Business Model of Cross-border power transmission line: Examples from Europe and America

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Abstract. This paper selects three typical European and American cross-border power transmission lines for case study, and sorts out the business model of cross-border transmission lines, including investment entities, financing and cost recovery methods. According to the difference of regulatory environment, it is divided into the complete market model, the complete supervision model and the combination of the two models. The paper compares the advantages and disadvantages, as well as the applicability, and provides suggestions for investing in the construction of cross-border transmission lines.

1. Introduction

Cross-border transmission lines are the cornerstone and crucial support for cross-border power trade. As the transmission lines are affected by geographical location, regional economic development, population density, and the policies of the relevant national electricity market, the construction and business model are different. This paper selects three typical cross-border lines and summarizes the characteristic of their business model.

2. Overview of typical cross-border power transmission lines

Cross-border power transmission lines are mainly located in Europe and North America. Europe has the world's densest grid, with a total of 310,000km of transmission lines, and its long-term goal is to establish a European "super grid" covering all members of the European Operators Union (ENTSO-E). In North America, the United States has built several cross-border transmission lines between Mexico and Canada to facilitate power trading.

2.1 BritNed

BritNed is the UK's third cross-border transmission line and is the only commercial transmission line among the four cross-border transmission lines in the UK. It is a 450KV submarine HVDC cable connecting the Isle of Grain in Kent, England and Maasvlakte in the Netherlands, with a total length of 260km and a maximum transmission capacity of 1GW. BritNed's construction project was officially announced in May 2007 and put into operations in April 2011. At the same time, it is an important link of the European Super Grid project[1].

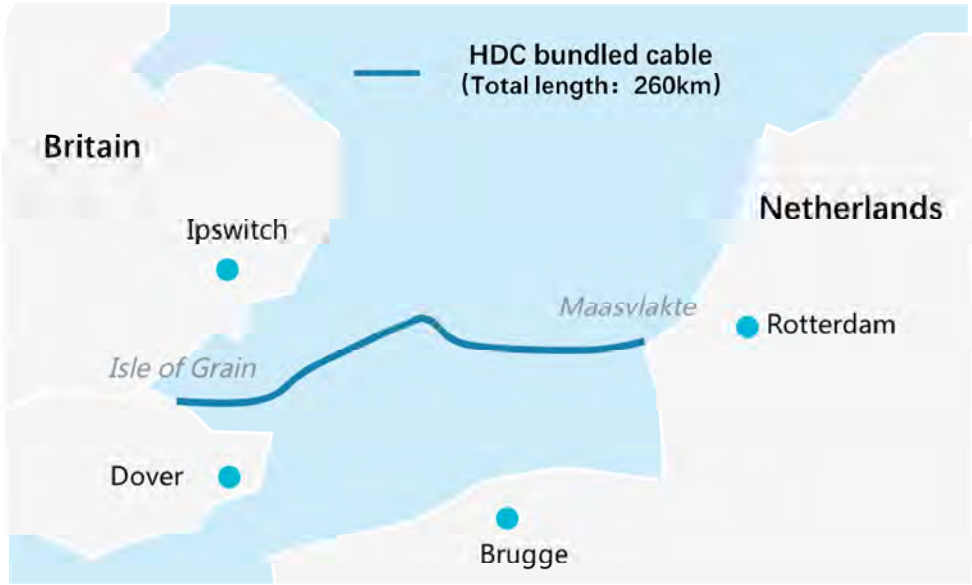

Fig. 1. Schematic diagram of BritNed submarine cable

2.2 Moyle transmission line

The Moyle project connects Currarle Port in South Ayrshire, Scotland, and Portmuck South in Antrim, Northern Ireland. It consists of two transmission cables with a total length of 64km. The transmission capacity of the two cables is 250 MW each[2].

Fig. 2 Schematic diagram of Moyle transmission line

2.3 G82R cross-border transmission line

The G82R line is the fourth cross-border transmission line between Manitoba Hydro and MISO's US market. Except for the new line of Minnesota Transmission Engineering (MMTP) that is still under construction, it is the newest connection. The G82R was officially brought into operations in October 2002. It is a 230kV high-voltage transmission line with an import and export capacity of 200MW and a total length of 103 miles[3]. It connects the Glenboro substation in southern Manitoba, Canada with

the Rudby substation in North Dakota, USA, and then the electricity is transferred from Rudby to the power load center of North Dakota, which is also connected to load centers in Minnesota and Wisconsin.

