

Analysis on the Dilemma Mechanism of Subsidies for Renewable Energy Power Generation Projects in China

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Abstract

Renewable energy power generation, as an effective way to promote peak carbon dioxide emissions's carbon neutrality, has achieved rapid development with the support of relevant industrial policies in China. However, the substantial increase of renewable energy subsidies and long-term arrears have seriously restricted the sustainable growth space of renewable energy power generation industry. By combing the evolution characteristics of subsidy policy for renewable energy power generation projects in China, this paper analyzes the formation mechanism of the dilemma of subsidy retreat for renewable energy power generation projects, and puts forward specific measures to alleviate the subsidy retreat.

Keywords

Renewable Energy; Subsidy Time Lag; Subsidy Intensity; Slope Retreat Dilemma.

1. Introduction

By the end of 2021, the cumulative installed capacity of renewable energy power generation projects in China reached 1.063 billion kW, accounting for 44.8% of the total installed capacity; In 2021, the electricity generated by renewable energy will reach 2.48 trillion kWh, accounting for 29.8% of the total electricity consumption. The vigorous development of renewable energy power generation industry has led to a substantial increase in the demand for renewable energy subsidies[1]. Because renewable energy power generation projects have the characteristics of long payback period and high operation and maintenance cost, the cash flow reduction and return rate reduction caused by the sharp decline of subsidies have seriously affected the capital inflow and aggregation of renewable energy power generation industry. Therefore, it is of great significance to analyze the formation mechanism of subsidy recession and put forward corresponding solutions to promote the steady development of renewable energy power generation industry[2].

2. Definition and Classification of Renewable Energy Power Generation Projects

Renewable energy power generation project refers to the project of comprehensive utilization of energy that can be recycled and regenerated by nature itself for electric energy conversion. From the utilization mode, renewable energy power generation projects in China can be mainly divided into wind power, solar power, biomass power and hydropower. Among them, wind power includes onshore wind power and offshore wind power; Solar power generation includes centralized photovoltaic and distributed photovoltaic; Biomass power generation includes agricultural and forestry waste power generation, garbage incineration power generation and landfill biogas power generation; Hydropower includes dam hydropower, diversion hydropower, tidal hydropower and pumped storage hydropower[3]. According to the current subsidy policy for renewable energy power generation projects in China, the scope of subsidies covers wind power, solar power and biomass power generation, excluding

hydropower. At the same time, because the distributed photovoltaic in solar power generation has the characteristics of too scattered investment subjects and small electric energy transmission, it is significantly different from the centralized renewable energy power generation project in grid connection, operation management and economic benefits. For the convenience of comparative analysis, the research objects of this paper are defined as wind power, centralized solar power and biomass power generation projects, excluding distributed photovoltaic and hydropower projects[4].

3. Historical Evolution and Characteristics of Subsidy Policy for Renewable Energy Power Generation Projects

3.1. Initial Exploration Stage (2005-2011)

China's policy support for renewable energy power generation industry can be traced back to the People's Republic of China (PRC) Renewable Energy Law promulgated in February 2005. The law clearly establishes a full-guaranteed acquisition system for renewable energy power generation, requiring power grid enterprises to give priority to dispatching and fully acquire the power generated by renewable energy projects; According to the type and geographical location of renewable energy power generation projects, the on-grid electricity price is determined, and the difference between the electricity purchase cost generated by grid enterprises acquiring renewable energy projects and the electricity generation cost generated by conventional energy sources is compensated by collecting renewable energy electricity price surcharges on the sales side; The state finance establishes a renewable energy development fund, and the sources of funds include special funds from the state finance and additional income from renewable energy electricity prices. In January 2006, the "Trial Measures for the Management of Renewable Energy Power Generation Price and Cost Allocation" made it clear that renewable energy power generation projects other than hydropower should be subject to government-guided prices, and the price standard is equal to the sum of the benchmark on-grid electricity price and subsidized electricity price of desulfurization coal-fired units; The electricity price of renewable energy shall be separately accounted for and earmarked, and shall be dynamically adjusted according to the period of not less than one year[5]. The Notice on Improving the On-grid Electricity Price Policy for Wind Power Generation issued in July 2009 and the Notice on Improving the Electricity Price Policy for Agriculture, Forestry and Biomass Power Generation issued in July 2010 divided the whole country into four types of wind energy resource areas and formulated the benchmark on-grid electricity price for wind power respectively. Unified benchmark grid price for agricultural and forestry biomass power generation projects is 0.75 yuan /kWh. The Interim Measures for the Administration of the Collection and Use of Renewable Energy Development Fund promulgated in November, 2011, clarified that the additional collection scope of renewable energy electricity price is the sales electricity after deducting agricultural production electricity except Tibet Autonomous Region, and the standard is 0.008 yuan/kWh[6].

