Long-term mechanism and key issues of trans-provincial and trans-regional power transmission

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Abstract. In recent years, the trans-provincial and trans-regional power transmission have been an important manner in the power industry development in China. However, some annual capacity factors of power transmission lines are at a low level. This could reduce the power resource allocation efficiency and increase the social electricity cost. In this paper, the long-term mechanism and key issues of trans-provincial and trans-regional power transmission are studied, which aim to eliminate unnecessary transmission restrictions of the transmission lines based on long-term multilateral agreements.

1. Introduction

China’s power load centers are mainly concentrated in the southeast coastal areas. However, coal, wind power, photovoltaic and other energy sources are mainly concentrated in the three north (northwest, northeast and north China) regions. This reverse distribution of resources and power loads has led to greater demand for trans-provincial and trans-regional power transmission across China [1]. To achieve the above long-distance power transmission, China has built a lot of HVDC (High voltage direct current) and HVAC (High voltage alternating current) transmission lines [2].

HVDC transmission line has become an important manner for China's long-distance transmission of electricity, which has promoted the rapid development of China's power. In recent years, some annual capacity factors of HVDC transmission lines are at a low level. The transmission power amount does not reach the design value at the planning stage. The main reasons are that the load and power supply deviate from the expected values, the local protectionism and the lack of “contractual spirit”, which have caused the interests of all parties of HVDC not to be guaranteed. Since the construction of HVDC transmission lines also requires high costs, the low annual capacity factors of HVDC transmission lines are not high, which leads to a higher stranding cost. Based on maximizing the whole society benefits, it is needed to study the potential of HVDC transmission and eliminate unnecessary transmission restrictions.

2. The basic situation of trans-provincial and trans-regional power transmission

As shown in Figure 1, for an HVDC transmission line, the starting point and the ending point are actually in two different provinces in China. The province A is the power sending province. That is, the power source (the thermal power unit, the wind farm, the photovoltaic power station, etc.) associated with the HVDC transmission line collects power here. The province B in Figure 1 is the power receiving province. That is, the province B is the province that receives electricity and supplies it to the load.
Some thermal power units, wind farms and photovoltaic power plants are the supporting power sources for HVDC transmission lines. The National Energy Administration requires that the annual capacity factors of HVDC transmission lines reach a certain threshold, such as 4000 hours and 4500 hours. According to the HVDC transmission capacity, the amount of electricity that the HVDC transmission line needs to be delivered within one year can be calculated.

Some HVDC transmission lines are equipped with supporting power sources during the planning and construction stage. These supporting power sources can be thermal power units, wind farms or photovoltaic power plants. In the power transmission/purchase agreement, the supporting power sources are usually included in the power balance plan of the power receiving province. However, for some HVDC transmission lines, even with supporting power sources, the annual capacity factors of HVDC transmission lines cannot meet the requirements. The main reasons include the following:

- **Power price.** The electricity prices on the HVDC transmission lines are too high and the power receiving province is reluctant to buy. This situation is more common when the price of electricity delivered by the HVDC transmission line is higher than the catalog price of the power receiving province. One reason for this situation is the lack of “contractual spirit” in the construction and operation of HVDC planning. If the power supply of the end province is insufficient, the power receiving province hopes to build the HVDC transmission line. However, after the completion of the HVDC transmission line, the power supply and demand situation in the sending and receiving provinces changed. Due to the abundant power supply in the power sending province, it is no longer willing to purchase power from the provinces that are sent to the province through the HVDC transmission line.

- **Local protectionism.** Even if the power price of the HVDC power sending province is cheaper than that of the power receiving province, the power receiving province is not willing to buy electricity through the HVDC transmission line. The important reason is that the province is responsible for protecting the power generation enterprises in the region, so it is more willing to use the electricity generated by the power generation companies in the region.

- **Concerns about future power supply expectations.** The power receiving province of the HVDC transmission line is worried that the future energy supply will rely too much on the sending provinces, so it is more willing to use the resources in the province to solve the problem of power supply.

### 3. Information may be required in long-term power transmission/purchase agreement

At present, State Grid Corporation of China has solved the problem of trans-provincial and trans-regional transmission by urging the power sending province, the power receiving province, State Grid Corporation of China and other units to sign a multi-lateral agreement on HVDC long-term power
transmission. In signing the long-term power transmission/purchase agreement, it is necessary to clarify some important information. Mainly as follows:

3.1. Supporting power sources information.
The supporting power sources information includes thermal power, wind power and photovoltaic power stations, and corresponding information, such as power generation capacity.

