Opportunities and Challenges for Interconnection Investment in Europe: Case Example of Estlink HVDC Power Cable Between Estonia and Finland

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Introduction

According to Jong & Hakvoort (2006), lagging commercial investment in interconnections is slowing the unification process of the European electricity market. Electricity market integration and liberalization is not possible without new cross-border transmission lines for the exchange of power between neighboring countries. Additionally, the appearance of new merchant interconnection lines increases the need for cross-border market pricing agreements. Price agreements between countries create a single price zone where there are no cross-border power exchange limitations. For example, the North-Western Europe (NWE) price agreement is awaited in November 2013. It is one of the stages of the pan-European market integration. According to the NWE, this agreement will combine into one large system countries in Central Western Europe, Nordic countries, Great Britain, Baltic countries, and the SwePol link between Sweden and Poland. Following this combination, every consumer in Europe will be able to purchase power contracts from any supplier in Europe and suppliers will get access to all European customers.

Cross-Border Power Transmission in Europe

According to the recent report by IEA, "Redrawing the energy-climate map," requires improving power transmission lines and providing additional transmission capacity. Additionally, in order to decrease the level of the power sector carbon-dioxide emissions, it is necessary to boost investment in new transmission and distribution lines. Interconnection links also lead to a increased supply security, stronger competition among suppliers, higher price transparency, as well as creating the possibility of an advanced cross-border integration to exchange energy. A well-functioning network of transmission power lines across countries' borders is also a source of national energy efficiency improvement.

Other sources emphasize the importance of market driven incentives to invest in electricity transmission networks. Considering energy transmission power regions, the European Commission highlights the importance of investments in interconnections between the UK and mainland Europe, as well as between the Iberian Peninsula and mainland Europe. European electricity grid optimization, to be achieved by increasing interconnection capacity between member states is part of ENTSO-E's Ten-Year Network Development Plan, (TYNDP). Additionally, another study named "Vision for European Electricity Markets in 2030," undertaken by Lappeenranta University of Technology and the Finnish Energy Industry in 2010, underlines the importance of incentives for TSOs to reduce the number of bottlenecks. It calls for more investment in new intra- and interregional transmission lines and for the simplification of permitting procedures for new transmission investments. The EU study, Connecting Europe Facility (CEF), addresses the question of mitigating the risks involved in the public funding of construction of new transmission lines as put forth in TYNDP. The CEF also stresses the strengthening of interconnection links between Finland, Sweden and Poland as part of the Baltic Energy Market Interconnection Plan (BEMIP). BEMIP implementation is one of the top priorities for the EU. It is an action plan aimed to integrate the Baltic Sea Region to EU's internal energy market, both for electricity and gas. Introducing more interconnections in the region will eliminate market isolation, enhance supply security, and fuel internal market liquidity. Sufficient investments are best ensured when the power price is market driven, not artificially regulated.

European electricity market liberalization is regulated by European parliament directive. According to an EU press release, EU 2020 energy and climate objectives will require EUR 9.1 billion investment in trans-European energy infrastructure. BEMIP requires a total investment of EUR 5 billion in the electricity sector with an estimated investment gap of EUR 3 billion. Estonia and Finland investment requirements are estimated at EUR 0.3 and 0.8 billion, respectively.

In this paper, an analysis of the Estlink-1 HVDC submarine power cable is used as one example of improving power system security and enabling power market integration in the Baltic region. A brief description of the Finnish and Estonian power sector is included. It is supplemented with data analysis based on data points from Nord-PoolSpot on Elspot hourly prices (EUR/MWh) and interchange data (MW) dur-

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ing the first 28 weeks of 2013.

Description of the Market Setup for the Estlink Transmission Line

Finnish Power Market

In Finland, power is generated mainly from nuclear plants, hydropower plants, and thermal plants fueled by natural gas and coal. The share of renewables in this generation mix is quite small and depends on the amount of hydropower available on the Nordic market, in particular from Norway and Sweden. Starting in 2007, electricity network operations were unbundled and the Finnish power network was integrated into the Nordic power system. There are 120 companies producing electricity and approximately 400 power plants operating in Finland. Since July 2007, the Finish electricity market has been open for international companies. Therefore, such companies as Vattenfall and E.ON have joined Finish energy production, sales, and distribution. The major Finnish companies such as Fortum operate in the Nordic and Baltic markets as well as in Russia, providing energy-related services. Finland has the ability to transmit electricity to Sweden, Norway and Russia. Fingrid Oyi is a national electricity transmission grid operator with the Finland owning 53.1% and other institutional investors owning 46.9%.

