



Business Model Innovation for Electric Energy Substitution: The Case of Electric Vehicles

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Abstract. With the increasing energy shortage and environmental pollution problems, electric energy substitution has become one of the important ways to solve energy problems and reduce pollution emissions. As a representative electric energy substitution project, the innovation of its business model is crucial to promote the development of the electric vehicle industry. Therefore, this paper focuses on the subject and business model of the electric energy replacement project, and on this basis, takes the electric vehicle as the research object, analyzes its market characteristics and obstacles, and innovatively puts forward three business models according to the profit, operation and maintenance subject of the electric vehicle project. Finally, some suggestions on the future development of the business model of electric energy replacement projects, including electric vehicles, are put forward.

Keywords: Electric energy substitution; Electric vehicle; Business model

1 Introduction

With the continuous deepening of China's reform and opening up and the development of economy and society, China's demand for energy is constantly increasing. But the traditional extensive economic development model can not meet the needs of economic and social development in the new era, and has brought serious environmental pollution problems. For example, more industrialized cities are plagued by environmental problems such as smog and acid rain every year. Therefore, it is an ideal and feasible way to replace traditional energy with electric energy in the new era.

Literature [1] analyzes and discussed the strategies for the promotion of electric energy alternative market in order to cope with the current situation. Literature [2] explains the meaning of electric energy substitution, analyzes the existing problems, and puts forward effective solutions. Literature [3], after analyzing the energy situation of a certain region, believes that promoting electric energy substitution is of great

significance to improving the proportion of regional electric energy terminal consumption and improving the level of electrification.

In terms of research on business model innovation, literature [4] proposes that it is urgent to actively promote the replacement of business model by electric energy, and the support of government policies can make the work of energy conservation and environmental protection more orderly. Literature [5] takes China's energy-saving service industry as the research object. Based on the analysis of the background of energy reform and power system reform, and combined with the emerging energy Internet technology, it analyzes the competitive environment faced by the energy-saving service industry and power replacement business, and clarifies its development advantages and disadvantages, as well as opportunities and challenges. On this basis, the business model of energy-saving service business is innovated, including PPP model, electricity sale model and cloud service business model. Literature [6] summarizes three development stages of electric energy replacement business model in view of the unfavorable factors faced by electric energy replacement, and proposes a business model design idea based on market cultivation capital demand and end-user power consumption scale.

In this context, China has put forward a variety of policies to promote the replacement of electric energy, which will be an important measure to promote the revolution of energy consumption, implement the national energy strategy, and promote the development of clean energy. The implementation of electric energy substitution is an important way to form a clean, safe and intelligent new energy consumption mode [7]. Among them, electric vehicles are the latest development in the transportation industry and an important field of electric energy replacement. As a new type of transportation with no pollution and diversified energy allocation, it has become an inevitable choice for the future development of the automobile industry. Literature [8] holds that the new round of scientific and technological revolution represented by new energy and artificial intelligence is triggering profound reforms in the traditional manufacturing industry, while the automobile industry, as a major winner in the traditional manufacturing industry, has entered an unprecedented period of reform. External forces such as new model operation companies such as big data companies have crossed the border into the automotive field, and they have worked with traditional vehicle companies and parts companies to accelerate the transformation and upgrading of the industry, so that new brands, new technologies, and new models continue to emerge. Literature [9] selected a case of electric vehicle charging station construction in Zhuhai City, Guangdong Province, China, invested by the local power grid company, analyzed the technical scheme, social benefits, environmental benefits and economic benefits of electric energy substitution in the new energy vehicle industry, and summarized the experience and achievements of the project construction.

Therefore, the effective use of electric energy replacement policies, focusing on the field of electric vehicles, and targeted business models can promote the use of clean energy, reduce dependence on traditional energy, reduce environmental pollution and carbon emissions. Relevant research is of great significance to promote the wide application of electric energy substitution and make positive contributions to sustainable development.

2 Analysis of the main participants of the electric energy substitution project

Electric energy substitution is a government-led, grid driven, social participation project. In the process of implementing electric energy substitution, it mainly involves the government, power generation enterprises, power grid companies, third party investors, equipment manufacturers and users^[10].