In the initial exploration stage, the state's subsidy policy for renewable energy power generation projects focuses more on the macro-level regulation of income sources and disbursement channels, and the scope of additional collection of renewable energy electricity prices has been approved from the aspects of geographical division, power type and unit price standard[7]. As the basic calculation formulas, the "additional income of renewable energy electricity price collected from power users by special funds for the development of national finance and public budget of renewable energy development fund" and "renewable energy power generation project subsidy electricity price = renewable energy power generation project benchmark on-grid electricity price-desulfurization coal-fired unit benchmark on-grid

electricity price" are clarified, but the order, disbursement method and fund amount of subsidies for various projects are not clarified[8].

3.2. Mature Development Stage (2012-2018)

The Interim Measures for the Administration of Additional Subsidy Funds for Renewable Energy Electricity Price promulgated in March 2012 stipulates that the application for subsidy catalogue of renewable energy power generation projects should follow the principles of provincial and central level audit, and the audit of subsidy catalogue should be led by the financial, price and energy administrative departments; The supplementary subsidy funds for renewable energy electricity price shall be allocated in advance on a quarterly basis and at the end of the year. In March 2012, the Notice on Improving the Price Policy of Waste Incineration Power Generation was issued at the same time, which made it clear that the benchmark on-grid electricity price of waste incineration power generation project was 0.65 yuan /kWh, and at the same time, it was necessary to convert the waste treatment capacity into on-grid electricity for subsidy settlement according to the standard of 280kWh/t; The subsidized electricity price of waste incineration power generation project is divided into two levels, and the provincial power grid bears 0.1 yuan /kWh, and the rest is solved by renewable energy electricity price. In August 2013 and January 2016, the Notice on Adjusting the Additional Standard of Renewable Energy Electricity Price and Environmental Protection Electricity Price and the Notice on Raising the Collection Standard of Renewable Energy Development Fund were issued respectively, and the additional standard of renewable energy electricity price was raised to 0.015 yuan /kWh and 0.019 yuan /kWh successively. In addition, from 2013 to 2018, the Ministry of Finance published a total of seven batches of subsidies for renewable energy power generation projects, and the renewable energy power generation projects that passed the examination and approval can obtain subsidies in the form of "special financial allocation and transfer payment by power grid enterprises".

In the mature development stage, a two-level subsidy catalogue review mechanism led by the administrative department was determined, and the average publication period of subsidy catalogue was about 1 year. Facing the increasing demand for subsidies brought by the vigorous development of renewable energy power generation projects, the state has realized the problem of subsidy gap for renewable energy power generation projects, raised the additional standard of renewable energy electricity price charged to power users in a targeted manner, and formed a two-stage electricity bill settlement model that "power grid enterprises first pay the electricity purchase fee to renewable energy power generation enterprises in real time according to the benchmark on-grid electricity price of desulfurization coal-fired units, and then transfer it to renewable energy power generation enterprises according to the special subsidies allocated by the state".

3.3. Lean Classification Stage (2019-2021)

In January and September, 2020, "Several Opinions on Promoting the Healthy Development of Non-water Renewable Energy Power Generation" and its supplementary notice were successively issued, proposing that the state would no longer publish the catalogue of subsidies for renewable energy power generation projects, and the grid enterprises would review and publish the list of project subsidies; Define the reasonable utilization hours of four types of wind power resource areas, three types of solar power resource areas and biomass power generation projects in the whole life cycle, and approve the subsidy amount for renewable energy power generation projects included in the subsidy catalogue according to the reasonable utilization hours; It is clear that after the wind power and photovoltaic power generation projects have been connected to the grid for 20 years, and after the biomass power generation projects have been connected to the grid for 15 years, they will no longer enjoy renewable energy subsidies regardless of whether they have reached the reasonable utilization hours in the whole life cycle.

