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Harmonization and integration of national balancing markets in Europe – Regulatory challenges

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SUMMARY

A 'balancing market' can be defined as an institutional arrangement that establishes market-based balancing, and consisting of three main pillars: balance responsibility, balancing service provision, and imbalance settlement. In today's liberalized power markets, balance management is becoming increasingly market-based.

Recently, the integration of balancing markets has received the interest of the European Commission, TSOs, and the electricity industry itself. Balancing market integration can be regarded as a logical next step after day-ahead and intraday market integration (coupling) to establish a single Internal Electricity Market for Europe. It is believed to reduce balance procurement costs, as a result of increasing competition in balancing service markets.

Balancing market internationalization of currently national European balancing markets contains the notions of harmonization and integration. Harmonization focuses on equalization of the important balancing market rules; integration on the facilitation of cross-border balancing service trade by means of balancing service market integration.

The realization of balancing market harmonization and integration both require the reaching of agreement by TSOs and regulators on a variety of balancing market rules, which forms a large regulatory barrier for balancing market internationalization. In addition, balancing market integration involves new technical and market arrangements related to cross-border balancing service exchange, which translate into further regulatory changes. Another regulatory challenge is the development of supranational (regional) legislation on balance management. Viewing the uncertainty and variety existent in balancing market design, it will take some time before balancing markets in Europe will be harmonized and integrated, but experience from the Nordic system and Germany shows that the challenges can be overcome.

KEYWORDS

Balancing market, market integration, harmonization, power markets, electricity policy

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1. INTRODUCTION

Balance management entails the continuous balancing of power supply and demand, and is necessary for the safeguarding of security of electricity supply. We define a *balancing market* as an institutional arrangement that establishes market-based balancing in deregulated power markets.

In Figure 1 we have outlined the basic structure of a balancing market: the fundamental elements and their interrelations. The basic structure and definitions are described in several European documents on balance management [2]-[4],[6],[7].

The balancing market consists of three main pillars: balance responsibility, balancing service provision, and imbalance settlement. Control can be viewed as a fourth pillar, but is outside the scope of this paper. There are three main actors involved: the Transmission System Operator (TSO), the Balance Responsible Party (BRP), and the Balancing Service Provider (BSP).

In many markets, BRPs are obliged to comply to their bids in the day ahead market and/or plans submitted to the TSO. In the Netherlands this is materialized through so-called energy programs for each Program Time Unit (PTU), and we will use the term energy program generically. An energy program is thus here to be understood as the balanced sum of production, trade, and consumption for each PTU. BSPs submit balancing service bids to the TSO. A basic distinction is made between reserve capacity and balancing energy, where the first ensures the availability of balancing energy, and the second is used to restore the system balance in real-time. Selected reserve capacity bids bring 'contracted' balancing energy bids into the balancing energy market. The activation of balancing energy bids in a specific PTU leads to a certain balancing energy price, on which the imbalance price is based.

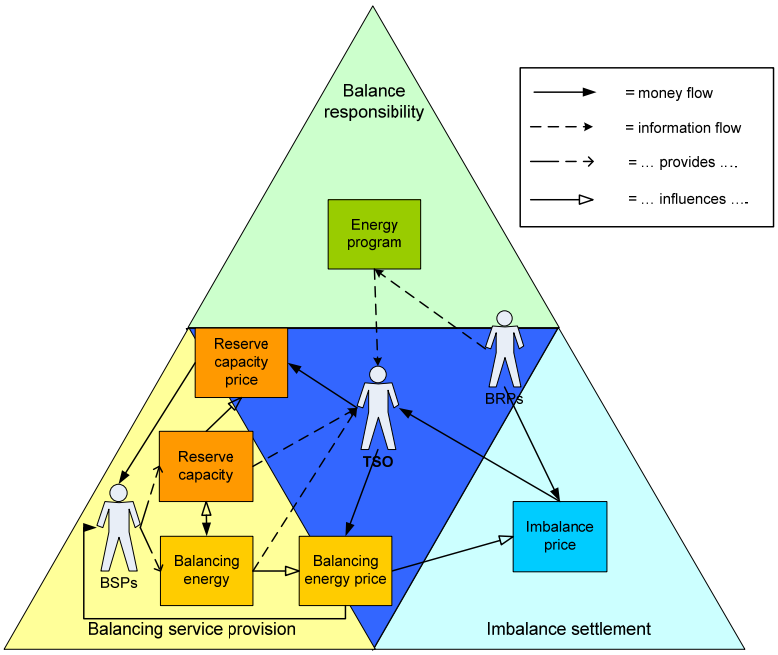

Figure 1: Basic structure of a balancing market

Balancing market integration has recently received interest in Europe, especially from the European Commission and from TSOs, since 2009 organized in ENTSO-E. The main goal of the European Union regarding the power sector is to create a single Internal Electricity Market for Europe, cf. EU electricity directive 2009/72/EC [1]. Currently, day-ahead markets of different European countries are increasingly coupled to form 'regional' markets, an intermediate step towards an Internal Electricity Market. Logical next steps would be the

integration/coupling of intraday markets, and subsequently internationalization of balancing markets. According to ERGEG, the European Regulators Group for Electricity & Gas, 'a lack of integration of balancing markets is a key impediment to the development of a single European electricity market' [2].
The objective of balancing market integration is to reduce balancing procurement costs due to the more efficient, regional activation of balancing energy bids [2]-[4]. Although the costs reductions are constrained by the availability of interconnection capacity between control areas, balancing market harmonization and integration is expected to improve short-term power market functioning by increasing competition in both balancing service markets and day-ahead and intra-day markets. The aim of this paper is to discuss the regulatory challenges for balancing harmonization and integration in European power markets.