2.1 Government

The government is in a leading position in the power replacement project, and its main function is to introduce relevant support policies, supervise and regulate all aspects, and ensure the process norms and legality of transactions and investments. It also coordinates the relationship between various subjects in the process of promoting the replacement of electric energy, propagandizes and encourages all parties to actively participate in the replacement of electric energy, and formulates reasonable pricing policies, subsidy policies and tax policies according to the needs and contributions of different subjects. The main benefits of the government come from the economic benefits of the whole society, including energy conservation and emission reduction, energy structure optimization, and industrial upgrading.

2.2 Power generation companies

Power generation enterprises, as the beginning of the energy flow, mainly replace fossil energy with clean energy on the power generation side, and are transported through UHV, UHV, HV and other transmission lines. From the perspective of power flow, power generation enterprises can not only provide electric energy to power grid companies, but also directly deal with users who meet the requirements through direct supply by large users[11].

2.3 Grid companies

The power grid company is the main body of the electric energy replacement project, its role is mainly to connect the user and the power generation enterprise, and play a role in the overall coordination of the electric energy replacement project. According to the national policy, the power grid company formulates the electric energy substitution strategy and actively promotes the development of electric energy substitution technology and market expansion. Its main benefits come from the direct economic benefits brought by the increase in electricity consumption and the improvement of power supply quality brought by the transformation and upgrading of distribution network.

2.4 Third party investor

Third party investors can participate in the investment link in the construction of electric energy replacement projects, participate in financing, bank loans, etc. The introduction of third-party investment enterprises can play the role of the market in resource allocation, and at the same time can reduce the pressure of insufficient funds for some user enterprises with the desire to replace and transform electric energy, and seek win-win cooperation. Third-party investors pay more attention to the project economy and maximizing their own interests [12].

2.5 Equipment manufacturer

Equipment manufacturers provide power replacement users with specific information about power equipment to help them understand the general situation of the equipment, so as to better develop energy-saving transformation plans. From the perspective of equipment supply, equipment suppliers can not only directly trade with users, provide equipment or technology, but also build cooperation platforms with power grid companies to provide equipment support to users, and improve the interests of all parties in the electric energy replacement market.

2.6 Users

The user is the end of the energy flow, and its types include factories, enterprises, schools, shopping malls, communities, ordinary residents and so on. The power substitution potential and purpose of different users are also different, such as factories and enterprises pay more attention to maximizing their own interests, while ordinary residents pay more attention to the quality and convenience of power service.

3 Analysis of typical business models in the application process of electric energy substitution projects

Different electric energy replacement technology promotion projects have their own characteristics, technology application and promotion can adopt EMC, BT, BOT, PPP and other typical business models.

3.1 EMC model

EMC mode is a new mechanism which is promoted by the state in recent years by using market means to promote energy saving and emission reduction. The full name of EMC model is contract energy management, which refers to the energy-saving investment method that pays for the full cost of energy-saving projects with reduced energy costs. Its essence is to reduce energy costs to pay for the entire cost of energy conservation projects 13. The EMC model is shown in Figure 1.

