

Influence and Strategy Research of Cross-Regional Renewable Energy Incremental Spot Trading

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Abstract. Due to the incremental spot trading position for sending provinces of abandoned energy (water, wind or photovoltaic power), the renewable energy incremental spot transaction has obvious price advantages. At present, grid enterprises should actively participate in the spot trading of renewable energy in inter-regional provinces. With the reform of the electric power system, the power grid enterprises can participate in the spot trading of renewable energy of renewable energy in the inter-regional provinces through their own sales companies. By purchasing the peak support service from the power plant, we should deal with the peak problem caused by the spot trading of renewable energy in trans-regional provinces. The resulting peak support service costs are no longer shared by power plants, but should be compensated for by the profit generated by the incremental spot exchange.

1. Introduction

National Energy Commission issued a reply to the pilot work on the development of cross-regional renewable energy spot trading on February 14, 2017. The document pointed out cross-regional renewable energy spot trading is targeted for the incremental delivery of surplus renewable energy power generation in the province, district, or city. After the regulation resources have been used and all kinds of medium and long term decomposition plans have been implemented on the power generation side, renewable energy is still rich and may cause abandon water, wind, or solar, the renewable energy spot trading should carry out. The spot trading [1] includes previous and intraday forms [2], [3].

Large-scale cross-regional renewable energy spot trading will influence the grid business and power grid operation [4]–[6]. Cross-regional renewable energy has an advantage on price and will bring opportunities to the power grid, but the uncertainty of renewable energy also poses a challenge.

Based on the positioning of renewable energy spot trading and the characteristics of renewable energy power generation, this paper analyzed the influence of cross-regional spot trading and suggested power grid enterprises participate in this trading as soon as possible [7]. With the advancement of the electricity market, power grid enterprises will participate actively in it with the electricity sales companies established by the grid enterprises in the future. The cost will be reduced, and the grid peaking problems will be solved through the purchase of auxiliary services [8], [9].



2. Trading Rules

Cross-regional renewable energy spot trading needs to meet the security constraints of both sides of the grid and the cross-regional channels to achieve the harmonization of the safe of the grid and the orderly operation of the market.

2.1. The Market Main Parts

The market main parts include:

1) *The seller*: hydropower, wind power and other renewable energy power generation enterprises in the terminal power grid. The renewable energy power generation enterprises participate in spot trading, sign and perform power transaction contracts according to the definition of electrical energy of abandoned water, abandoned wind, abandoned solar proposed by government departments.

2) *The buyer*: large users, electricity sales companies, power grid enterprises which agent large users and electricity sales companies initially. Power grid enterprises should ensure the safety of cross-regional transmission channels and other transmission and distribution facilities according to the rules of transmission and distribution of electricity, also the fair of transmission and distribution services in the market.

3) *Transmission side*: the transmission enterprises. The power dispatch department is responsible for organizing the province of large users and electricity sales companies, checking the security of power network and signing contracts.

2.2. The Trading Mode

Previous spot trading is mainly used to organize the trading of incremental delivery of surplus renewable energy after the annual, monthly cross-regional trading plans have been implemented. Recently, the spot trading is organized on a daily basis. The next day 96 points (0:15-24: 00,15 minutes as a point of time) trading will be organized on each day.

After the daily spot transaction is completed, the day spot trading is based on the change of supply and demand and the delivery plan. According to the current electricity price trading price, the current power trading result can be improved or reduced appropriately. The day trading of renewable energy shall be organized in the following day: 15-4:00, 4:15-8:00, 8:15-12:00, 12:15-16:00, 16:15-20:00, 20:15-24:00, and the six trading segments (15 minutes for a period of time).

The incremental spot transaction adopts the centralized bidding clearing mechanism, which considers the security constraints of the channel, and clears it in time.

(1) The seller's quotation is sorted from low to high, and the buyer's quotation is sorted from high to low. According to the high and low matching way, The lowest bidder and the highest bidder make the transaction first. The principle of decreasing the price difference between the buyer and seller shall be cleared in turn. When different buyers have the same price difference and the seller can not sell the quantity, then the proportion of the remaining purchase quantity of the buyer shall be distributed.

(2) Each transaction is allocated to a cross-regional channel based on the proportion of surplus space in the cross-regional channel. If the transmission line between the buyer and seller reaches the transmission capacity, it shall be regarded as the end of the transaction between the parties concerned. The seller and the buyer's quotation corresponding to the channel are deleted from the quotation sequence, but can still sell electricity to other regional market entities.

