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# Research on Green Certificate Trading Mechanism of Renewable Energy

Liu Mi<sup>1</sup>, Han Jinshan<sup>1</sup>, Liu Dunnan<sup>1</sup>

<sup>1</sup> State Key Laboratory of Alternate Electrical Power System with Renewable Energy Sources, North China Electric Power University, Beijing, 102206, China.

\*Corresponding author's e-mail: 18701062380@163.com

**Abstract.** The green certificate trading system is a mandatory quota for renewable energy. On the one hand, it can promote the development of renewable energy. On the other hand, it can help to respond to the national policy of energy conservation and emission reduction. Firstly, this paper reviews the development status of renewable energy green certificate trading, and designs the framework of renewable energy green certificate trading mechanism in China. On this basis, with the help of certificate income, the weighted grid price of newly built onshore wind power will reach parity in 2020 and the additional level of renewable energy will remain unchanged. The green certificate price will be calculated on the premise that the full amount of funds will be used to subsidize the price of renewable energy and meet the demand. Finally, according to the results obtained under different measurement conditions, the changes of interests of different subjects after the implementation of green certificate are analyzed, which can provide reference for the implementation of green certificate system in China.

## 1. Introduction

Green Power Certificate (hereinafter referred to as "Green Certificate") is a system to promote the development of renewable energy power through market mechanism on the basis of the compulsory quota of renewable energy power. Mandatory market quota and green certificate trading mechanism are mature international systems to promote the development of renewable energy and electricity. The main implication is to issue a green certificate for a certain scale of renewable energy power generation (usually 1 MW/h), and at the same time to regulate the renewability that must be achieved by power supply enterprises or power grid enterprises. Energy generation or electricity sales account for the proportion of its total power generation or electricity sales. Enterprises that do not reach the required proportion need to buy green certificates in the market. Renewable energy power generation enterprises can get corresponding benefits through green certificate trading.

## 2. Development Status of Green Certificate Transaction for Renewable Energy

In March 2016, the State Energy Administration promulgated the Guiding Opinions on Establishing the Target Guidance System for the Development and Utilization of Renewable Energy and the Measures for the Management of Full Guarantee Acquisition of Renewable Energy Power Generation. In April 2016, the State Energy Administration also issued the following documents: On Establishing the Quota Assessment System for Non-Water Renewable Energy Generation of Coal-fired Thermal Power Notice of Customs Requirements (Draft for Opinion) etc.<sup>[1,2]</sup> In January 2017, the State Development and Reform Commission, the Ministry of Finance and the State Energy Administration jointly promulgated the Notice on the Trial Implementation of the System for the Issuance and



Voluntary Subscription of Green Power Certificates for Renewable Energy, which clearly states that a voluntary subscription system for green power certificates for renewable energy should be established, and the formal subscription of green power certificates for renewable energy should be launched from July 1, 2017. This notice encourages government organs, enterprises, institutions, social institutions and individuals at all levels to voluntarily subscribe for green power certificates as proof of consumption of green power. According to the market subscription situation, renewable energy quota assessment and green power certificate compulsory binding transaction will be started at 2018.<sup>[3]</sup>

The purpose of establishing the target guidance system of renewable energy development and utilization is to establish a comprehensive index statistical assessment system, guide local governments to formulate the target of renewable energy development and utilization scientifically, formulate and implement the energy development plan, clarify the responsibilities of local governments, power grid enterprises and power generation enterprises in the development of renewable energy. And on this basis, the corresponding monitoring and evaluation system is established to achieve more effective after-the-event supervision, and then promote the transformation of energy system towards green and low-carbon direction. Implementing renewable energy quota assessment and green power certificate compulsory restraint trading is a concrete measure to implement the goal guidance system, establish monitoring and evaluation system, and also an important grasp to mobilize and urge all relevant parties in the energy field to promote energy transformation. It should be taken as a guide to gradually establish a comprehensive and reproducible system.<sup>[4,5]</sup> The management and assessment system of raw energy indicators will truly implement the requirements of energy transformation and non-fossil energy proportion put forward by the state. The goal guidance system of renewable energy development and utilization is the foundation of establishing green certificate mechanism.