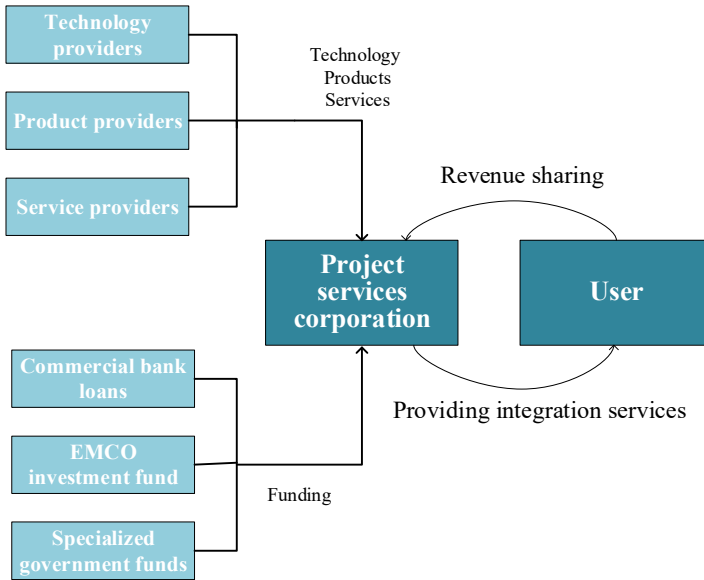


Fig. 1. EMC model

The EMC business model can be widely used in power substitution projects. EMC in solar power can work with users to provide selection, installation and maintenance of solar panels, and remotely monitor and manage solar power systems through smart grid technology. In addition, the company can also carry out the financing, investment and operation management of solar power generation projects to provide users with reliable solar power generation solutions. Biomass power generation companies can work with the agricultural sector to establish and manage the biomass supply chain. At the same time, EMC can also invest in the construction of biomass power generation equipment and provide integrated energy management solutions. EMC in hydropower can work with hydroelectric power plants to purchase, build and maintain equipment, as well as remote monitoring and operation management of hydropower plants through smart grid technology. In addition, energy management companies can provide energy optimization services to optimize the operational efficiency of hydropower systems by analyzing big data and predictive models.

3.2 BT model

The full name of BT mode is "Build Transfer", that is, the project financing construction mode of "first construction and then transfer". It refers to the establishment of BT project company in accordance with certain legal procedures by the investors granted project construction concessions by the government, and the investment financing and project construction, the completion of the task within the time stipulated by the two sides and the transfer of the project after the completion of the project according to the previous agreement, and the final payment of project investment by the government department. Distributed projects with large amount of capital, small amount of

monomer and large total number are suitable for BT model 14. The BT model is shown in Figure 2.

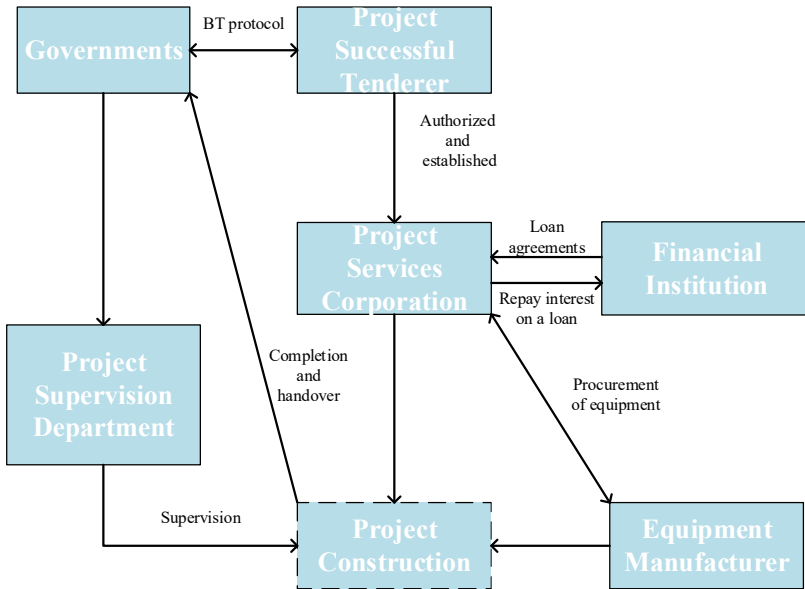


Fig. 2. BT model

In the BT business model, the energy service company works with the user to provide a customized energy replacement technology solution based on the user's needs and existing energy consumption. Include energy review and assessment, identify energy waste links, and recommend and provide suitable energy saving equipment, such as LED lighting, energy saving appliances, etc. At the same time, the company works with users to design and implement energy management systems, including energy monitoring and control systems based on the Internet of Things, intelligent building management systems, etc., so as to maximize the application and effect of electric energy replacement technologies. In this way, the energy service company in the BT business model can effectively help users achieve energy efficiency and energy substitution.