(3) The market will be cleared in order until the buyer or seller reports the full amount of electricity. But there exists the other case, when the price difference between buyers and sellers is negative, the trade ends. At the end of each delivery, the average price of the two parties shall be the system marginal price, and the total amount of the transaction shall be settled at the marginal price of the system.

3. Current Situation of Renewable Energy Generation in China

3.1. The Overall Situation

By the end of 2016, the power supply was 164.6 gigawatts. Coal installed 943 gigawatts, accounting for 57.27% of the total. Gas power generation 0.7 billion kw, accounting for 4.26 percent. Hydropower 332 million kw, accounting for 20.18%; Nuclear power was 0.34 billion kw, accounting

for 2.04 percent. Wind power 1.49 billion kw, accounting for 9.03%; Photovoltaic power generation is 0.77 billion kw, accounting for 4.70%, and other installed 0.41 gw, accounting for 2.51%.

In 2016, China generated 5.99 trillion KWH of electricity. Wind power generated 24.1 billion KWH, accounting for 4.02% of total power generation. Photovoltaic power generation is 66.2 billion kilowatt-hours, accounting for 1.11% of total power generation.

At present, abandoning wind and photovoltaic situation in China is grim. In 2016, the total number of abandoned wind energy reached 49.7 billion kWh, increase of 46.6% compared to last year. The rate of abandoned wind in Gansu is 43%, Xinjiang is 38%, Jilin is 30%, and Neimenggu is 21%. In 2016, the total number of abandoned photovoltaic energy reached 7.4 billion kWh, increase of 85% compared to last year.

3.2. Relevant Conditions in North China

In 2016, the maximum load of north China power grid was 206.81 million kw, and the total social power consumption was 1227.7 billion KWH, with a total installed power generating capacity of 274.26 million kilowatts. Among them, renewable energy generation capacity is 488.2 million kilowatts, accounting for 17.8 percent of the total installed power generation, and the electricity generation reaches 7921.1 billion kilowatt-hours, accounting for 6.5 percent of the total power consumption in the whole society.

The maximum load of Tianjin power grid was 13.92 million kw, and the total power of the whole society was 76.3 billion KWH, with a total installed capacity of 14.67 million kilowatts. Among them, the renewable energy generating capacity is 989 million kilowatts, about 7 percent of the total power generating capacity, and 13.54 billion kilowatt-hours of power generation, accounting for 1.8% of the total power consumption in the whole society.

The maximum load of hebei is 2158 million kw, and the maximum load of hebei south network is 3266 million kw. Hebei power grid has 326.5 billion kilowatt-hours of electricity, with a total installed capacity of 62.75 million kilowatts. Among them, the renewable energy generating capacity is 182,000kw, accounting for 28.7% of the total installed power generating capacity and 9.9 billion kilowatt-hours of power generation, accounting for 9.2% of the total power consumption. Between 2017 and 2020, it is expected to add 22.7 gigawatts of renewable energy. In 2020, the renewable energy generation will reach 4072 mw, of which the wind power will be 208 million kw. (the hebei grid will be 19.30 million, hebei south net 1.5 million), and the solar power will generate 15.5 million kw.

The maximum load of the power grid in shanxi was 25.37 million kw, and the total power consumption of the whole society was 179.7 billion KWH. Among them, renewable energy generation capacity is 13.31 million kilowatts, accounting for 17.4 percent of total power generation and 212.3 billion kilowatt-hours of electricity generation, accounting for 11.8 percent of total social use. From 2017 to 2020, it is expected to add 17.69 million kilowatts of renewable energy. In 2020, there will be 31 million kilowatts of renewable energy, including 16 million kilowatts of wind power and 12 million kilowatts of solar power.

3.3. Relevant Conditions in Northwest CHINA

In 2016, the maximum load of the northwest power grid was 73.59 million kw, and the total social power consumption was 556.3 billion KWH. The total installed power generation was 222.95 million kw. Among them, the renewable energy generating capacity is 103.19 million kilowatts, accounting for 46.3% of the total installed power generating capacity and 173.1 billion kilowatt-hours of electricity generation, accounting for 31.1% of the total power consumption in the whole society.

