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Assessing cross-border integration of capacity mechanisms in coupled electricity markets

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ABSTRACT

There is momentum in a number of European electricity markets towards the implementation of national generation capacity mechanisms. This renewed interest in capacity mechanisms raises the question of the cohabitation of both relatively well-integrated short-term energy markets and national generation capacity mechanisms. This paper examines a key issue of generation adequacy policies in a multi-market environment: the effect of foreign generators' and interconnectors' inclusion in national capacity mechanisms. The results show that the absence of cross-border participation could lead to significant social welfare losses associated with over and under-capacity procuring risk. This implies a vicious circle: as capacity mechanisms over or under-procure capacity, cross-border trade of electricity becomes more distorted, which in turn undermines the effectiveness of capacity mechanisms themselves. The findings also show that the inclusion of interconnectors in national capacity mechanisms could induce investments in merchant interconnections by compensating for network externalities and adjusting profit levels on the basis of the interconnection costs. However, despite the participation of interconnectors in capacity mechanisms, the exclusion of foreign generation of this market-based scheme undermines efficiency. In the absence of a wider EU single capacity mechanism, the inclusion of foreign generators and interconnectors in national capacity mechanisms should ensure the most efficient cohabitation of the EU Single Market and national capacity mechanisms.

1. Introduction

To date, a large number of EU members have already implemented a certain type of capacity remuneration policy or are considering doing so to address national generation adequacy concerns.[1] The functioning principles and the pace of implementation of the capacity mechanisms differ considerably from one country to another, as they are being driven by case-by-case scenarios to achieve the best fit to the local requirements. The specifics of market-based capacity mechanisms range from the central buyer solution, such as the capacity auction implemented in GB in 2014, to the supplier obligation solution, such as the decentralised capacity market implemented in France in 2016 (De Vries, 2007; Finon and Pignon, 2008; Cramton et al., 2013). Alternatively, a targeted mechanism for strategic reserves exists or is being installed in several European countries such as Sweden, Finland, and Poland. Thus, capacity mechanisms can either remunerate all generation or demand contributing to the long-term security of supply (capacity markets), or can contract generation assets that will only be used if markets no longer clear or if the price exceeds a strike price (strategic reserves). These differences suggest that there is no standard design of capacity mechanism and that a consistent European solution for capacity remuneration, therefore, is unlikely in the short-term.

Through the Energy Union strategy (EC, 2015a) and the so-called "Winter Package" of energy laws (EC, 2016a), the European Commission (EC) has raised concerns that the security of supply goal may be undermined by the fact that market design decisions are made at the national level and are weakly harmonised across Europe.[2] The EC is of the view that uncoordinated capacity mechanisms may distort cross-border trade and hinder the achievement of the Internal Electricity Market in Europe. Therefore, market capacity mechanisms must be

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[1] Capacity market is not a new concept. Several markets in the US and South America have implemented capacity markets with varying degree of success (Cramton et al., 2006; Barroso et al., 2007; Finon and Pignon, 2008; Joskow, 2008).

[2] EC also launched in April 2015 a sector-wide inquiry (EC, 2015b, 2016b, 2017) into capacity mechanisms. The inquiry gathered information on capacity mechanisms to examine whether they ensure sufficient electricity supply without distorting competition. It was initially focus on Belgium, Croatia, Denmark, France, Germany, Ireland, Italy, Poland, Portugal, Spain, and Sweden. The EC's final report points out that many Member States currently have inadequate security of electricity supply frameworks in place and they use outdated and inconsistent approaches to assessing security of electricity supply. It also states that Member states must not restrict capacity in their territory from participating in foreign capacity markets.

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open to explicit cross-border participation in order to minimise distortions to cross-border competition and trade, ensure incentives for continued investment in interconnection and reduce the long-term costs of European security supply (ACER, 2013; EC, 2016a, 2016b).

Still from the EU perspective, the Third Package[3] (EC, 2009) promotes the European Electricity Target Model (ETM),[4] which aims to enhance competition by opening the national markets to foreign participants, thereby increasing supply security and cost efficiency. By design, the ETM, optimises cross-border flows by combining the demand and the supply curves for electricity of coupled markets to set market clearing prices, with and without cross-border transmission constraints. Under the ETM, if two neighbouring countries experience a stress event simultaneously, power would tend to flow out of the country with the lowest prices, irrespective of whether that country had called upon its capacity providers to deliver greater supply.[5] However, the cohabitation of the ETM and capacity mechanisms raises concerns about the reliability of the direction of flow for an interconnector during a period of power system stress (RAP, 2013). Because congestion in the interconnections split the collective good "adequacy" between interconnected markets, if power is going to flow according to the ETM it might be difficult for a foreign generator to take on an obligation that is beyond their control (Cramton et al., 2013; Finon, 2014). While the risk of coincident stress events and/or market inflexibilities may be relatively small, these are genuine risks and impact short- and long-term efficiency.

Several possible approaches may be adopted to address the question of the cross-border competition in an interconnected electricity market with capacity mechanisms. These approaches take into account different methods of cross-border participation in capacity mechanisms: i) the statistically likely contribution from interconnectors (i.e. implicit cross-border participation with no trade of capacity rights); ii) the explicit participation of the interconnectors in capacity mechanisms; iii) the actual cross-border participation of foreign generation capacity under heterogeneous capacity mechanism; iv) the actual cross-border participation of foreign generation capacity under harmonised capacity mechanisms and; v) the implementation of pan-European capacity mechanism.