3.3 BOT model

BOT mode is the abbreviation of English Build-Operate-Transfer. The essence of this model is a way of public infrastructure investment, construction and operation. Based on the concession agreement reached between the government and private institutions, the private institutions are specially authorized by the government to raise funds to build a certain infrastructure and to operate and manage the facility for a certain period of time¹⁵. The BOT model is shown in Figure 3

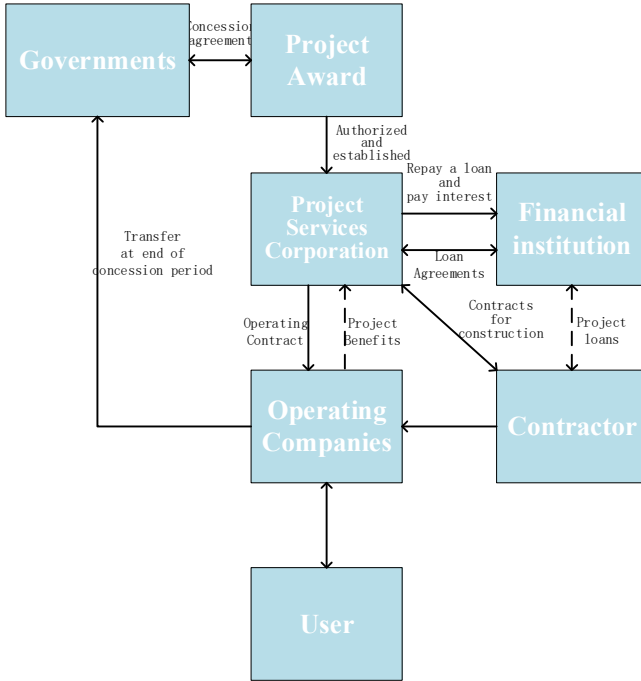


Fig. 3. BOT model

In the BOT business model, professional energy companies can work with users to provide specific energy alternative technology solutions based on the user's energy needs and existing energy consumption. Professional energy companies can cooperate with users to invest in the construction and operation of renewable energy generation projects, such as solar power plants, wind farms, etc., to provide users with green and renewable energy alternatives. Energy companies can also work with users to provide the design and implementation of intelligent energy management systems for optimal allocation and operational control of energy consumption.

3.4 PPP model

PPP model is short for public-private-partnership, that is, public-private Partnership, which is an emerging model in which Private enterprises participate in Public infrastructure construction projects. PPP mode refers to a project mode of mutual cooperation between the government or relevant public sector and private enterprises based on a certain investment project. The PPP model is suitable for projects with large investment, long construction period and slow return on capital, including the transportation sector such as railways, roads, Bridges and tunnels, the energy sector such as electricity and gas, and the communication industry such as telecommunications networks. The PPP model is shown in Figure 4.

