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The cross subsidy of electricity price in China

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Abstract**—** *A new-round electric power system reform and electric power deregulation reform is on going in China. Of which, the transmission and distribution price reform has generated great impacts on electric power companies. Under this background, how to tackle cross subsidy of electricity price has become a burning issue in China. In this paper, the cross subsidy of electricity price in China is reviewed. Firstly, three categories of cross subsidy of electricity price are introduced; Secondly, the reasons for cross subsidy of electricity price are discussed in details; Thirdly, the impacts of cross subsidy of electricity price are analyzed; Finally, several policy implications are proposed for tackling the issues of cross subsidy of electricity price in China. This paper can provide references for policy decision-making of related government administration..*

Keywords**— electricity price; cross subsidy; policy implications; China.**

I. INTRODUCTION

Since the implementation of the reform of electric power system in 2002, China has achieved initial results in the separation of power plant network and the construction of electric power side market [1]. How to further deepen the power market reform has become a general concern. Reasonable and complete electricity price mechanism is one of the key factors to ensure the smooth progress of electricity market reform and promote the sustainable and rapid development of electric power industry in China [2-3]. Reasonable sales price can reflect the situation of electricity supply and demand in a timely and effective manner, which is beneficial to guide users to use electricity reasonably and promote the optimal allocation of electric power resources [4-5].

The electricity sale price in China has been determined by the government department. The classification of consumers and the establishment of the price level of all types of consumers are the key to the establishment of electricity sales price, which should theoretically reflect the real electricity supply cost of all types of electricity users. However, in China, in addition to considering the real electricity supply cost, several other issues are also considered, including social stability, electric power universal service responsibility, dedication to the macroeconomic regulation, industrial structure adjustment policies and other social functions [6]. These cause the deviation the power user's price level from the actual electricity supply cost. Some of the electricity users perform the electricity price below the real electricity supply cost, while some consumers pay the electricity price more than the real electricity supply cost. This will cause cross-subsidy of electricity price, which means the consumers who pay higher electricity price have compensated those consumers who pay lower electricity price [7-8]. In the long run, the cross-subsidy of electricity price in China is wide in scope and large in quantity, which not only exists widely among various voltage levels and various types of consumers, but also has a high subsidy amount. It is not conducive to the adjustment of China's sales electricity price structure and hinders the advancement of China's electric power market construction. From the perspective of long-term development, serious cross-subsidies will not only hinder the construction of an effective competitive electric power market, but also do harm to the overall coordinated development of the national economy and the realization of resources optimal allocation of the whole society.

On March 15, 2015, the Chinese government issued 'Several Opinions on Further Deepening the Reform of Electric Power System', which pointed out that the cross-subsidy among different types of electricity prices should be one of the key tasks to promote the reform of electric power system in the near future. With the continuous deepening of the market-oriented reform of electricity transmission and distribution price in China, the existing cross-subsidy of electricity price has become a key problem which need be faced up to and solved urgently in the sustainable development of electricity power industry. At present, power grid enterprises have taken the function of universal power service. The reform of electricity transmission and distribution price will change the profit mode of power grid enterprises. The cross-subsidy of electricity price will affect cost recovery and profitability

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of power grid enterprises investment. Therefore, in the process of a new round of power system reform, it is necessary to study the current situation, existing problems and solutions of cross-subsidy of electricity price. On the one hand, it can correct the distortion of electricity market prices and give full play to the role of market mechanism in electricity price determination. On the other hand, it can avoid the market subjects to get "reform dividend" by avoiding cross subsidies of electricity price, and then protect the interests of vulnerable groups.

II. THE CATEGORY OF CROSS SUBSIDY OF ELECTRICITY PRICE IN CHINA

From 1949 to 1986, China's electricity price maintained a relatively reasonable level and comparison relationship, and the electricity price ratio between residents and large-scale industries remained around 2. Since the year of 1987, China has began to raise funds nationwide to generate electricity, and the price of electricity has been greatly increased. The price of electricity for large-scale industries and commercial industries has been greatly increased. The ratio of residents to large-scale industries has been reduced from 1.58 in 1990 to 0.94 in 1995.

