the basis of the theory or practice of consumer behavior.

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Appendix 1 - Questionnaire

1. Gander [Selective]

   ○male ○female

2. Age [Open-ended questions]

   ____

3. Education [Selective]

   ○High school/Junior college

   ○Bachelor's degree

   ○Master's degree

   ○Doctorate

4. Monthly Income (CNY) [Selective]

   ○3,000RMB and below

   ○3,000 RMB -5,000 RMB

   ○5,000 RMB -10,000 RMB

   ○10,000 RMB -20,000 RMB

   ○20,000 RMB -50,000 RMB

   ○50,000 RMB -100,000 RMB

   ○100,000 RMB and above

5. Do you have drive license [Selective]

   ○Yes ○No

6. Do you have car [Selective]

   ○Yes ○No

7. Do you have new energy vehicle [Selective]

   ○Yes ○No

8. Brand of New Energy Vehicle [Open-ended questions]

   ____

9. Price of the car you own (CNY) [Selective]

   ○50,000 RMB and below

   ○50,000 RMB -100,000 RMB (including 100,000 RMB)

   ○100,000 RMB -200,000 RMB (including 200,000 RMB)

   ○200,000 RMB -300,000 RMB (including 300,000 RMB)

   ○300,000 RMB -400,000 RMB (including 400,000 RMB)

   ○400,000 RMB -500,000 RMB (including 500,000 RMB)

   ○500,000 RMB -800,000 RMB (including 800,000 RMB)

   ○800,000 RMB -1,000,000 RMB (including 1,000,000 RMB)

   ○Over 1,000,000 RMB

10. Would you prefer a new energy vehicle when buying a car? [Rating scales]

    Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

11. Would you recommend people around you to buy a new energy vehicle? [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

12. Are you willing to buy a new energy vehicle in the future[Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

13. What type of new energy vehicle do you prefer? [Multiple Selective]

□Battery Electric Vehicle (Tesla series, NIO, Xpeng, BMW i3, Mercedes-Benz EQ series, Audi e-tron series, BYD EV, etc.)

□Hybrid Electric Vehicle (Toyota Prius, Toyota Renegade, Toyota Corolla, etc.)

□Plug-in Hybrid Electric Vehicle (PHEV models from Volkswagen, Audi, Mercedes-Benz, BMW, Volvo, etc.)

□Range-Extended Electric Vehicle (Li Auto ONE, BMW i3 REEV, VOYAH FREE REEV, AITO M5, etc.)

□Fuel Cell Electric Vehicle (Toyota Mirai, Honda Clarity, etc.)

□Hydrogen Internal Combustion Engine Vehicle (Toyota MIRAI, Hyundai NEXO, BMW iX5 Hydrogen, SAIC Datsun MAXUS MIFA Hydrogen, etc.)

14. The brand of new energy vehicle you would like to buy[Open-ended questions]

____

15. Your budget for purchasing a new energy vehicle (CNY) [Selective]

○50,000RMB and below

○50,000 RMB -100,000 RMB (including 100,000 RMB)

○100,000 RMB -200,000 RMB (including 200,000 RMB)

○200,000 RMB -300,000 RMB (including 300,000 RMB)

○300,000 RMB -400,000 RMB (including 400,000 RMB)

○400,000 RMB -500,000 RMB (including 500,000 RMB)

○500,000 RMB -800,000 RMB (including 800,000 RMB)

○800,000 RMB -1,000,000 RMB (including 1,000,000 RMB)

○Over 1,000,000 RMB

16. Do you think the price of new energy vehicles is cheaper than that of traditional gasoline vehicles? [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

17. You think the discounts for buying new energy vehicles are bigger? [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

18. You think new energy vehicles are more cost-effective? [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

19. You think there are more choices of new energy vehicles than traditional oil vehicles in the same price range? [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

20. You prefer luxury brands (Mercedes-Benz, BMW, Audi, Land Rover, etc.) when purchasing new energy vehicles. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

21. You think the price premium of luxury brands is more serious in the same class of new energy vehicles. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