Table 1. Renewable Energy in the Northwest Region of 2016(Unit: gw)

	SHAN XI	GAN SU	QIN GHAI	NINGXIA	XIN JIANG	Total
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Renewable energy installations	697	2827	1943	1516	3336	10319
1.Wind power	179	1277	69	942	1776	4242
2. Solar power	246	686	682	526	893	3033
3. Biomass power	0	3	0	5	2.61	10.61
4.Water power	272	861	1192	43	665	3032

3.4. Relevant Conditions in Northeast China

In 2016, the northeast power grid had a maximum load of 524.7 million kw, and the total social power consumption was 416 billion kilowatt hours, with a total installed power generation of 131.33 million kw. Among them, the renewable energy generating capacity is 38.45 million kilowatts, accounting for 29.3% of the total installed power generating capacity, with 69.2 billion kilowatt-hours of power generation, accounting for 16.6% of the total power consumption in the whole society.

Table 2. Renewable Energy in the Northeast Region of 2016(Unit: gw)

	LIAO NING	JI LIN	HEILONG JIANG	MENG DONG	Total
Renewable energy installations	1045	979	753	1069	3845
1.Wind power	695	505	561	932	2692
2. Solar power	52	56	17	99	224
3. Biomass power	5.4	40	73	5.4	124
4.Water power	293	378	102	33	805

4. Influence of Cross-Regional Renewable Energy Incremental Spot Trading

4.1. Business Impact Analysis of Power Grid Company

In 2016, Beijing electric power trading center organized ten times "power supply XINJIANG" market transactions through the trading platform. More than 360 power generation enterprises of XINJIANG to participated, the new energy sources such as wind power and solar energy power generation enterprises is more than 90%. XINJIANG sent to JIANGSU 882 million degrees, JIANGXI 118 million degrees, TIANJIN 201 million degrees, GUANGDONG 1005 million degrees, BEIJING 301 million degrees. The total amount traded was 25.07 billion. New energy, such as wind and solar, was about 280 million. On January 14, 2017, XINJIANG launched a new energy surplus in the spot trade. The price of the power of the new power generation is 0.15 yuan per kilowatt hour. Assuming the transmission power price is 0.1 yuan/kWh, the ground side price is 0.25 yuan/kWh. Compared with the current electricity price of 0.3514 yuan/kWh in TianJin, incremental spot trading electricity price has obvious price advantage.

Due to the incremental spot trading position for sending provinces (autonomous regions and municipalities) is abandon water, abandoned wind power, or abandoned photovoltaic power, if without across regional renewable energy increment spot transactions between provinces, this part of the power will be wasted, so this part of the electricity price will be lower than the normal trading quantity of electricity price. At present, power grid enterprises can reduce the cost of electricity purchase and increase the profit of enterprises by purchasing the spot of renewable energy in the cross-regional province. With the reform of the electric power system, the power grid enterprises can participate in the spot trading of renewable energy of renewable energy in the inter-regional provinces through their own sales companies.

4.2. Power Grid Peak Regulation Influence

Due to uncertainty about the power of renewable energy generation, cross-regional renewable energy incremental spot trading will aggravate the problem of power grid peak regulation. Tianjin power grid has typical characteristics of urban grid, and the load peak valley is increasing year by year. The maximum peak valley gap reached 517.7 million kilowatts in 2016, accounting for 37.2 percent of the maximum load. At the same time, the main power plants in the area are basically all the heating units, the newly built thermal power units are all heat and power generation units, and the peak power capacity of the power grid is severely limited during the winter heating period.

5. Research on the Strategy of the Cross-Regional Renewable Energy Incremental Spot Trading

5.1. Business Strategy Analysis of Power Grid Company

Power grid company need to comprehensive analysis on various areas sending renewable energy increment spot trading of feed-in tariff and price of transmission channel, landing price assessments by the end of the region, so as to make the optimal electricity purchasing strategy, the specific strategies are as follows:

(1) Research on the price of electricity in each delivery area

Based on the load of present and forecast of the sending area, conventional power supply, renewable energy power generation capacity situation and planning condition, and the situation of abandoned wind or photovoltaic power, we can research on the price of electricity in each delivery area.

(2) Research on transmission power price

According to the transmission channel situation of the delivery to the affected area, such as transmission channel capacity, transmission distance, etc, the electricity price from sent to the end of the transmission can be calculated. But it needs to be pointed out, the national development and reform commission and the national energy administration will organize the cost supervision of transmission projects in trans-provincial and trans-regional transmission lines, and re-evaluate transmission prices (including line losses) according to the results of cost supervision.

