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An analysis of design options for markets for cross-border balancing of electricity

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ABSTRACT

A set of design variables is used to define balancing market design. Performance criteria are defined and the market designs are evaluated using weights and scores for each performance criterion. It is concluded that solutions based on trading between Balancing Service Providers and Transmission System Operators will reduce socio-economic welfare. Major causes for this result are a reduction of the effectiveness of the balancing markets, a reduction in balancing planning accuracy, a reduction in price efficiency and a decrease in dynamic efficiency. The designs with a Common Merit Order List perform well in the evaluation, although reservation of cross-border capacity will be a challenge.

1. Introduction

With the objective to increase the efficiency of the European electricity market, the EU is moving in the direction of a single electricity market, enabling electricity trade with the EU similar to trade in goods and services, helping to keep prices as low as possible and to increase standards of service and security of supply. Directive 2003/54/EC concerning common rules for the internal market in electricity, gave common rules for the internal electricity market. This Directive aimed to ensure a level playing field in generation and to reduce the risks of market dominance, to provide third-party grid access rights, to protect the rights of small customers and to disclose information on energy sources for electricity generation, among others. It was subsequently repealed by Directive 2009/72/EC that strengthens these issues and also puts major weight on unbundling of generation, grid related activities and supply and on the establishment of national regulators. However, these Directives focus more on common rules than on actual integration.

The European Regulators' Group for Electricity and Gas (ERGEG) agreed in the spring of 2006 to launch an initiative to create seven regional energy markets in continental Europe as an interim step aimed to remove barriers for cross-border trade within those regions. Examples of regional markets in Europe are the Nordic market (Nord Pool), the Central Western European (CWE) market coupling, and the Iberian market between Spain and Portugal. The CWE region is now integrated with the Nordic region through a so-called Interim Tight Volume Coupling. Finally the connection of NorNed[1] to the CWE market coupling in 12 January 2011 created an integrated day ahead market for 9 countries.

Abbreviations: ACE, Area Control Error; AGC, Automatic Generation Control; AVP, Additional Voluntary Pool; BE, Balancing Energy; BEE, Balancing Energy Exchange; BEM, Balancing Energy Market; BRP, Balance Responsible Party (a market participant or its chosen representative responsible for its imbalances); BSP, Balancing Service Provider (a market participant providing balancing services to one or several TSOs); CBC, Cross Border Capacity; CWE, Central Western European; EMCC, European Market Coupling Company (provides congestion management services for the electrical transmission networks by means of market coupling in the Central Western European and Nordic systems); ENTSO-E, European Network of Transmission System Operators for Electricity (represents all electricity TSOs in the EU for all their technical and market issues); ERGEG, European Regulators' Group for Electricity and Gas (a formal advisory group to the European Commission created in 2003, and subsequently dissolved in 2011 after the creation of ACER, the Agency for the Cooperation of Energy Regulators); ETSO, European Transmission System Operators (the former association of European transmission system operators founded in 1999 in response to the emergence of the internal electricity market, later merged into ENTSO-E); HVDC, High Voltage Direct Current; IEA, International Energy Agency; MOL, Merit Order List; PTU, Program Time Unit; RC, Reserve Capacity; RCM, Reserve Capacity Market; TSO, Transmission System Operator; UCTE, Union for the Coordination of the Transmission of Electricity (now merged into ENTSO-E).

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[1] NorNed is the 700 MW HVDC interconnection between the Netherlands and Norway.

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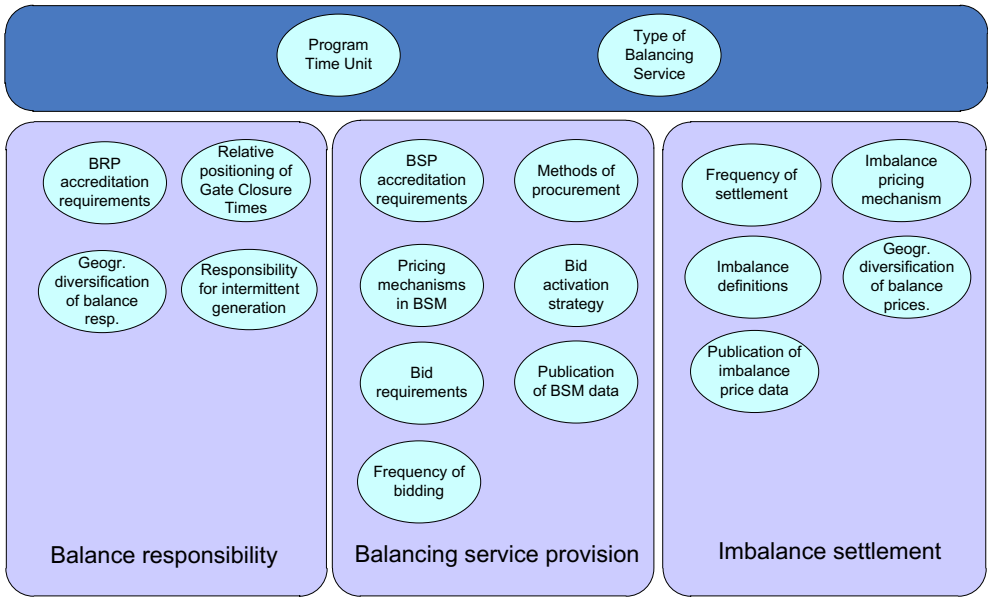