Currently, there are three categories of cross-subsidy of electricity sale price in China, which are introduced as follows.

(1) Cross-subsidy among different kinds of consumers

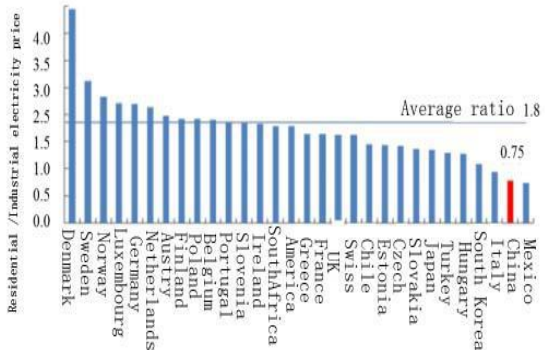

Fig. 1: Electricity price in different countries and regions

Cross subsidy among different kinds of consumers is mainly reflected in different consumers at the same voltage level. Large and general industrial and commercial users offer the subsidies for household and agricultural electricity users. Industrial and commercial users have strong profitability and affordability, high pricing level, and bear the main cross-subsidy responsibility. Domestic electricity price is currently 75% of industrial electricity price, while in most countries with market-oriented electricity market, the average domestic electricity price is about 1.8 times of industrial electricity price, as shown in Figure 1.

(2) Cross-subsidy among consumers with different voltage levels

Cross subsidy among consumers with different voltage levels is mainly reflected the same kind of consumers in different voltage levels. Theoretically speaking, the power transmission and distribution price of users with low voltage level should be higher than that of users with high voltage level because large number of grid assets is used by consumers with low voltage level, high loss and low load rate. From the perspective of actual implementation, as most users with high voltage level belong to the main enterprises in the industry, their bearing capacity of electricity price is strong and their pricing level is relatively higher compared with their cost. Low voltage level users have a poor bearing capacity, and the pricing level relative to its cost is low. As a result, consumers with high voltage level provide subsidy for consumers with low voltage level.

(3) Cross-subsidy among consumers with different power load characteristics

The consumption behavior of electricity consumers can be represented by load rate to some certain extent. In general, the higher the user's load rate is, the more fully the power system facilities are utilized, and then the lower the cost of unit electricity. According to the cost-plus pricing principle, this kind of consumers should enjoyed the lower electricity price. Currently, the electricity sale price does not consider the consumer characteristics and power load rate difference, which all electricity users are charged according to the average electricity characteristics or average load rate pricing. This generates the cross-subsidy of electricity price, which the electricity users with high load rate offer subsidy to electricity users with low load rate.

Actually, the above-mentioned three kinds of cross subsidies are coupled with each other and overlap in structure and quantity. Among them, cross-subsidy among different electricity consumers are paid more attentions because there are relatively certain subsidies and subsidized subjects with relatively large amount. Cross-subsidy among different electricity consumers and voltage levels are equal in amount, but different in structure. Generally, the voltage levels of large-scale industrial electricity users and general industrial and commercial users are higher than that of household and agricultural electricity users, and the cross-subsidy among user types and the cross-subsidy among voltage levels are basically similar in direction and amount. Cross-subsidy among electricity users with different load rates is more complex than cross-subsidy among electricity users with different consumption types and voltage levels, because there are

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both high and low load rates among users with different consumption types and voltage levels. However, according to the load characteristics of ordinary users, the load rate of large-scale industrial users and ordinary industrial and commercial users is higher than that of household and agricultural production users. However, the difference of load rate among users with different voltage levels does not seem to be particularly significant. In terms of the amount of cross-subsidy, under the cost-sharing scheme, the cross-subsidy due to different loading rates at each voltage level is equal to the cross-subsidy provided or enjoyed by that voltage. Therefore, it can be considered that the cross subsidy among voltage levels is equal to that among different load rates. The relationship of the above-mentioned cross-subsidy types is shown in Figure 2.