### **3. Framework Design of Green Certificate Trading Mechanism for Renewable Energy**

From the international experience, the compulsory market share or quota system is a mature mechanism, which is implemented in dozens of countries and regions such as the United States, the United Kingdom, Sweden, Australia, Japan, South Korea and so on. It is an important market mechanism to promote the development of renewable energy in these countries. Some power grid enterprises (such as most states in the United States and the United Kingdom) and some power generation enterprises (such as Korea and Taiwan) are responsible for the mandatory quota. Therefore, the main body of quota liability can be selected among power generation enterprises and power distribution (power grid) enterprises.

At present, China's electricity sales (power grid) enterprises as the main body of quota responsibility can reduce the demand for subsidized funds, solve at least the increasingly severe problem of renewable energy power consumption, and provide stable and sustainable development of renewable energy in the future through appropriate quota index requirements. Growth space to ensure the achievement of the national non-fossil energy development goals in 2020 and 2030.

### **4. Green Certificate Price Estimation**

#### *4.1 Boundary Conditions for Green Certificate Price Estimation*

According to the target of 15% non-fossil energy in 2020, and considering the 13th Five-Year Plan target of energy and renewable energy development under discussion, according to the scale and power consumption of wind power, solar power, biomass power generation and the whole society in Table 4-1, the power generation capacity of coal power in 2020 is 5 trillion kWh. By 2020, the ratio of total non-water renewable energy generation to total coal-fired power generation is estimated to be 15.4%. According to the preliminary results of the Energy Research Institute of the National Development and Reform Commission and the National Renewable Energy Center in the Study of the Roadmap of Wind and Solar Power Parity on the Internet, it is conservatively anticipated that the weighted price of new wind power will be reduced to 0.45 yuan/kWh in 2020, the weighted price of

photovoltaic power will be reduced to 0.6 yuan/kWh, and the average price of coal power will be reduced to 0.45 yuan/kWh. The lattice is 0.36 yuan per kilowatt-hour (without considering the impact of green certificates). Every megawatt-hour of non-water renewable energy power production is recorded as a green certificate, and 755 million green certificates will be issued nationwide by 2020.

The following boundary conditions are taken into account in the preliminary calculation:

(1) The proportion of non-water renewable energy generation in coal-fired power generation of power generation enterprises in 2020 should reach the national average (15%), which means that by 2020, every power generation enterprise producing about 6.5 MW of coal-fired power needs a green certificate; if not, it must purchase a certain green certificate. To meet the proportion requirement;

(2) Regardless of the renewable energy power, the share of green certificates is the same, i.e. one green certificate for every megawatt hour of electricity;

#### 4.2 Green Certificate Price Estimation Scheme and Results

Based on the above basic assumptions and boundary conditions, two schemes are designed to calculate the price of green certificates. The two schemes consider different preconditions. First, with the help of certificate income, the weighted grid-connected price of new onshore wind power will reach parity in 2020. Second, the additional level of renewable energy will remain unchanged, and the full amount of funds will be used to subsidize the price of renewable energy and meet the demand.

(1) Scheme 1: With the benefit of certificates, wind power can be calculated with the green certificate price in the case of coal-fired power parity by 2020.

For all renewable energy projects built in 2020 and before, there is no difference in the way of green certificate income of various renewable energy technologies through market behavior. Due to the differences in the cost of renewable energy projects built in different technologies and in different periods, it can be moderately balanced by different electricity price standards or electricity subsidy standards.

According to the above boundary conditions, the average price of each green certificate (1 MW-hour non-water renewable energy power) is about 78 yuan, and the additional cost for each MW-hour coal-fired power generation enterprise is 12 yuan.

Table 1. Scheme 1: Setting Conditions and Calculating Results of Green Certificate Price

category	2020	
	Average electricity price (yuan / kWh)	Generation capacity (billion kilowatt hours)
Wind power	0.45	5000
photovoltaic	0.6	2000
biomass		750
hydropower		12000
nuclear power		4000
Coal electricity	0.36	50250
Total		74000
Non-water renewable energy accounts for of coal-fired power in 2020 (%)	15	
Number of Production Certificates	775000000	
Certificate price (yuan)	78	
Increased Cost of Coal-fired Electricity at 1 MW/h	12	
Average price after wind power and coal price (RMB/KWh)	0.372	

The price of renewable energy certificate is very sensitive to renewable energy generation capacity under the condition that the proportion of renewable energy Certificate in coal-fired power generation enterprises is unchanged. Even a 5% increase in renewable energy capacity over expectations could

lead to a significant drop in certificate prices. On the contrary, the price of certificates may rise considerably.