Fig. 1. Design variables for Balancing Markets (Doorman et al., 2011).

Although these developments show that electricity markets in Europe are increasingly integrated, a corresponding integration of balancing markets has just begun. According to ERGEG (2009), lacking integration of balancing markets is a key impediment to the development of a single European market. Balancing markets are still highly concentrated in many countries and integration will increase competition and lower prices. In addition, increased production from wind and solar leads to more variable and less predictable generation patterns (IEA, 2009). This in turn will increase the need for balancing services that may become expensive and difficult to deliver by one country alone.

Several entities have published reports, guidelines and position papers on cross border balancing. ETSO (2006) identifies the main challenges for cross-border trade of tertiary reserves being product compatibility, differences in price structure and differences in the procurement positions of the TSOs. The report identifies three technical models without explicit recommendations for any of these. ETSO (2007) states that the main drivers for regional integration processes are competition and efficiency. The need for harmonization is also identified. A reference model is defined and three different integration steps are described, respectively pooling of reserves, sharing of reserves and regional control. ERGEG (2009) addresses roles and responsibilities of stakeholders, cross border capacity, cross border procurement of reserve capacity, design aspects and transparency and monitoring. ACER's Framework Guidelines on Electricity Balancing (ACER, 2012) specifically address the roles and responsibilities of stakeholders involved in electricity balancing and the procurement of reserve capacity. Eurelectric, the Union of the Electricity Industry, a sector association which represents the common interests of the electricity industry at pan-European level, describes in Eurelectric (2008) the final structure of their preferred reserves and balancing market based on a number of core principles. The specific focus is on maintaining the traditionally high security of supply and the use of market based mechanisms and the role of the TSO. In its response to ACER (2012), Eurelectric emphasizes that "It is remarkably positive that the FG Balancing shows a clear preference for harmonisation, cost-effectiveness and cross-border trade, which EURELECTRIC strongly supports." ENTSO-E (2011) aims at outlining this organization's initial views regarding cross-border balancing with focus on the TSOs' responsibility for the safe and secure operation of electricity transmission systems, maintaining security of supply and the need for a common target model. For cross-border exchanges of reserves, ENTSO-E recommends cross-border bilateral or multilateral reserve trading, while for cross border exchanges of balancing energy, ENTSO-E recommends a multilateral model without common merit order.

The scientific literature on cross-border balancing is still relatively scarce. Madlener and Kaufmann (2002) state that on the European level, balancing markets have a potential to add liquidity to the wholesale electricity trade, without requiring additional infrastructure investments. Vandezande (2011) focuses both on the current national balancing markets in Europe and the multinational cross-border balancing markets. She suggests a proposal for appropriate national balancing marker design, ensuring both market based balancing services procurement and cost reflective real-time prices. She studies several market designs similar to those in the present paper. Also, Vandezande et al. (2009) show that cross-border balancing between the Netherlands and Belgium is an achievable goal that does not need unrealistic or elaborative efforts. Van der Veen et al. (2010) carry out a qualitative analysis for each arrangement based on the designated performance criteria for cross-border balancing. Jaehnert and Doorman (2010) describe a model of an integrated northern European balancing power market, including generation scheduling and unit commitment. Van der Veen et al. (2011a, 2011b) conduct an agent-based model to evaluate the effect of the main cross-border balancing arrangements. Abbasy et al. (2011) carry out an agent based simulation to study the potential effect of the BSP-TSO cross-border balancing arrangement between Norway and the Netherlands.

In the present work we use a framework of design variables to describe the design space of first national (or single Control Area) balancing markets and subsequently cross-border balancing markets. The approach makes an explicit distinction between reserve capacity and balancing energy. Reserve capacity is secured by the TSOs to have access to power capacity for control purposes in their control area, while balancing energy is activated from the reserve capacity (or other available resources) by the TSOs in real time to maintain the balance within their control area (ENTSO-E, 2011).

The contribution of this paper is three-fold. Firstly, we explicitly define a range of design variables for balancing markets. Although this has been done implicitly in other references, we believe that