2. BALANCINGING MARKET HARMONIZATION AND INTEGRATION

Regarding internationalization of national balancing markets, we distinguish between harmonization and integration. *Balancing market harmonization* relates to equalization of balancing market rules of all balancing market pillars. *Balancing market integration* focuses on the facilitation of cross-border balancing service trade by means of the integration of balancing service markets. Integration can also be considered to be a shift of rules from the national to the supranational level. In addition, integration requires changes in the market architecture, while harmonization only increases the uniformity of (still national) rules.
The European Commission aims at both harmonization and integration of balancing markets, because both contribute to the development of an Internal Electricity Market, cf. Figure 2 and Table I. Harmonization creates a level-playing field for balancing market parties (BRPs and BSPs), and contributes to the primary goals of transparent and non-discriminatory markets. Integration creates multinational markets, and contributes to the goal of competitive markets. An important distinction between balancing market harmonization and integration is that integration requires (some) harmonization, and therefore is a more advanced, complex and influential step than harmonization.
Balancing market harmonization and integration are related but different notions of 'internationalization' of balancing markets, in terms of impact, but also in terms of implementation. This distinction is also acknowledged by ERGEG, who uses instead of harmonization the term 'compatibility' [2].

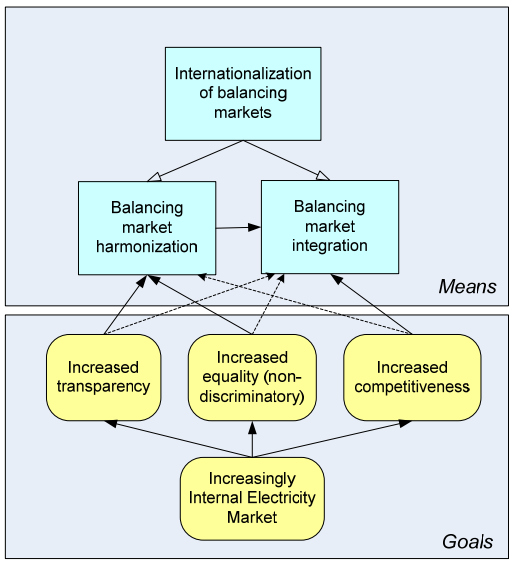

Figure 2: Subject of balancing market internationalization

Table I: Paragraph of EU electricity directive concerning balance management

"*Rules adopted by transmission system operators for balancing the electricity system shall be objective, transparent and non-discriminatory, including rules for the charging of system users of their networks for energy imbalance. Terms and conditions, including rules and tariffs, for the provision of such services by transmission system operators shall be established pursuant to a methodology compatible with Article 23(2) in a non-discriminatory and cost-reflective way and shall be published*." ([1], article 11, sub 7)

3. REGULATORY CHALLENGES OF HARMONIZATION

We can say that the balancing market design is determined by the values of a number of *design variables* that together define the balancing market *design space*. Based among others on references [5]-[7], the most important balancing market design variables are summarized in Table II.

There are two general design variables. The Program Time Unit is the basic time unit used in the balancing market; energy programs and balancing service bids are submitted for each PTU. Product definitions are the definitions used for different types of balancing services. A distinction is made between primary, secondary and tertiary control [8]. As remarked in Section 1, the distinction between reserve capacity and balancing energy is fundamental, and is not related to a specific variable.

Within the area of balance responsibility, there are two important design variables, the gate closure times (GCTs) for the energy programs of the BRPS and the imbalance definitions. The initial gate closure time is the time at which BRPs must submit an initial energy program, usually at the day-ahead (D-1), after closure of the day-head spot market. The final gate closure time is the time at which energy programs become final, typically one hour before the PTU of delivery. 'Imbalance definitions' is about the definition of different types of balances that BRPs can have responsibility for. Two basic options are separate balances for production, consumption/trade (like in the Nordic system), or one total balance.

With respect to balancing service provision, there are five important design variables. Except for 'reserve requirements', these are applicable to both reserve capacity and balancing energy. The 'procurement mechanism' indicates the main method of acquirement of reserve capacity and dispatch of balancing energy. The basic options are bilateral contracting or auctions. In addition, bidding by BSPs can be compulsory or voluntary. 'Reserve requirements' are the required quantities of reserve capacity of each category. 'Timing of balancing service markets (BSMs)' is about two main time aspects of balancing services markets. Firstly, the position of the gate closure times of these markets relative to each other, to real-time, and to day-ahead and intraday markets. Secondly, the frequency of bidding in reserve capacity and balancing energy markets. 'BSM pricing mechanisms' describe the principles for the payment of the BSPs. 'Bid requirements' define the requirements that bids must meet in the balancing service market.

