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Investment in mutually exclusive transmission projects under policy uncertainty

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ABSTRACT

In this paper we evaluate mutually exclusive transmission projects under policy and economic uncertainty. The alternatives being considered are transmission investment projects between Norway and Germany, and Norway and the UK. We apply a real option valuation framework allowing the investor to choose the optimal time and location of the investment, and also how different conditions affect the decision to invest in either of these two projects. The analysis shows that the value of the option does not necessarily increase with volatility.

1. Introduction

The European Union (EU) has committed to a binding goal for all member states of fifteen percent cross-border transmission capacity by the end of 2030. In this paper we aim to analyse the profitability and optimal investment timing of additional transmission capacity between countries when uncertainty is taken into account. This is done using real option valuation with the option to invest in one of two mutually exclusive projects; either building an interconnector from Norway to Germany or from Norway to the United Kingdom (UK).

The main contribution of this paper is twofold. First, we apply real option analysis to consider which country to connect to. In the real options literature there are several papers considering mutually exclusive investment projects (Childs et al., 1996; Dixit, 1993; Décamps et al., 2006), but they do not consider the option of choosing between different locations. Second, our paper is one of the few to apply real option valuation to transmission assets. We draw inspiration from the paper of Fleten et al. (2011), who analyse the option to invest in an interconnector, where the aim is to choose the optimal capacity of the cable. In this paper we focus on the application of real options when choosing between mutually exclusive projects under policy and economic uncertainty.

The two policy schemes we focus on are the EU emission trading system (ETS) and capacity markets. We find that capacity markets have no impact regarding project choice, but it does influence the option value. A reform to the EU ETS, necessarily increasing CO_2 emission prices, can increase the option value, leading to an increased spread between the Norwegian and German/UK electricity prices. The differences in production mix between the German and the UK market also makes a tightened EU ETS have a different effect on the two markets. The effects of the policy schemes are included in the model through the revenues from the two cables. We model the revenues as uncertain and fluctuating over time.

We further investigate the benefits of looking at the option to invest in one of the two locations. Other papers have developed models for choosing the optimal entering strategy into a new market. Gilroy and Lukas (2006) considered the option of choosing between two different market entry strategies. They emphasise the value of considering the option to invest as mutually exclusive

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choice between different locations. By doing so, the value of the option increases and it helps practitioners obtain an optimal investment strategy.

The valuation methodology builds on Rubinstein (1994), and takes into account the yearly revenue streams for two potential projects, ramping restrictions and capacity markets. One important finding is the effect of uncertainty on the option value. The result shows that the option value does not necessarily increase when the volatility increases, unlike what we commonly find in real option valuations.

The rest of this paper is organised as follows: In Section 2 we present characteristics and trends in the electricity market, together with a brief description of the Norwegian, German and the UK electricity market. Section 3 discusses the main policy related uncertainties in the electricity market and how these uncertainties might affect the electricity price. Section 4 introduces and explains the two factor real option model. Section 5 presents the data set and describes the main findings. In Section 6 we perform a sensitivity analysis of the real option model and conclude in Section 7.

2. The electricity market

In the Norwegian production system hydropower produces over 98% of the total generated electricity. Only a small fraction of the system is thermal generation emitting CO_2. Norway utilizes a market based support scheme established to promote new electricity production based on renewable energy sources, the Norwegian–Swedish electricity certificate market. The increased portion of new renewable generation is expected to increase the surplus in the Nordic system. The electricity price in Norway is low compared to other countries in Europe, as hydropower is the price setter in most hours.

In the United Kingdom, 36% of the total generated electricity was generated from coal, 28% from natural gas, 21% from nuclear and 17% from renewables in 2013 (Department of Energy and Climate Change, 2015). The government is also investing in a new nuclear power plant, Hinkley Point C, to secure supply as most of UKs existing nuclear stations are due to close before 2023. A capacity market will be introduced in December 2014 to create incentive to invest in new generation. The UK chose to introduce a price floor of 18 £/tCO_2 for all market participants to give an incentive to invest in low-carbon power generation.[1]

In Germany, 48% of the total generation was generated from coal, 28% from renewables, 17% from nuclear and 6% from natural gas in 2013. Germany actually has a target of consuming 80% of its total electricity consumption from renewables by 2050. To this end, Germany has introduced a feed-in-tariff aimed to accelerate investments in renewable energy by providing a fee above the retail electricity price. This is a part of the Energiewende in Germany, the transition of the power sector from nuclear and coal to renewables.

The financial crisis has stalled investments in new generation capacity and reduced demand for electricity. This in combination with increased deployment of wind and solar generation, the evolution in the costs of gas and coal, and the low carbon price have resulted in reduced wholesale electricity prices in Germany (European Commission, 2015).

3. Policy uncertainty

The European Union introduced the EU2050 target to make the transition to a competitive low-carbon society by 2050. As a consequence of the framework, the energy markets have experienced extensive changes during the last decades, creating an uncertain environment for investors. This paper focuses on what we consider the two main sources of policy uncertainty in EU during the next 45 years; the future of the EU ETS and the possible introduction of capacity remuneration mechanisms. The EU ETS was implemented to reach the 2050 target of 80% emission reduction compared to 1990 levels (European Council, 2014). Today it is not incentivising much emission reductions due to the low carbon price. If it fails to increase the incentive to invest in green technology, it is expected that it will be reformed or replaced with another type of scheme. In addition, several countries have either implemented capacity markets or are considering it because they are concerned for their security of supply.

3.1. EU emission trading system

The EU ETS was started in 2005 and is the largest cap-and-trade scheme in the world. An absolute quantity limit (or cap) on CO_2 emissions is placed on 12000 emitting facilities located in the EU. This constitutes 45% of the total carbon emissions in the EU. These facilities must measure and report their CO_2 emissions and subsequently surrender an allowance for every ton of CO_2 they emit during annual compliance periods.

The carbon price fell from almost 30 €/tCO_2 in mid-2008 to less than 5 €/tCO_2 in mid-2013 as there was a surplus of 2 billion allowances in 2013. The surplus has primarily been built up as a reaction to the financial crisis. It led to a reduction of industrial production, emissions, and thus the demand for allowances. The supply of allowances for 2008–2020, which is based on a much better outlook for the economy, is fixed. This has led to a low carbon price, which weakens the incentive for emission-saving investments.[2]

The short-run effect of an increase in CO_2-prices in EU ETS is an increased electricity price. However, long term effects depend on investment reactions, which in turn is highly dependent on governmental policies. The future

[1] *Carbon price floor: reform and other technical amendments* published by the British government https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/293849/TIIN_6002_7047_carbon_price_floor_and_other_technical_amendments.pdf.

[2] The web page of European Commission on EU ETS http://ec.europa.eu/clima/policies/ets/reform/index_en.htm

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