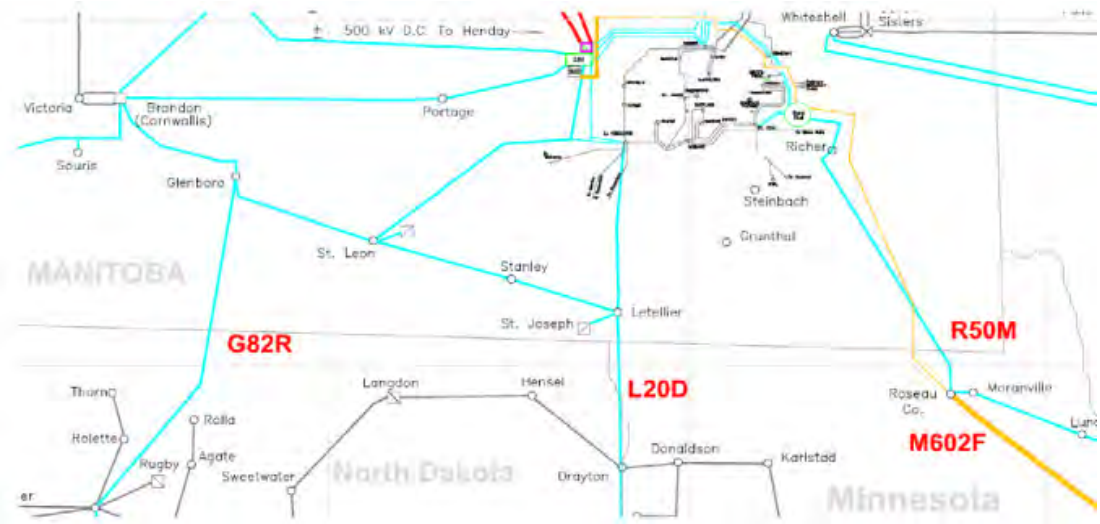

Fig. 3 Schematic diagram of the G82R line

3. Business model of cross-border power transmission lines

3.1 Investment entity

One way is to establish a joint venture company by different companies involved in cross-border transmission between the two countries. The two parties jointly inject capital and are responsible for the construction, installation and later operation of the line. BritNed Power Grid, which is invested by National Grid UK and TenneT by 50% respectively, has established a BritNed joint venture company to be responsible for specific matters.

The other way is that companies form two countries are responsible for investing in the construction of their own domestic transmission lines seperately. In the example of G82R line, the investors are Manitoba Hydro in Canada and Northern Power in the United States (belonging to Xcel Energy). Manitoba Hydro is responsible for investing in the construction of transmission lines from Glenboro to the border in Canada, and has the ownership of the line within Canada. The National Power of Northern Minnesota is responsible for the construction of transmission lines from Rugby to the US-Canada border and has the ownership of this line.

3.2 Finance

The financing of cross-border transmission lines mainly includes internal financing and debt financing.

BritNed's total investment is 600 million euros. The main source of funds is internal financing. In the frist stage, debt financing was accounted for less than 1%, while in recent years, the proportion of debt financing in the capital structure has increased year by year. However, the debt/equity ratio remains below 15%.

The main investment of the Moyle project transmission line is 150 million pounds. Now it is owned and operated by Moyle Transmission Company. Molye has invested and built by issuing long-term bonds. And its users are power supply companies.

The total investment of the G82R is approximately 15 million dollars according to information provided by the Manitoba Annual Report, the length of the Canadian part is 50 miles and the investment is approximately 13 million dollars. Since the investment amount of this line is not large, the funds mainly come from internal financing [4].