3.2. Annual capacity factors that the HVDC transmission line needs to be achieved.
In the general power transmission/purchase agreement, it is stipulated that the power delivered by the HVDC transmission line is preferentially consumed in the receiving province. According to the delivery of supporting power sources, e.g., thermal power and renewable energy, the electricity market of the receiving province and the constraints of the grid, the annual power transmission scale is measured year by year. After a few years, the agreement ensures that the HVDC transmission line annual capacity factors reach the nationally approved required hours.

3.3. Annual capacity factors of supporting thermal power.
This term guarantees the benefits of supporting thermal power and stipulates the minimum power generation capacity of the supporting thermal power in one year. Some transmission agreements will stipulate that the utilization efficiency is not lower than the average utilization hours of the same type of generating units in the receiving province.

3.4. Annual renewable energy transmission amount.
According to the situation of HVDC supporting renewable energy and the need for the receiving province to complete the consumption responsibility of renewable energy power, the annual renewable energy transmission amount is determined in the year specified in the power transmission agreement.

3.5. Benchmark electricity price.
Benchmark electricity price is the power price reference value of the HVDC transmission line.

3.6. Electricity price adjustment mechanism.
That is, the actual price of the HVDC transmission line is the above-mentioned benchmark price plus the price of electricity that is increased or decreased by the electricity price adjustment mechanism.

3.7. Terminal price limit.
In some long-term power transmission agreements, the price of the HVDC transmission line in the receiving province is not higher than the average purchasing price of the receiving province. This mechanism also ensures that the power delivered by the HVDC transmission line is competitively priced in the receiving provinces.

3.8. Peak-to-valley ratio.
That is, the ratio of the output of the thermal power unit during the peak period of the electric load and the period of the valley period. In some HVDC long-term power transmission agreements, it is necessary to agree in advance on the valley time and peak time of the end province load. The HVDC basic power transmission curve and the peak-to-valley ratio are determined by comprehensively considering the peaking capacity of the supporting thermal power unit, the power generation of the renewable energy source, and the power consumption characteristics of the receiving province.

3.9. Specific agreement with supporting power sources.
This term is used to specify the output of supporting power sources. Without this agreement, the agreement cannot restrict supporting power sources.
4. Key issues analysis in HVDC transmission

Although it is possible to stabilize the HVDC transmission expectations by signing an HVDC long-term transmission agreement. However, if some key details are not clearly defined or agreed upon in the agreement, there is no guarantee that the HVDC transmission will be completed.

4.1. The peak shaving problems brought about by the renewable energy need to be clearly resolved.

Objectively, the renewable energy peak shaving pressure is mainly solved by the sending province, which is also determined by the direct current line operation (to adjust the taps frequently). Part of HVDC transmission lines can solve the peak shaving problem of renewable energy by sending electricity by means of wind power and thermal power bundling.

4.2. The receiving provinces need to assume responsibility for the new energy consumption.

On the basis of the above-mentioned renewable energy peak shaving pressure is solved by the sending province, renewable energy should be fully absorbed in the day-ahead electricity market of the receiving province.

4.3. It should be clear that the HVDC transmission line is not the exclusive line of the sending province.

It is necessary to clarify in the policy documents and transmission agreements that power on the HVDC transmission lines can be collected using power supplies outside the province. The purpose of is to give the sending province a competitive pressure. And to ensure that in the case of the power transmission of the province through the transmission line is insufficient, other provinces can use this HVDC transmission line. In this way, the annual capacity factors of the HVDC transmission lines can be guaranteed.

4.4. Determining the agreement execution guarantee mechanism.

The agreement needs to stipulate the disputes arising from the agreement and related matters of the agreement, and the methods to be resolved by the agreement. For example, it can be resolved through negotiation. If no agreement can be reached after consultation, it may be submitted to the government department of the National Energy Administration for coordination.

5. Conclusion

This paper focuses on the long-term mechanism and key issues of trans-provincial and trans-regional power transmission. The basic situation of trans-provincial and trans-regional power transmission is introduced. Then, the information may be required in a long-term power transmission/purchase agreement is discussed. Finally, the key issues of the HVDC long-term transmission agreement are analyzed in this paper.

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References

[1] Several opinions on further deepening the reform of the electric power system. Central Committee of the Communist Party of China.
http://www.ndrc.gov.cn/fzgggz/tzgg/tzggx/201504/t20150409_676931.html

[2] Guidance on promoting cross-regional energy trading. National Development and Reform Commission, State Electricity Regulatory Commission. http://www.nea.gov.cn/2012-01/04/c_131262595.htm.