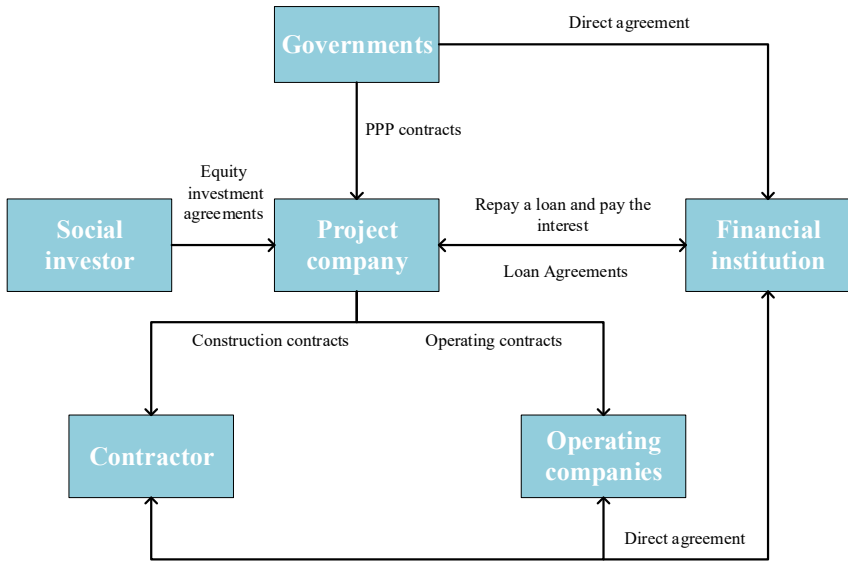


Fig. 4. PPP model

In the PPP business model, the government attracts high-quality enterprises and social capital to participate in electric energy replacement projects through bidding and competitive negotiations. These energy replacement technologies can include energy-saving lighting, smart grid construction, renewable energy generation facilities, etc.

4 Innovative research on the business model of electric vehicle participation in electric energy substitution projects

In recent years, with the global attention to environmental protection and sustainable development, electric vehicles as a means of clean energy transportation has received widespread attention. In promoting the development of electric energy replacement projects, business model innovation also plays a crucial role. Therefore, this paper takes the development of electric vehicles as an example to explore the business model innovation of electric vehicles participating in electric energy replacement projects. Through analysis and research, the business model innovation is carried out to promote the development of electric energy replacement field including the electric vehicle industry and promote the use of clean energy.

4.1 Background analysis of electric vehicles

Electric Vehicle Market Characterization

As a renewable energy application, electric vehicles have the ability to participate in the power grid peak cutting and valley filling. Peak cutting and valley filling is a way to balance the load of power network by adjusting the difference between peak

and valley of power consumption when the load of power system fluctuates greatly. Electric vehicles can use their energy storage system to charge and store electric energy when the load fluctuation is low, and release the stored electric energy when the load fluctuation is high, so as to balance the load of the grid, reduce the dependence on the traditional power system, and improve the stability of the power system. The battery energy storage system used in electric vehicles can be flexibly adjusted according to the needs of the grid. For example, during peak grid demand, electric vehicles can actively reduce charging power or stop charging, releasing stored electrical energy to support the grid. At the same time, in low grid demand or low periods such as night, electric vehicles can use cheap electric energy to charge and store, improving energy efficiency.

In addition, with the development of intelligent charging technology, electric vehicles can communicate and interact with the power grid through intelligent charging piles to achieve more accurate load scheduling. Intelligent charging piles can be flexibly regulated according to the power grid load and electricity price information, optimally utilize the charging demand of electric vehicles, and help the power grid achieve balance¹⁶.

At the same time, the electric vehicle market involves multiple stakeholders, including manufacturers, users, governments, financial institutions and others. These stakeholders play an important role in the development and promotion of the electric vehicle market. The table 1 below shows the analysis and impact for each stakeholder.

Table 1. Analysis of electric vehicle stakeholders

Engagement with stakeholders	Resources and capabilities available	Cash inflow	Cash outflow
Automobile manufacturer	Production technology, production line, brand awareness	Sales of cars, after-sales service	Raw material procurement, production costs, marketing
Charging equipment manufacturer	Charging pile technology, production equipment, supply chain management	Sales of charging equipment, after-sales service	Material purchase, production cost, marketing
Battery manufacturer	Battery technology, production equipment, supply chain management	Sales of batteries, technology licensing fees	Material purchase, production costs
Charging infrastructure operators	Charging station, charging pile technology, operation and maintenance ability	Charging service fee, rental income	Equipment procurement, operation and maintenance costs
Shared travel platform	Platform technology, user base, operation management ability	User fees, advertising revenue	Operating costs, marketing

Energy company	Renewable energy generation facilities, energy management technologies	Sales of electricity, charging service fees	Equipment construction, operation and maintenance costs
Government department	Regulation formulation, policy support, infrastructure construction	Subsidies, tax revenue	Policy subsidies, infrastructure construction
Auto parts supplier	Parts production technology, supply chain management	Selling auto parts	Raw material procurement, production costs
Financial institution	Financial support, financial service ability	Loan interest, income from financial products	Capital cost, risk management cost
User	Purchase demand, use demand	Purchase electric vehicle, charging service fee	Purchase cost, charging cost, maintenance cost