(3) Calculate each delivery end to the landed price

According to the price of electricity in each delivery area and transmission power price, each delivery end to the landed price can be calculated.

(4) Determine the optimal purchasing power strategy

The optimal power purchase strategy is determined by comparing the power price and transmission channel.

5.2. Peak Regulation Strategy Analysis

At present, the cost of the compensation assistance service in north China is distributed by the power plant at the cost of the electricity [10], [11]. The specific compensation method for compensation peak service is as follows: (a) The unit will be compensated by 250 yuan/MWh for the amount of power less than the basic peak. (b) The single-machine capacity less than 100MW (including 100MW) will be compensated 1000 yuan/MW if turning off peak once. The single-machine capacity more than 100MW will be compensated 1500 yuan/MW if turning off peak once [12], [13].

According to the principle of "who benefits, who bears", it should be regarded as a paid peak, because the incremental spot transaction results in the peak of the affected area. The resulting peak support service costs are no longer shared by power plants, but should be compensated for by the profit generated by the incremental spot exchange.

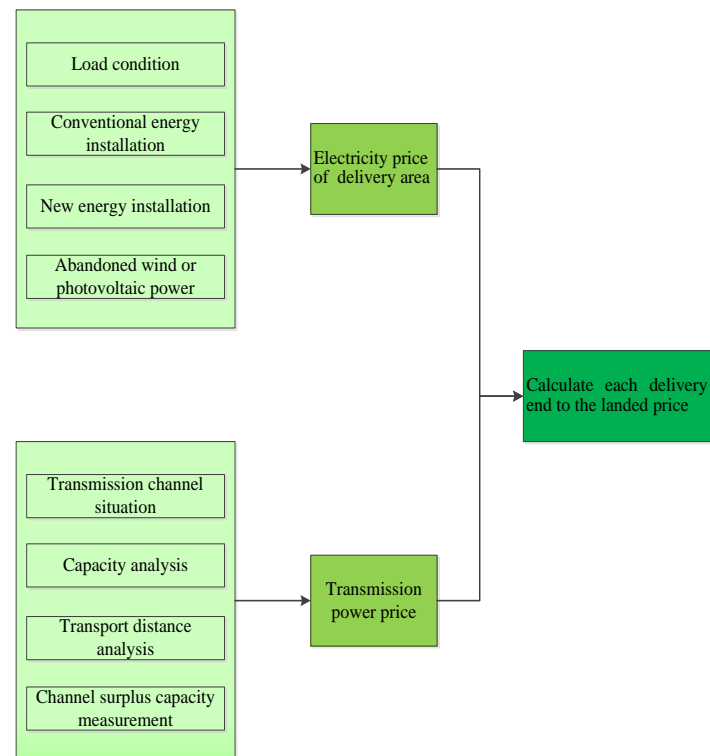


Figure 1. Business strategy of power grid company.

6. Conclusion

The renewable energy increment spot transaction has obvious price advantages, which can bring some profit growth points for the company. Due to the incremental spot trading position for sending provinces (autonomous regions and municipalities) of abandoned energy (water, wind or photovoltaic power), if without across regional renewable energy increment spot transactions between provinces, this part of the power will be wasted, so this part of the electricity price will be lower than the normal trading quantity of electricity price. At present, grid enterprises should actively participate in the spot trading of renewable energy in inter-regional provinces. With the reform of the electric power system, the power grid enterprises can participate in the spot trading of renewable energy of renewable energy in the inter-regional provinces through their own sales companies.

In 2016, the abandonment rate of abandoned wind in Xinjiang and Gansu exceeded 30 percent, and the problem of abandoning wind and light was outstanding. It is recommended that the spot trading of renewable energy in renewable energy should be given priority at the present stage with Xinjiang and Gansu. In 2020, with the development of wind power solar power in Hebei and Shanxi, it will give priority to the spot trading of renewable energy in with Hebei and Shanxi.

By purchasing the peak support service from the power plant, we should deal with the peak problem caused by the spot trading of renewable energy in trans-regional provinces. The resulting peak support service costs are no longer shared by power plants, but should be compensated for by the profit generated by the incremental spot exchange. With the reform of electric power system and the opening of auxiliary service market, we should further study the coping strategy.

At last, in order to carry out the cross-regional renewable energy incremental spot trading, we must strengthen the operation and control of the power grid, improve the structure of the backbone network frame, and ensure the safe and stable operation of the power grid.

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