3.3 Cost recovery mechanism

In the fully market-oriented model, multinational grid investment operators obtain revenues through auction of transmission capacity, including explicit auction and implicit auction. Multinational grid investment operators cannot enjoy government subsidies and are fully exposed to market risks. BritNed and Molye are two typical representatives of cross-border transmission lines in a fully market-based model. Cost recovery mechanisms include long-term transmission capacity auctions and congestion rent. There is no upper limit to the income that BritNed can receive, and the way in which the proceeds are distributed and used is not restricted. BritNed's revenue is mainly derived from the auction of long-term transmission capacity and the collection of blocked rent.

In the full supervision model, the permitted costs of transmission lines, including depreciation expenses, operation and maintenance fees, etc., are verified by the regulatory authorities. Most of the cross-border transmission lines between the United States and Canada belong to this category. For example, in the G82R project. Manitoba Hydro's revenue is from electricity sales that regulated by PUB, which requires the total revenue consist essentially of production costs, taxes and reasonable profits. And Manitoba Hydro allocates the total required revenue to different categories of users (including MISO's power users). The net income from the export of electricity will be directly used to offset the production costs allocated by different categories of users in the province, thus reducing the price of electricity obtained by users in the province.

The third model is a combination of market and regulation, represented by the UK's cross-border grid. The UK stipulated that the transmission lines that are put into operation or started construction after 2014 will be able to apply to OFGEM for the new cost recovery policy, the *Cap and Floor Regime*. The mechanism stipulates the upper and lower limits of the income that the grid owner can obtain. The part that exceeds the upper limit is returned to the user, and the part below the lower limit is replenished by NGET, and then the TRUoS recovers the part of the fee. Investors of multinational transmission lines can voluntarily choose to adopt the *guarantee capping* policy, or they can adopt a market-oriented operation model, and accept no government subsidies. At present, among the 7 transnational transmission lines under construction and planned in the UK, 6 of them have chosen the policy of *guarantee capping*.

Table 1. Comparison and applicable situation of three different models

Model	Advantage	Disadvantage	Applicable situation
Full market model	It can provoke investors' enthusiasm when the price difference between the sender and the receiver is high and the profit is clear. There is no need for government subsidies or apportionment to power users, and the political pressure on project implementation is small.	Faced with large market risks, it is difficult for multinational transmission line investors to recover investment when the price difference between the transmission and reception ends is reduced. And investors are not motivated to invest in this situation.	It is suitable when the project's prospects are relatively clear, and it is expected to be sustainable in the long-term. There will be no profiteering space and ensure that investors can receive reasonable income.
Full supervision mode	It can ensure the normal recovery of investors' costs and reasonable income, and attract investors to participate in the construction of multinational power grids. It can avoid market risks and ensure that investors' income is not affected when the market environment changes.	All costs are shared by power users, and project implementation faces greater pressure. When the market environment changes, the gap between the transmitter and receiver is narrowed, and the power transmission capacity is insufficient, the power users still need to share the cost, and investment decision makers face greater pressure.	It is suitable when the project is of great significance, and relevant national governments promote the project with high enthusiasm, but the project economy is general, and the government needs to ensure the investment recovery by allowing *cost plus reasonable income*.
Combination of market and regulation	It can comprehensively consider the benefits and risks, avoid market risks to a certain extent, and	It limits investors' income and is not conducive to motivating investors. It ensures the lowest return of investors, and obtains excess returns	It is suitable when the projec‘s economy is excellent that investors are easy to obtain excess profits, and it is necessary to control the excess profits.

	encourage investors to make rational decisions, which is conducive for flexible design according to different policy objectives of regulators.	when the spread of the sender and receiver is high, facing greater political pressure. It puts higher requirements on the supervisory ability of the regulator.	It is applicable to projects with more urgent network needs but economy is ordinary. It ensures investors to recover costs through guarantees, and encourages innovative models and expands profits. It is applicable when the regulatory agencies have strong ability to fully grasp the cost and benefit of the project.

4. Summary

There are three main business models for cross-border transmission facilities: purely regulated, semi-regulated and semi-commercial, and purely commercial. Each model has its own cost recovery and financing characteristics, and is a key consideration in investing in cross-border transmission facilities. In addition, consideration should be given to the nature of existing lines, changes in power supply and demand, applicable technologies and construction cycles, and stakeholder input.

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