Electric vehicle business model barrier analysis

At present, the business models of electric vehicles in our country mainly include vehicle sales, electric exchange mode, and shared leasing. Although business model innovation has made great progress, it still faces many obstacles to development. It mainly includes:

a) Policy uncertainties: the government's strong support for the distributed development of electric vehicle business models, such as financial assistance and tax incentives. But uncertainty about policymaking is another factor. Policy uncertainty can discourage investment in business models and increase the risk of business operations.

b) Price and cost: At this stage, the higher selling price of electric vehicles relative to fuel vehicles is a major obstacle. Battery technology and manufacturing costs remain high, leading to higher prices for electric vehicles. In addition, charging infrastructure construction and maintenance costs are also a burden.

c) Charging infrastructure construction: Electric vehicles need the support of charging infrastructure, including charging piles, charging stations, etc. However, the current distribution of charging infrastructure is uneven, the coverage is not extensive enough, and the charging efficiency and convenience need to be improved. This limits the popularity of electric vehicles and the ease of long-distance travel.

d) Range and charging time: the limitations of battery technology lead to a relatively short range of electric vehicles and a relatively long charging time. By contrast, gas-powered cars have a longer range and can be refueled more quickly. This has brought some concerns and inconvenience to users

e) Technical standards and operability: Different regions and manufacturers have different technical standards and charging interfaces for electric vehicles, leading to operational problems, which makes users face some hassles when using charging facilities across regions or brands.

4.2 Electric vehicle business model innovation

Based on the characteristics of electric vehicles and their market analysis, this paper proposes three kinds of innovative thinking and research on business models according to their profit and operation and maintenance subjects.

Business Model I: Third Party Investment Business Model

Third party investment refers to investors who are independent of all stakeholders and participate in the operation and management of the invested enterprise in a certain way. In the past, the role of third-party investors was mainly to provide capital support, but with the rapid development of the economy, the role of third-party investors has gradually evolved to participate in management and provide professional knowledge and management experience.

The rapid development and popularity of electric vehicles has brought many business opportunities and innovation possibilities to third-party investors. In the field of electric vehicles, third-party investors can meet user needs, promote the development of the industry through innovative business models, and obtain good economic returns.

First of all, the construction and operation of charging facilities is an important business model innovation direction. As the number of electric vehicles increases, the construction of charging infrastructure is urgent. Third-party investors can cooperate with governments and enterprises to build charging stations in cities and provide convenient and efficient charging services. They can use advanced technical means, such as fast charging, intelligent charging management system, etc., to optimize the charging experience and improve user satisfaction.

Second, battery recycling and reuse is a business opportunity with huge potential. Recycling and reuse of electric vehicle batteries is an environmentally friendly and economically viable solution. Third-party investors can focus on battery recycling, inspection, repair, and reuse, extending battery life and value, and providing sustainable support to electric vehicle manufacturers.

In addition, the shared electric vehicle platform is also a compelling business model innovation. Third-party investors can create shared electric vehicle platforms that meet users' needs for flexible, short-term vehicles. Through online reservation, positioning system and other technical means, to realize the operation of vehicle sharing and sharing economy model, to provide users with convenient travel options.

In addition, vehicle networking and data services are also a promising area of business model innovation. Third-party investors can use the Internet of vehicles technology to collect data on electric vehicles and provide related data services. Through the analysis of vehicle records, charging and other data, to provide users and enterprises with personalized services and intelligent decision support, to promote the development of electric vehicle industry.

With the further development of the electric vehicle market, these innovative models will bring more opportunities and challenges for investors, and will also promote the sustainable development of the entire electric vehicle field.

Business Model II: Grid Enterprise Operation Business Model

At present, traditional electric vehicles participate in the operation of power grid enterprises by connecting to intelligent charging systems and participating in demand response, providing sup promoting effective interaction between electric vehicles and the power grid. The figure5 below shows the transactional links between electric vehicles and related businesses.