In practice, European countries started implementing capacity mechanisms under purely national schemes without providing for a remuneration of cross-border capacity (e.g. GB, France, Nordic Countries and Italy).[6] The most used approach has been an implicit methodology, which calculates the statistically likely contribution from interconnectors when deciding the domestic generation capacity to procure. However, several countries are currently considering adapting their capacity mechanisms to cross-border capacity participation (AEEG, 2013; DECC, 2013a, 2013b; RTE, 2014; EC, 2015b, 2016b, 2017).

In the GB capacity mechanism, for example, interconnectors are eligible to bid into the capacity auction since 2015 for the delivery year 2019/2020 onwards and have the same obligations to deliver energy than conventional generation capacity.[7] The interconnectors are the bidding parties and become the holder of a capacity agreement up to the level of the de-rated capacity. They receive the clearing price in the auction and hold the capacity obligation in line with the requirements for the other technologies. This modification in the market design has also raised the interest of merchant interconnectors[8] seeking additional revenues to cover their capital cost. From the public authorities' perspective, it is presented as an opportunity to deal with the lack of interconnector investments, which has been commonly pointed out as one of the main barriers towards an efficient integration of the European electricity markets.

The impact assessment of the interaction of capacity mechanisms in a multi-market environment has been a critical issue for consideration among regulators, policy makers and academics when designing and implementing generation adequacy policies. Although most previous researchers have centred on the heterogeneity of the capacity mechanisms in interdependent electricity markets and the relevance of the cross-border generation participation (Cepeda and Finon, 2011; Finon, 2014; Meyer and Gore, 2015; Viljainen et al., 2013), little attention has been focused on the dynamics of the market interconnection and its impacts on the long-term equilibrium in coupled markets with capacity mechanisms. While externalities generated by the use of the interconnectors for trade between markets, such as deferring generation investments and contributing to reliability, lead to sub-optimality of interconnector investment[9]; this paper argues that cross-border participation in capacity mechanisms partially corrects for these externalities.

The purpose of this paper is to investigate a key issue of generation adequacy policies in a multi-market environment: the effect of both foreign generators and interconnectors' inclusion in national capacity mechanisms. For this, four different cases are examined: (Case 1 – reference case) two inter-linked markets with interconnector and foreign generation participation in capacity mechanisms; (Case 2) two inter-linked markets with interconnector participation but without foreign generation participation in capacity mechanisms; (Case 3) two inter-linked markets without any type of cross-border generation participation in capacity mechanisms; and (Case 4) one energy-only market linked with one market with capacity mechanism without any type of cross-border participation in capacity mechanism. The purpose here is to compare over time the dynamic evolution in two inter-linked markets for these different cases, assessing the economic performances of different policies (e.g. the evolution of the generation technology mix, the reliability criteria, and the overall social welfare).

The analysis relies on a long-term dynamic model of two inter-related markets to assess different cross-border generation adequacy policies. The model is based on Cepeda and Finon (2011) and is expanded to incorporate both strategic bidding behaviour in the energy market and endogenous development of the interconnection capacity. It has been developed using concepts and tools from system dynamics, which is a branch of control theory applied to economic and management problems. This methodology has been extensively used in electricity market modelling to represent capacity expansion planning in wholesale markets (Forrester, 1961; Bunn and Larsen, 1992; Ford, 1997, 1999; De Vries and Heijnen, 2008; Cepeda and Finon, 2011). The following section examines the question of competition among interconnected electricity markets with capacity mechanisms and merchant interconnectors. Section 3 describes the long-term dynamic model of

[3] The term "Third Package" refers to a package of EU legislation on European electricity and gas markets that entered into force on 3 September 2009.

[4] The ETM is set out in the Framework Guideline on Capacity Allocation and Congestion Management for Electricity (CACM FG) published by the Agency for the Cooperation of Energy Regulators (ACER) in July 2011.

[5] If energy prices reach the same price cap in both markets, there will be an indeterminacy and a tie-breaking rule would be necessary (Mastropietro et al., 2015). It is worth noting that price caps in the day-ahead and intraday markets in Europe were unified under the framework of the Capacity Allocation and Congestion Management Regulation. It has decided to set the maximum and minimum clearing price for single day-ahead coupling to €3000/MW h and − €500/MW h respectively, and for single intraday coupling to €9999/MW h and − €9999/MW h respectively.

[6] The former capacity payment in Ireland considered cross-border participation. The new Irish capacity market will also allow cross-border participation.

[7] Interconnectors were unable to participate in the first capacity auction held in December 2014. Amendments to the Regulations have been laid in Parliament to enable interconnectors to participate in the Capacity Market. https://www.gov.uk/government/news/interconnectors-to-participate-in-the-capacity-market-from-2015.

(*footnote continued*)

[8] Merchant interconnectors are considered as a commercial alternative to regulated TSO investments. Unlike regulated interconnectors, merchant interconnectors are repaid through congestion revenues over the interconnector instead of the regulated transport tariff. Merchant interconnectors may be granted exemptions from regulations such as: tariff, regulation, non-discriminatory third-party access and ownership unbundling.

[9] Interconnection investments provide another externality. It reduces market power in the generation market by creating additional options for meeting domestic demand (Stoft, 2002; Stoft, 2006; Borenstein et al., 2000).