According to Fingrid, in 2009 15% of the total power consumed by Finland was imported from Russia, Norway, and Sweden. Finland is connected to the Nordic system with several transmission connections:

two 400kV and one 220kV AC connection to Sweden
HVDC link Fenno-Skan to Sweden (second submarine HVDC link is under construction)
one 220kV AC connection to Norway
one 350kv HVDC cable to Estonia
three 400kV and one 110kV DC link to Russian Federation

Estonian Power Market

Eesti Energia is a state owned company in Estonia with 97% of the production capacity and an 88% share of the retail market. Eesti Energia controls the Estonian transmission system. The Estonian market consists of 4 balance operators, 50 independent generators, and 40 independent DSOs that account for 15% of the market. Estonia accounts for 8 existing interconnectors:

two 330kV and two 110kV to Latvia
three 330kV to Russian Federation
one 350kV HVDC cable to Finland

According to EU Directive, the Estonian electricity power market is expected to be open by the end of 2013. This compares to Lithuania and Latvia with fully liberalized electricity markets,. However, Latvia and Lithuania intend to open the Elbas intraday market only at the end of 2013. In Estonia, Elspot and Elbas markets have been available as parts of the Nordic day-ahead market since 2010. According to the NordPoolSpot annual report, Estonian bidding turnover in 2011 was 4.6 TWh, up from 1.8TWh in 2010.

Baltic Market Price

According to a study done by "T E N – Energy – Invest," in which particular attention was paid to the future development of the energy market in the Baltic region, a Baltic power exchange must be first created with day-ahead market coverage, and later expanded to include intraday market and financial market coverage.

As part of the market integration, Estonian, Latvian and Lithuanian TSOs have purchased shares of the NordPoolSpot, Europe's largest power exchange. This will enable Baltic TSOs to participate in the power market decision-making process. Moreover, reinforcing transmission links between the Baltic and Nordic countries is an important step toward a common power market. Therefore, additional interconnection cables such as Estlink-2 and NordBalt are planned to be completed by 2014. Estlink-2 will increase transmission capacity between Finland and Estonia to 1,000 MW (additional 650 MW) and NordBalt will create a total transmission capacity of 700MW between Lithuania and Southern Sweden.

Consideration of Governance Structure

Merchant interconnections are financially and legally independent of the government. However, these transmission lines require approvals from national authorities and TSOs. Therefore, agreeing on a long-term perspective and including contract provisions for all mechanisms needed for efficient and fair decision making is vital. Additionally, it is important to include all payout schemes in the contract, especially for periods of highly fluctuating electricity flow. The main governance structures usually are full ownership by one TSOs, joint ventures between TSOs, or joint ventures with third parties.

Estlink-1 HVDC is a submarine transmission link of 350 MW from Estonia (Harku) to Finland (Espoo) and is owned by the Nordic Energy Link AS. It started commercial operations in November 2006 with full cable capacity coming on line the 20th of September 2010. Nordic Energy Link AS is a direct subsidiary of Eesti Energia AS. Partners of the Estlink project are Eesti Energia (39.9%), Latvenergo (25%), Lietuvos Energija (25%), and a 10.1% share divided between Pohjolan Voima and Helsingin Energia of Finland. Therefore, the cable governance structure today is that of a joint venture with third parties. However, according to the Estlink investment agreement, the cable will be transferred into full ownership of Elering and Fingrid (TSO in Estonia and Finland) in 2013. According to Elering corporate web page, the total cost of Estlink-1 was EUR 40 million. Estlink-2 HVDC submarine interconnection cable of 650 MW from Estonia (Püssi) to Finland (Anttila SS) is planed to be built by 2014. Estlink-2 is also owned by Fingrid and Elering. According to the Fingrid web page the total budget for Estlink-2 is approximately EUR 320 million with a EUR 100 million subsidy from the EU. Construction is underway and progressing according to schedule.

Data Analysis

The power balance in the Nordic and Baltic countries determines the current flow on the Estlink-1 connection. On average, the flow is more often in the direction of Estonia as prices are higher there. However, another characteristic has been noticed. During night hours (11.00 p.m. to 05.00 a.m.) the flow is towards Finland. At 06.00 a.m., it switches back towards Estonia.