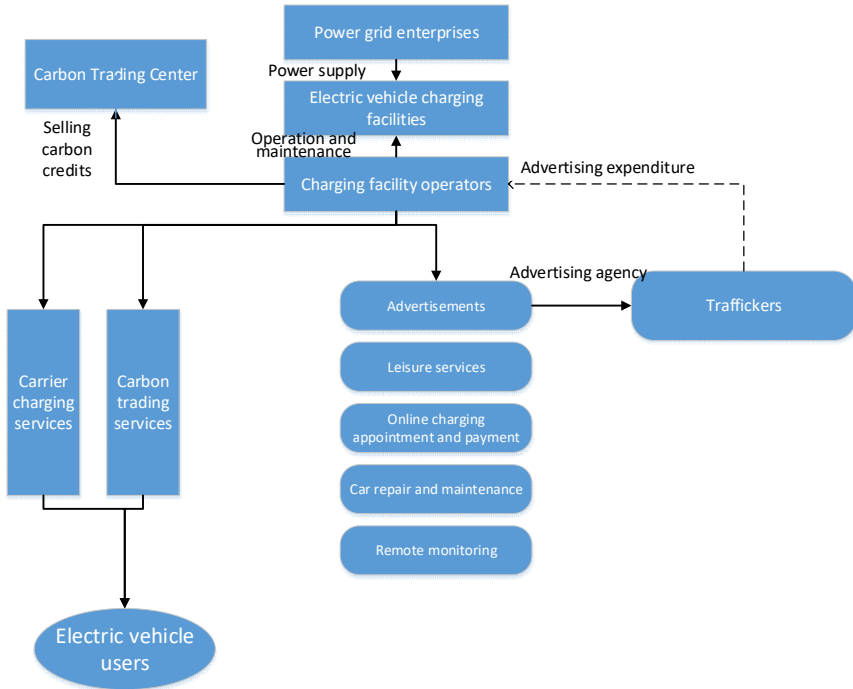


Fig. 5. Transaction linkage chart

With the rapid development of electric vehicles, electric vehicle charging facilities have become one of the key factors to support their popularization and promotion. In this context, the business model innovation of electric vehicle grid enterprises is becoming more and more important. This innovation can not only meet the charging needs of users, but also promote the sustainable development of the electric vehicle industry. Traditionally, charging of electric vehicles has relied on individual homes or public charging stations. However, this model has problems such as insufficient charging facilities, slow charging speed and lack of unified management. Therefore, there is a demand for innovation in the business model of electric vehicle grid enterprises.

Therefore, the grid enterprise operation business model allows power companies to incorporate electric vehicle charging services into their business. Companies can set up charging stations or partner with other institutions to set up charging stations to provide value to users and earn profits from the charging service. Companies can form

partnerships with car manufacturers, charging device manufacturers and other service providers to provide integrated services

In addition, power companies can also achieve business model innovation by changing the grid architecture. Because the demand for electric vehicles is sometimes large, car charging can cause a greater load on the power system, so power companies can use intelligent grids to adjust the power supply to adapt to different charging needs. In addition, power companies can also develop new charging technologies, such as wireless charging technology, to improve service quality and enhance competitive advantage.

In general, by increasing the construction and investment of charging facilities, promoting the integration of charging facilities and energy systems, providing a full range of services and government support, we can create a more convenient, efficient and sustainable electric vehicle charging network, and inject new vitality into the development of the electric vehicle industry.

Business Model III: Electric vehicle owners invest in the business model

With the rapid growth of the electric vehicle market, many electric vehicle owners are starting to think about how to use their vehicles for investment and business innovation. This owner-invested business model innovation can not only provide additional revenue streams for car owners, but also drive the development and adoption of the electric vehicle industry.

A common business model for EV owners to invest in is shared charging piles. Owners can install their own charging piles in private homes or commercial locations and make them available to other electric vehicle users. By providing a fee-based service, car owners can earn additional income. This business model can not only solve the problem of insufficient charging facilities, but also increase the coverage of charging piles and improve the convenience of charging users.