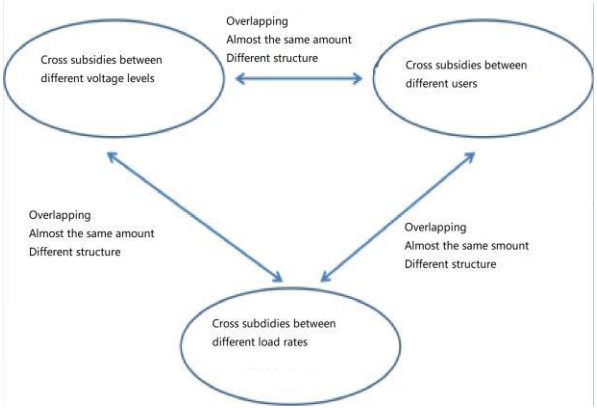

Fig. 2: The relationship of three categories of cross-subsidy of electricity price

III. REASONS ANALYSIS OF CROSS SUBSIDY OF ELECTRICITY PRICE IN CHINA

The electricity sale price in foreign countries mainly reflects the real power supply cost of electricity users and formulates the sale price level of all kinds of electricity users. However, in China, electric power enterprises also undertake to fulfill the responsibilities of electric power universal service, macroeconomic regulation and industrial structure adjustment and other social functions. In order to realize these social functions, China's electricity price has deviated from the real power supply cost for electricity users, and has formulated various electricity price policies, such as low electricity price for residents' welfare, preferential electricity price for agriculture, encouragement for the development of renewable energy, support for emerging industries and restriction of industries with excess capacity. Therefore, the electricity sale price bearing a variety of social functions is the fundamental cause of cross-subsidy of electricity price in China.

The government administrative pricing method is the main cause of the cross-subsidy of electricity price. At present, most provinces in China compile the table of electricity sale price according to two dimensions of industry and voltage level. The traditional tariff classification structure produces the horizontal and vertical paths of the cross-subsidy of electricity price, the detailed reasons of which are discussed as bellows.

(1) The causes of horizontal cross subsidy of electricity price

Horizontal cross subsidy of electricity price is the cross subsidy of all kinds of electricity users in the same voltage level. For the cross subsidy of the similar electricity users with different voltage level, the cost of each voltage grade with different factors has been considered, and catalog electricity price is designed according to the principles of high voltage level with low electricity price and low voltage level with high electricity price. However, due to the fact that some provinces of China have not fully implemented the electricity transmission and distribution price of different voltage levels, the electricity transmission, transformation and distribution costs of each voltage level are not clear and accurate. Therefore, the price gap between different voltage levels is small. Take Tianjin city of China as an example, the capacity electricity price of large-scale industrial electricity users of 10 KV and 35 KV levels is 17 RMB yuan/ kVA per month, and the energy price is 0.703 RMB yuan/kWh and 0.683 RMB yuan/kWh respectively, which the gap between these two energy price is only 2 cents. In fact, for the most part of 10 kV-level voltage electric power comes from the high voltage level (including 35 kV, 110 kV, 220 kV and 500kV), so 10 kV voltage class should share the partial transmission cost and transformation cost of the higher voltage class together with the partial transmission and transformation cost of the voltage class (the part to be subtracted from the supply to the voltage class below 10 kV) , finally forming its total cost. The shared capacity cost for electricity users of the 10 kV voltage class is higher than that of the 35 KV voltage class. Current Chinese tariff is deviated horizontally, according to the principle that electricity price should reflect the cost, and the differences in electricity price among the different electricity grade derive from the difference of capacity liability cost. In Tianjin city, the price difference of each voltage level is reflected in the energy price instead of the capacity price, which is contrary to the principle of cost pricing. Moreover, the price difference between electricity users with different voltage levels cannot be reasonably widened, leading to a large degree of cross-subsidy.