In June and December, 2020, the Notice on Nuclear Reduction of Additional Subsidies for Renewable Energy Electricity Price of Waste Incineration Power Generation Projects with Environmental Violations and the Notice on Nuclear Reduction of Additional Subsidies for Renewable Energy Electricity Price of Agricultural and Forestry Biomass Power Generation Projects with Environmental Violations were successively issued, requiring that waste incineration power generation projects can only be included in the scope of subsidy list after installing the monitoring system of "installation, tree connection", and the pollutant discharge of agricultural and forestry biomass power generation projects is not up to the standard, so the amount of subsidized electricity can be reduced or removed from the subsidy list. The Notice on Issuing the Additional Subsidy Fund Budget for Renewable Energy Electricity Price in 2021, which was issued in May, 2021, determined three types of subsidy disbursement principles according to different project categories: giving priority to timely and full disbursement, allocating according to the proportion of 50%, and allocating according to the proportion of subsidy gap payable.

In the lean classification stage, the state has made more operational details on the approval of on-grid tariff and the level of subsidy allocation; Decentralize the audit authority of subsidy catalogue to power grid enterprises, and give market economic factors a more important role in resource allocation of renewable energy power generation projects; Facing the problem of subsidy arrears caused by the widening gap of renewable energy subsidies, the upper limit of renewable energy subsidies for a single project is locked by setting the lower condition of "reasonable utilization hours in the whole life cycle" and "longest grid-connected operation years"; For two kinds of biomass power generation projects, agricultural and forestry biomass and garbage incineration, punitive measures such as reducing the subsidy amount and removing the subsidy list are required to meet the environmental protection standards.

4. The Internal Reasons for the Decline of Subsidies for Renewable Energy Power Generation Projects

The subsidy allocated to renewable energy power generation projects comes from the renewable energy electricity price surcharge levied on power users. Only under the premise that the additional income of renewable energy electricity price is \geq the subsidy expenditure of renewable energy power generation projects, renewable energy power generation projects can get subsidies in full and on time. From the source point of view, the additional income of renewable energy electricity price = the appropriate electricity quantity on the sales side \times the collection standard. In 2020 and 2021, the national electricity consumption growth rate was 3.1% and 10.3% respectively, and the collection standard has been fixed at 0.019 yuan /kWh since 2016. At present, the growth rate of renewable energy power generation is much higher than the growth rate of electricity consumption in the whole society, and the additional levy standard of renewable energy electricity price is far lower than the subsidy intensity of renewable energy power generation projects. The serious imbalance between the additional income of renewable energy electricity price and the subsidy expenditure of renewable energy power generation projects is the fundamental reason for the decline of renewable energy subsidies. Under the policy background of "peak carbon dioxide emissions is carbon neutral", the growth rate of renewable energy power generation and its proportion in the whole society's electricity consumption will continue to rise, but there is no effective expansion channel for the growth of renewable energy tariff additional income. On the one hand, the growth of electricity consumption in the whole society is restricted by the speed of macroeconomic development. On the other hand, if the collection standard is raised again, the cost of electricity consumption will be transmitted to the end users, which will increase the cost burden of enterprises and inhibit the investment vitality. The contradiction between the narrow growth of additional

income from renewable energy electricity price and the rapid growth of renewable energy power generation is bound to be more acute.

5. Measures to Deal with Subsidies for Renewable Energy Power Generation Projects

(1) Promote the construction of carbon emission reduction market and expand the sources of renewable energy subsidies. Incorporate renewable energy power generation projects into the construction of carbon emission trading and management system, and change the single situation that renewable energy subsidy funds only come from renewable energy electricity price surcharge by collecting carbon emission tax and using a certain proportion of it for renewable energy subsidy payment. The green certificate trading mechanism for renewable energy and electricity will be launched in due course, and thermal power generation enterprises and electricity sellers will bear the transfer payment cost of some renewable energy subsidies by purchasing green certificate quotas. Within the framework of the national unified carbon emission trading and management system, the contribution of renewable energy power generation to emission reduction will be converted into paid income, which will support the sustainable development of renewable energy power generation industry.

(2) Introducing multiple investors to create a medium-and long-term development fund for renewable energy. In the process of allocating the existing renewable energy subsidies, the Ministry of Finance and the power grid companies only collect the additional funds for renewable energy tariffs and then transfer them to renewable energy power generation enterprises. The additional funds for renewable energy tariffs have not achieved continuous improvement in value through capitalization. The Ministry of Finance and power grid companies can jointly establish a medium-and long-term development fund for renewable energy by organizing professional financial institutions or asset management companies with strong financial strength and rich operating experience. The fund takes renewable energy electricity price additional funds as its original rights and interests, fully links the capital operation ability, value creation ability and sustainable financing ability of all parties involved in the investment, designs and promotes customized financial products according to investment demand and risk preference, and enhances the income level through interaction with the capital market, thus alleviating the liquidity problem of subsidy arrears.