Considering that the proportion requirement of green certificate is adjusted year by year according to the development situation of renewable energy and electricity demand, if the proportion requirement of green certificate is appropriate, the price of certificate is less affected by the change of renewable energy power generation. When the renewable energy power generation increases by 100 billion kW, the price of certificate is false. The fixed generation capacity of the whole society will remain unchanged, and the quota certificates for the same coal-fired power demand will increase, resulting in an increase in the power cost of coal-fired power at 1 MW, which is about 13.5 yuan. At this time, the price of green certificates will decrease to 76 yuan. If renewable energy power is reduced by 100 billion kilowatt-hours, the price of green certificates will rise to 80 yuan, but the cost of coal-fired power will fall to 10 yuan per megawatt-hour.

Based on the existing policy conditions, the total demand for renewable energy price subsidies in China is estimated to be about 65 billion yuan in 2015. With the additional receivable of renewable energy price, the income of renewable energy development fund is about 57 billion yuan. There is a shortfall of nearly 10 billion yuan in that year, but due to the collection of self-owned power plants. The actual income fund is about 51.5 billion yuan, and the gap is 13.5 billion yuan. In 2020, if we take into account the decline in the cost and price demand of the aforementioned scenic spots and the absence of green certificate income, the total demand for renewable energy price subsidy funds will be about 180 billion yuan. In the case of additional receivable of renewable energy price, the revenue will be about 90 billion yuan, and there will be a gap of about 90 billion yuan in that year. According to the above green certificate price level, the demand for renewable energy price subsidy fund can be reduced by 70 billion yuan in 2020, and the income and expenditure of renewable energy additional fund are slightly insufficient, but the accumulated surplus of previous years can be used to supplement the gap. However, there may still be a gap of about 20 billion yuan if the actual levy ratio is used.

(2) Scheme 2: The additional level of renewable energy remains unchanged, and the full amount of funds is used to calculate the green certificate price when the renewable energy price subsidy can meet the demand.

The calculation of green certificate price is still at the level of 2020. Considering that the current 1.9 cents per kilowatt-hour additional subsidy for energy and electricity price is no longer adjusted, and all the funds collected are used for renewable energy and electricity price subsidy, then:

1) In the case of exhaustive receivables, the average price of each green certificate (1 MW-hour non-water renewable energy capacity) is estimated to be about 84 yuan; in the case of power generation enterprises, the additional cost for each MW-hour coal-fired power supply is 12.9 yuan.

2) According to the current levy rate, the average price of each green certificate (1 MW-hour non-water renewable energy capacity) is estimated to be about 102 yuan, and the additional cost for each MW-hour coal-fired power generation enterprise is 15.7 yuan.

Table 2. Scheme 2: Setting Conditions and Calculating Results of Green Certificate Price

category	2015		2020	
	Average electricity price (yuan / kWh)	Generation capacity (billion kilowatt hours)	Average electricity price (yuan / kWh)	Generation capacity (billion kilowatt hours)
Wind power	0.56	1863	0.45	5000
photovoltaic	0.92	392	0.6	2000
biomass	0.75	527(373 subsidized electricity)		750
hydropower				12000
nuclear power				4000
Coal electricity	0.36	50000	0.36	50250
Total		56045		74000
Regardless of Green Certificate Subsidy Demand (100 million)	650		1800	

Receivable Surcharge on Renewable Energy (100 million)	570	950
Non-water renewable energy accounts for coal-fired power generation in 2020(%)	15	
Number of Production Certificates	775000000	
Certificate price (yuan)	84	
Increased Cost of Coal-fired Electricity at 1 MW/h (RMB)	12.9	

## 5. Conclusion

(1) The implementation of green certificate transaction will affect the demand for renewable energy price or electricity subsidy. The coordination between these policies is easier to achieve. With the implementation of green certificate transaction, benchmark price standard and electricity subsidy standard can be adjusted in time. Therefore, for renewable energy power generation enterprises, there is an additional revenue channel, but in theory, the revenue level remains unchanged, and the revenue risk increases.

(2) According to the electric power system reform plan and the supporting documents, the increased cost will be directly reflected in the terminal price. If the above green certificate price calculation parameters are still used, the terminal price will be increased by 0.7 cents per kilowatt-hour in the first scenario of 2020 and 0.9 cents per kilowatt-hour in the second scenario.

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