(2) The causes of vertical cross subsidies of electricity price

Vertical cross subsidy of electricity price is the cross subsidy of electricity price between different voltage

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levels. As for the cross-subsidy issue between different voltage levels in the longitudinal path, China classifies them according to different industries and implements different electricity prices, which result in the widespread cross-subsidy phenomenon in China. Among them, the most serious is that the electricity consumption issue in large-scale industry, common industry and commerce offer subsidy to residents. The electricity users in China are basically divided into general industrial and commercial electricity users, large-scale industrial electricity users, agricultural production electricity users and household electricity users. The vertical cross subsidies of electricity users with different voltage levels are mainly caused by unscientific classification structure.

IV. THE IMPACTS OF CROSS SUBSIDY OF ELECTRICITY PRICE IN CHINA

(1) Positive impacts

The cross subsidy of electricity price has a special function, namely environmental tax with Chinese characteristics. However, the environmental tax reflected by the cross-subsidy of electricity price has not been passed through the tax system, which has been redistributed directly through electricity price. The use of income in the profitable field (industry and commerce sector) to make up for losses in the non-profit sector (resident sector) is the cross-subsidization of industrial and commercial electricity price to residential electricity price. By charging high prices for industry and commerce sectors, it is equivalent to substantially imposing an environmental tax on industries with high energy consumption and high pollution, which will force the transformation of high-energy-consuming industries to use clean energy, thus reducing environmental pollution, and achieving green dividends. The implementation of low electricity prices for residents actually transfers the environmental taxes collected from high-energy-consuming industries directly to the residents, increases the welfare of the residents, and realizes the dividend distribution process. Therefore, the cross-subsidization of electricity price has a positive impact to a certain extent, and it has a double dividend effect.

(2) Negative impacts

Under the current electric power market reform and transmission&distribution price reforms, the cross-subsidization of electricity price has no longer adapted to the current and future development requirement, and its negative impact is also significant.

Firstly, the value of resources is misplaced. From the perspective of residential users, the residential electricity price and agricultural electricity price are lower than the industrial and commercial electricity price. While from the perspective of power supply cost, the resident user is at the end of the power supply link with the lowest voltage level, lower load rate, and higher power supply cost than that of the industrial and commercial electricity users. The electricity consumption of taking low cost industrial and commercial electricity to subsidize high-cost residential electricity does not correctly reflect the value of resources or guide electricity users to rational consumption, while causes huge waste. Obviously, the real benefit of low electricity price is on rich households because they use more electricity energy and enjoy more subsidies, while poor households use less electricity and enjoy less subsidies. The misplacement of the value of resources is not conducive to electricity saving.

Secondly, it is not conducive to the adjustment of economic structure. In recent years, the blind developments of high-energy-consuming industries such as electrolytic aluminum and small steel-making have caused resources wastage and environmental damages, and has also increased the difficulty of industrial reconstruction.

Thirdly，it undermines the principle of fair burden. For a long time, industrial and commercial electricity users have been providing for subsidies. Industrial and commercial electricity users generally believe that when electricity prices are higher, production costs increase, and the burdens are heavier. In the long run, it will have an adverse impact on economic development.

Fourthly，it disrupts the order of electricity use. The original intention of cross-subsidy is to use price differences to reflect policy support. However, because of the price difference, there is the possibility of price rent-seeking. From the point of view of electricity inspectors in recent years, the phenomenon of low-cost and high-use happens frequently. In all kinds of violations with electricity usage, electricity price happens most frequently, during which power management are often involved, agriculture electricity price used for business and such often occur. If the unified electricity prices are implemented with no cross-subsidy of electricity price, it will block the institutional loopholes in the price multi-track system, and the order of electricity usage will be improved.