(3) issue special government bonds for renewable energy subsidies in batches. From the legal source, the subsidy for renewable energy power generation projects comes from the national credit granted by the Renewable Energy Law of People's Republic of China (PRC). By issuing special bonds with government support, social capital can be effectively mobilized, and the subsidy gap for renewable energy power generation projects can be reduced, which can also boost the market's confidence in the renewable energy power generation industry. In terms of issuance scale and duration, as the subsidy gap for renewable energy power generation projects has been determined by the end of 2021, on the basis of accurate statistics and review and calculation, with the subsidy gap for renewable energy power generation projects by the end of 2021 as the base, and with reference to the long-term special bonds for renewable energy with the interest rate of 20 years in the same period, the raised funds will pay the accumulated subsidies for renewable energy power generation projects by the end of 2021 in one lump sum; In view of the subsidies for renewable energy power generation projects that will continue to grow after 2021, short-term special bonds for renewable energy will be issued in five or ten years in a rolling manner to ensure that new subsidies can be paid in time every year.

(4) Promote renewable energy subsidies and loans. Renewable energy power generation enterprises included in the list of subsidies can apply for loans from financial institutions by taking their confirmed receivable renewable energy subsidies as pledges. Renewable energy

power generation enterprises and financial institutions comprehensively consider the income boundary conditions such as project type, reasonable utilization hours in the whole life cycle, subsidy years and expected consumption of electricity, calculate the subsidized cash flow that can be obtained during the operation period of renewable energy power generation projects, and then determine the loan amount, years and interest rate. Since Xiaogan Branch of Agricultural Bank of China issued the first 9.5 million yuan renewable energy subsidy confirmation loan to China Guangdong Nuclear Power Hubei Dawu Wind Power Co., Ltd. in July, 2021, the coverage and amount of renewable energy subsidy confirmation loan have been expanding all over the country, which proves that this method has wide market recognition and operational feasibility.

(5) Expand the ways of receiving, paying and transforming subsidies for renewable energy power generation projects. With the technology of renewable energy power generation projects becoming more and more mature, the cost of generating electricity per kilowatt-hour has continued to decline, and the dependence on subsidies has also weakened. For renewable energy power generation projects that have been connected to the grid, they can be given the option to accept the payment of renewable energy subsidies, that is, if they are willing to give up a certain proportion of subsidies after 2021, the accumulated arrears of subsidies by the end of 2021 can be paid first, and the higher the proportion of giving up subsidies, the greater the amount of subsidies that can be paid first. This method can alleviate the financial pressure of renewable energy power generation enterprises and national finance at the same time. For renewable energy power generation projects that have not yet been connected to the grid, more preferential policies can be given in terms of filing and auditing, grid connection and power consumption, and they can be operated as subsidy-free projects through negotiation.

References

- [1] Ardehali, M.M., 2006. Rural energy development in Iran: Non-renewable and renewable resources. *Renewable Energy* 31, 655-662.
- [2] Cochran, J., Mai, T., Bazilian, M., 2014. Meta-analysis of high penetration renewable energy scenarios. *Renew Sust Energ Rev* 29, 246-253.
- [3] Dell, G., Egger, C., Grubl, A., 1996. Renewable energy in Austria. *Renewable Energy* 9, 1116-1119.
- [4] Jennings, P., 2009. New directions in renewable energy education. *Renewable Energy* 34, 435-439.
- [5] Miller, A.S., Serchuk, A.H., 1996. Renewable energy in competitive electricity markets. *Renewable Energy* 8, 123-127.
- [6] O'Shaughnessy, E., Heeter, J., Shah, C., Koebrich, S., 2021. Corporate acceleration of the renewable energy transition and implications for electric grids. *Renew Sust Energ Rev* 146.
- [7] Sheikh, M.A., 2010. Energy and renewable energy scenario of Pakistan. *Renew Sust Energ Rev* 14, 354-363.
- [8] Shrestha, A., Mustafa, A.A., Htike, M.M., You, V., Kakinaka, M., 2022. Evolution of energy mix in emerging countries: Modern renewable energy, traditional renewable energy, and non-renewable energy. *Renewable Energy* 199, 419-432.