Another investment business model for electric vehicle owners is electric vehicle leasing. Owners can rent out their electric vehicles to others for rental income. This business model can both meet the needs of those who need a car temporarily, and allow owners to obtain additional benefits. At the same time, the environmental characteristics of electric vehicles have also made this leasing model receive more attention.

In addition, some car owners are also making commercial innovations through charging services, electric vehicle maintenance and other fields. They can provide charging services and provide other electric vehicle owners with services such as charging, maintenance and troubleshooting. At the same time, finally, the investment business model of electric vehicle owners can also adopt various financial means such as financial management and securitization to achieve innovation. For example, electric vehicle owners can participate in the investment of the electric vehicle industry chain by purchasing specific products or stocks. In this way, electric vehicle owners can enjoy the benefits of the capital market and realize the appreciation of their assets through long-term holding.

In general, electric vehicle owners investing in business model innovation provides more viable business opportunities for owners, while also promoting the development

of the electric vehicle industry. Through commercial innovations in areas such as shared charging points, vehicle rental, charging services and repairs, car owners can realize additional income and contribute to the sustainable development of the electric vehicle industry.

Comparative analysis of business models.

The third party investment business model of electric vehicles, the operation business model of electric vehicle grid enterprises and the investment business model of electric vehicle owners are three different business models. The following table 2 summarizes their characteristics for comparative analysis.

Table 2. Comparative analysis of the three business models

Business model	Description	Advantages	Shortcomings
Electric vehicle third party investment business model	Third-party investors buy electric vehicles and rent them out or share them with users.	<ol style="list-style-type: none"> 1. Flexible rental and sharing services to meet user requirements. 2. Car purchase cost and maintenance cost are reduced, and the user threshold is lowered. 	<ol style="list-style-type: none"> 1. Large investments are needed to buy electric vehicles. 2. Need to establish a sound management and operation system. 3. Limited by the development of the electric vehicle market and user acceptance.
Electric vehicle grid enterprise operation business model	Power grid enterprises through the construction of charging pile facilities, and provide charging	<ol style="list-style-type: none"> 1. The cost is relatively low 2. Provide convenient and fast charging service 	<ol style="list-style-type: none"> 1. Building charging pile facilities requires a lot of investment. 2. Low charging facility coverage and charging speed. 3. Need to cooperate with government, energy companies and other relevant parties to coordinate resources and policies.
Electric car owners invest in business models	Owners buy electric cars and rent them out or share them with other users, earning revenue from them	<ol style="list-style-type: none"> 1. Maximize the use of the owner's assets and obtain returns. 2. Provide more flexible rental and sharing options. 	<ol style="list-style-type: none"> 1. More management and operations. 2. Fierce competition and limited market share. 3. Need a reliable platform and safeguards

To sum up, the third-party investment business model of electric vehicles, the operation business model of electric vehicle grid enterprises and the investment business model of electric vehicle owners have their own advantages and limitations. Choosing the right business model needs to consider factors such as market demand, investment risk, management ability and resource support. In addition, the government's policy support and market environment also play an important role in the implementation and development of these business models.

5 Conclusion and outlook

Power substitution project is one of the important ways to achieve sustainable development and environmental protection, and the innovation of business model plays a key role in promoting the development of power substitution project.

In this paper, we first analyze the participants of the electric energy replacement project, and then sort out the typical business models in the application process of electric energy replacement project, including the energy service company model, the sharing economy model and the energy trading platform model. These business models realize the commercial operation of electric energy replacement projects, the improvement of energy efficiency and the maximization of resource utilization at different levels. Finally, we put forward three business model innovations, namely, "third-party investment business model", "grid enterprise operation business model" and "electric vehicle owner investment business model". These innovative business models are of great significance in solving the problems and pain points in power substitution projects.

In short, innovation in the business model of electric energy replacement projects based on electric vehicles is a key factor in achieving sustainable energy development. Through in-depth research on participants, sorting out typical business models and putting forward innovative models, it can provide useful references for the commercial operation and promotion and application of electric energy replacement projects. With the continuous development of electric energy replacement technology and in-depth exploration of business model innovation, electric energy replacement projects based on electric vehicles will achieve greater success and influence in the future.

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