V. POLICY IMPLICATIONS FOR TACKLING CROSS SUBSIDY OF ELECTRICITY PRICE IN CHINA

(1) The principles for tackling cross subsidy of electricity price

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1) The reform of cross-subsidy mechanism should be gradual and not in a haste

The reform should uphold the principle of efficiency as priority, giving full consideration to the price affordability of various businesses and residents. While maintaining the existing level of sales price, the reform should provide clear subsidies rather than secret ones, less subsidies rather than more. Meanwhile, it should gradually increase residential electricity prices, appropriately reduce the electricity price of industrial users, and finally form a sales price system which does not have cross-subsidy and can truly reflect the cost of electricity supply.

2) The reform of cross-subsidy mechanism should protect people's livelihood and must not blindly raise prices

Blind increase of electricity price will only enhance the public's misunderstanding of the monopoly of electric power industry. Therefore, it is possible to adjust the residential electricity price through the lifeline electricity price. That is, when the monthly electricity consumption per person is below a certain standard, the current preferential electricity price will still be charged. Except for the electricity charge, the amount of electricity that exceeds the specified range can be collected in an appropriate amount. When the conditions are ripe in the future, the price of electricity for residents will be gradually increased.

3) Power grid enterprises should play an important role in the general service

In addition to pursuing sales of electricity and profits as a business orientation, power grid companies also have obvious characteristics of public utilities. Therefore, reforms need to focus on the important role of power grid enterprises play in social general service, providing cross-subsidy mechanism to support key areas with 'catch-all' service, that is, in the case of electricity market liberalization, these areas will still enjoy a certain level of price discount. This kind of preferential price of electricity will realize to safeguard people's livelihood and promote the development of national economy.

(2) The policy measures for tackling cross subsidy of electricity price

1) The electricity price of entities such as residents and agricultural production, which are not involved in market transactions, will be gradually increased to make up for the unit's power supply cost, gradually align with the electricity price of participating market transactions.

With regard to the electricity price of residents, it can use the correct public opinions to guide residents to pay electricity prices according to the cost of electricity, and gradually increase the electricity price. Meanwhile, it can indirectly improve residents' electricity price by implementing time-of-use electricity prices, ladder electricity prices, two-part electricity prices and load-rate electricity prices.

Implementing two-part electricity price for all users, expanding the scope of implementation of two-part electricity price, pricing all users according to capacity and usage, reflecting the cost structure of electric power system in line with pricing theories and methods, can indirectly increase the electricity price of residents, low voltage grade electricity price and low load rate electricity price. For the implementation of load rate electricity price, the electricity price of low load rate of users can be improved, and it is recommended to implement the optional sales price reform based on the load rate level to reduce the high load rate user price and improve the user's free choice. Increase electricity price of low voltage level because low voltage level users use more power system facilities, and the transmission and distribution loss for them is also larger The electricity cost of low voltage user is significantly higher than that of high voltage ones, but enjoys relatively low electricity price. The reform should effectively increase the price of low-voltage electricity, reduce cross-subsidy and promote cost savings for users. Implement ladder electricity price and time-of-use electricity price, vigorously promote the ladder price and time-of-use electricity price based on the same distribution area market, the same voltage level and the same benchmark price. The ladder price refers to the current single form Quasi-tariff, instead with segmented forms according to users' consumption of electricity prices, which can avoid the waste of resources by sharing power sub-billing with fixed peak and valley price ratio ans can reflect the relationship between supply and demand, thereby promoting users to improve the efficiency of electricity consumption. Through these two kinds of electricity prices, the principles of fairness and efficiency can be fully embodied, and the marketization of electricity prices can be performed.

2) Gradually reduce the price of industrial and commercial electricity

Gradually reduce the industrial and commercial electricity prices, narrow the gap between the industrial and commercial electricity prices, and finally combine these two kinds of electricity prices to one benchmark electricity price in the same market with the same voltage level. This will eventually eliminate electricity price gap and form a unified price under the unified market.