22. You believe that luxury brands of new energy vehicles retain their value more (Mercedes-Benz, BMW, Audi, Land Rover, etc.) [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

23. You would buy a new energy vehicle of a certain brand because of its unique features (e.g. Tesla's Autopilot function) [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

24. You would add optional features (other than the standard features, which you need to pay for) to a new energy vehicle. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

25. You believe that new energy vehicles are safer than traditional energy vehicles (protection of passengers in the event of a crash, etc.) [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

26. Do you think the self-driving function of new energy vehicles is safe? [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

27. You think the intelligent features of new energy vehicles are practical (e.g. voice assistant, automatic driving, etc.) [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

28. You think the driving experience of new energy vehicles is better than that of traditional gasoline vehicles. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

29. You think the kinetic energy recovery system of new energy vehicles is more in line with your driving habits (slowing down by letting go of the gas pedal when driving a new energy vehicle) [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

30. You think the starting speed of new energy vehicles is more in line with your driving habits. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

31. You think the driving speed of new energy vehicles is smoother than that of traditional gasoline vehicles. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

32. You think it is necessary to install private charging stations. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

33. You think the number of public charging stations is sufficient. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

34. You think the charging facilities of new energy vehicles are more convenient. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

35. You accept that new energy vehicles require longer charging time (compared to the refueling time of traditional oil vehicles). [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

36. You will pay attention to the mileage when purchasing a new energy vehicle. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

37. You have mileage anxiety when driving a new energy vehicle. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

38. You will pay attention to the battery balance when driving a new energy vehicle. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

39. You are willing to use new energy vehicles for longer distances (more than 400 kilometers) [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

40. You think the actual cost of using a new energy vehicle (charging) is lower than that of a conventional vehicle. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

41. You think the actual maintenance cost of new energy vehicles is lower than that of conventional vehicles. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

42. You think the actual maintenance cost of new energy vehicles is lower than that of conventional vehicles. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

43. You think the breakdown rate of new energy vehicles is lower. [Rating scales]

Very reluctantly ○1 ○2 ○3 ○4 ○5 Very willing

Appendix 2 – Declaration

DECLARATION

Ye Kun (student Neptun code: KCEEDF)
as a consultant, I declare that I have reviewed the final thesis[1] and that I have informed the student of the requirements, legal and ethical rules for the correct handling of literary sources.

I recommend / do not recommend[2] the final thesis / dissertation / portfolio to be defended in the final examination.

The thesis contains a state or official secret: yes no*[3]

Date: 2024 year 04 month 04 day

____
insider consultant

[1] The other types should be deleted while retaining the corresponding thesis type.
[2] The appropriate one should be underlined.
[3] The appropriate one should be underlined.

DECLARATION

the public access and authenticity of the thesis/dissertation/portfolio[1]

Student's name: Ye Kun

Student's Neptun code: KCEEDF

Title of thesis: New energy vehicles (electric vehicles) industry development analysis----The Consumer Behavior of New Energy Vehicles.

Year of publication: 2024

Name of the consultant's institute: Institute of Agricultural and Food Economics

Name of consultant's deparment: Department of Agricultural Management and Leadership

I declare that the final thesis/thesis/dissertation/portfolio submitted by me is an individual, original work of my own intellectual creation. I have clearly indicated the parts of my thesis or dissertation which I have taken from other authors' work and have included them in the bibliography.

If the above statement is untrue, I understand that I will be disqualified from the final examination by the final examination board and that I will have to take the final examination after writing a new thesis.

I do not allow editing of the submitted thesis, but I allow the viewing and printing, which is a PDF document.

I acknowledge that the use and exploitation of my thesis as an intellectual work is governed by the intellectual property management regulations of the Hungarian University of Agricultural and Life Sciences.

I acknowledge that the electronic version of my thesis will be uploaded to the library repository of the Hungarian University of Agricultural and Life Sciences. I acknowledge that the defended and

- not confidential thesis after the defence
- confidential thesis 5 years after the submission

will be available publicly and can be searched in the repository system of the University.

Date: 2024 year 04 month 04 day

Student's signature