In order to evaluate the cable's profitability, calculations were made based on hourly Elspot prices from NordPoolSpot from 1 January 2013 until 19 July 2013. Hourly EUR/MWh prices in Finland and Estonia were recorded. The difference in these prices multiplied by the amount of capacity transmitted corresponds to the hourly profit. By summing up, the daily and weekly profit of the cable is obtained. This is shown in Table 1. (Note, however, there are a number of factors, such as planned maintenance and unplanned errors, which affect directly the profitability rate of the cable and these factors are not included in the analysis). The mean weekly prices shown in Figures 1 and 2 show a rather flat pattern, on average, with a higher level in Estonia than in Finland.

Date	Power flow from Estonia to Finland (EUR)	Power Flow from Finland to Estonia (EUR)
Week 1, 2013	360.4	198,061.79
Week 2, 2013	21,731.50	9,936.23
Week 3, 2013	79,788.74	12,519.39
Week 4, 2013	36,918.99	5,220.99
Week 5, 2013	20,586.41	19,561.63
Week 6, 2013	29,985.07	58.56
Week 7, 2013	12,782.13	67,589.42
Week 8, 2013	3,131.81	54,747.04
Week 9, 2013	94,799.52	10,877.81
Week 10, 2013	120,403.19	541.68
Week 11, 2013	17,578.39	120,596.34
Week 12, 2013	8,494.31	105,943.52
Week 13, 2013	22,477.39	139,880.14
Week 14, 2013	26,934.06	86,156.30
Week 15, 2013	2,329.93	96,725.63
Week 16, 2013	97,312.52	3,393.09
Week 17, 2013	155,167.59	0
Week 18, 2013	142,344.64	0
Week 19, 2013	62,603.512	0
Week 20, 2013	0	23,787.662
Week 21, 2013	665.42	83,583.69
Week 22, 2013	0	26,070.39
Week 23, 2013	524.06	46,027.59
Week 24, 2013	0	0
Week 25, 2013	0	1,264,200.12
Week 26, 2013	0	1,507,996.67
Week 27, 2013	0	218,284.84
Week 28, 2013	0	467,740.50
	956,919.58	4,569,501.02

Table 1. Weekly Profit of the Cable Based on Price Difference Model

Conclusion

There are many companies that have an interest in constructing interconnections in highly competitive electricity markets. The governance structure of these interconnection lines is an important question to answer. A joint venture contract between TSOs in many cases results in more efficient cable functionality. An Estlink example shows how the investment project carried out by third party members turns into the full ownership by national TSOs.

Estlink is an important connection link between Finland and Estonia that significantly increases the liquidity of electricity markets and broadens the opportunities for inter-regional power trade. The future of a pan-European

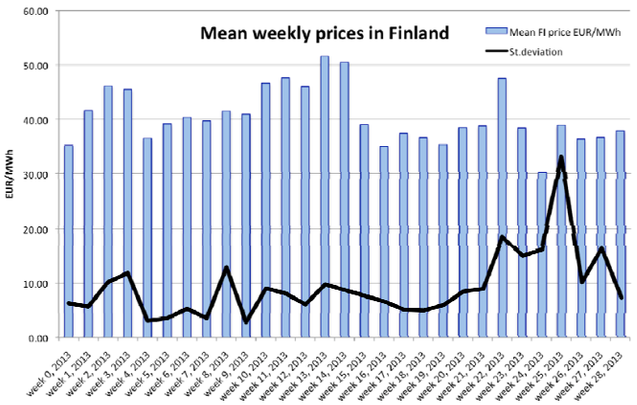

Figure 1. Mean Weekly Prices in Finland (EUR/MWh)

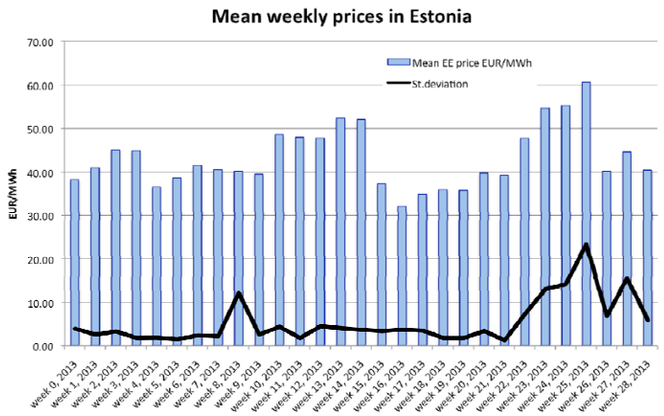

Figure 2. Mean Weekly Prices in Estonia (EUR/MWh)

integrated market depends on the development of such merchant interconnection links.

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