At the same time, the reduction space from transmission and distribution price reform should be used to reduce large-scale industrial and general industrial and commercial electricity prices. The new round of

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transmission and distribution price reform in China has reduced transmission and distribution prices. With the increase of trading electricity energy, the price reduction space generated will increase substantially. Currently, this part of price reduction space is used to reduce the price of end-user electricity, and it is not explicitly used to solve the cross-subsidy problem. It is suggested that the problem of heavy cross-subsidization burden for large-scale industries and general industrial and commercial enterprises should be planned to reduce their electricity prices.

It is suggested that a part of price reduction space generated by the reform of electricity sale market should be used to reduce the electricity prices of large-scale industries and general industrial and commercial sectors. China is actively promoting the reform of electricity market, which mainly includes power generation companies participating in market transactions with profit sharing, price cuts resulting in a share for households and enterprises electricity stakeholders. It is recommended to reduce the electricity prices of large-scale industries and general industrial and commercial enterprises in two ways: firstly, in the design of power market reform plan, consciously support large-scale industrial and general industrial and commercial users to participate in market transactions through access standards; secondly, directly take out some price cuts and directly use them to reduce electricity prices in large-scale industries and general industrial and commercial sectors.

3) Strengthen the internal fine management of electric power enterprise and scientifically optimize the investment decision for each voltage level power grid

With the reform of transmission and distribution price and the continuous advancement of new-round electric power system reform, such a direct impact has been posed on the business development and supervision mode of power grid enterprises. Taking Tianjin area as an example, the 35kV voltage level provides the largest cross-subsidization of electricity price, which has a great connection with the development process and structure of Tianjin Power Grid. In the future development of power grids, power companies should pay more attentions to scientific investment decisions. Based on rational power grid planning, relying on the full exploitation of the nature of power transmission and distribution reforms, the power grid companies should comprehensively strengthen the internal fine management level to realize the full recovery of related cost and reasonable solution of cross-subsidy of electricity prices. Rationally and scientifically formulate the investment and development plans for 220kV, 110kV, 35kV, 10kV and other voltage-level grid, which can promote the healthy and sustainable development of electric power industry.

4) Formulate and improve environmental tax laws

The cancellation of cross-subsidization of electricity price will inevitably lead to the introduction of environmental tax laws, and achieve a new balance through environmental taxes and transfer payments. The so-called environmental tax means heavily tax entities who have adverse effects on society and environment need to compensate for the social costs of environmental governance, and compensate heavy cost enterprises with positive externality or spillover benefits with tax returns or financial subsidies. For low-income groups, it can be carried out through the transfer method of civil administration system and tax reduction from tax system.

5) Making full use of the market power

The reform should strengthen the supervision on the entities participating in electricity market, reduce local protectionism, fully utilize the market power to realize the optimal allocation of resources in various types of electricity power markets, which is beneficial for the formation of market benchmark prices. At present, the proportion of China's total industrial power consumption to the total national electricity consumption has remained at around 74% for over 10 years, and 52% of industrial energy consumption comes from high-energy-consuming industries. Therefore, resident living and other electricity only accounts for a quite small part of social electricity, about 20%. Therefore, according to the market law, the price increase of the 20% electricity and reduction of the 80% electricity will have a huge and positive butterfly effect on society.

6) Formulate an independent electric power universal service policy

China has a general service policy for families relying on pension, which families with disabilities whose income level is lower than the poverty line, and other special groups in China. It is recommended to formulate electric power universal service policy as an assistant policy to solve the problem of cross-subsidization of residential electricity price. This supporting policy formulated by the central government should introduce a separate general service policy to protect the basic electricity needs of users with difficulties, clear service targets, scope, conditions, content and funding.

VI. CONCLUSION

In this paper, the cross subsidy of electricity price in China is studied from the perspectives of category, reasons, impacts and policy implications. Three categories of cross subsidy of electricity price are introduced, and the detailed

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reasons are discussed. The impacts of cross subsidy of electricity price are studied. Finally, under the current background of electric power system reform, several policy implications are proposed for tackling cross subsidy of electricity price in China. In the future research, the quantitative model for cross subsidy of electricity price will be performed.

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