Imbalance settlement is defined by two important design variables. The first, 'imbalance pricing mechanism', is about the rules for calculation of the price for imbalances. Firstly, there could be a different price for positive and for negative imbalance (dual pricing), or the same price (single pricing). Secondly, prices could be based on balancing energy prices, or also on day-ahead/intraday prices. Finally, different imbalance prices could be applied to different types of balances (see the variable of 'imbalance definitions'). The design variable 'frequency of settlement' is about how often the imbalance costs between BRPs and the TSO are settled.

Table II: Important design variables for balancing market harmonization

Variables	Explanation
General	
o Program time unit (PTU)	Basic time unit; used for energy programs and bids
o Product definitions	Definitions of different types of balancing services, notably primary, secondary and tertiary control
Balance responsibility	
o Energy program gate closure times	The initial and final GCTs for the energy programs submitted by the BRPs
o Imbalance definitions	Defined BRP balances, notably a total balance or separate balances for production and consumption
Balancing service provision	
o Procurement mechanisms	Bilateral vs. tender; compulsory vs. voluntary
o Reserve requirements	Security-related reserve capacity requirements for control areas, notably on available volumes
o Timing of BSMs	Order and moment of GCTs of balancing service markets; frequency of bidding
o BSM pricing mechanisms	Pay-as-bid pricing, average pricing or marginal pricing
o Bid requirements	Requirements for balancing bids regarding volume, price, grid location, activation speed, duration, etc.
Imbalance settlement	
o Imbalance pricing mechanism	Mechanism for determining the imbalance prices
o Frequency of settlement	Frequency of imbalance settlement, notably weekly, bi-monthly or monthly

There are significant differences between the values of these design variables in the present European control areas, reflecting the differences in the design of their balancing markets. E.g. PTUs of 15, 30, and 60 minutes are ued, gate closure times vary widely, total balances and separate balances are used, bidding frequencies are from bi-annualy to daily etc. These differences constitute major challenges for balancing market harmonization. Practical complications specifically occur with respect to the Program Time Unit, reserve requirements, product definitions and bid requirements.

In reality, the PTU is one of the ways the balance responsibility is divided between the TSO and the market. The BRPs are responsible for the net energy volume deviations over whole PTUs, whereas the TSO is responsible for the instantaneous power deviations within the PTU, as well as for the transition from one PTU to the next. Thus, a smaller PTU gives more balance responsibility to the market (but also creates more program steps per day). A change of PTU in one control area to facilitate internationalization may therefore incur objections from several stakeholders.

The minimum reserve requirements are defined for the synchronous system and divided between control areas. However, TSOs of individual control areas may increase these minimum quantities, and define specific requirements with respect to regulation speed, response times etc, based on their particular philosophy for system operation as well as the characteristics of the power system. There may also be specific bid requirement for a control area. The TSO may object to harmonization of such requirements on the basis of a perceived risk for a deterioration of system security. Also BSPs may resist because they may lose market opportunities for the sales of balancing services, or because of the need to make expensive investments to satisfy new requirements.

There are different but related reasons why the stakeholders (TSOs, regulators, BRPs, BSPs) would object to balancing market harmonization. Harmonization will change the preferred design adjusted to the particular situation in the control area. Indeed, harmonization may reduce some aspects of balancing market performance in a control area 'Losing' TSOs and regulators will object to this. In addition, stakeholders that currently benefit from a lack of transparency, equality or competitiveness, including market participants with market power, have an interest to obstruct harmonization efforts. Therefore, it is not unlikely that many countries will advocate their own design, turning balancing market harmonization in a political power struggle. Reaching an agreement is hard, as there are a lot of design variables that need to be harmonized. Viewing all this, it is unlikely that balancing markets will be harmonized at once. A stepwise approach is more likely, as illustrated by the Nordic experience, and the present efforts in Germany. In the Nordic case, a common merit order list was introduced in 2002, while harmonization of most of the other variables was realized first in 2009. Three of the German control areas have moved from limited cooperation to ACE netting (cf. the next Section) and then to common procurement of reserve capacity [10], while further integration is proposed.

4. REGULATORY CHALLENGES OF INTEGRATION

The most important design variables for integration based on [5]-[7] are presented in Table III. While the balancing market design variables in Table II are of a national (or single control area) character, the variables in Table III focus on the international (regional or multi control area) context.

Three general design variables are particularly important to balancing market integration. The 'definition of balancing regions' defines the geographical scope of balancing. According to ENTSO-E, a control area is 'a coherent part of the ENTSO-E interconnected system, operated by a single TSO, with physical loads and controllable generation units connected within the control area'. A control area sets the geographical boundaries of balance management. Following [6], we define a 'balancing region' as a number of control areas with a common balance management. So a balancing region can correspond to one (today’s normal situation) or several control areas. In the latter case, the distribution of reserves must take into account transmission constraints between (and within) the control areas. The 'organizational structure of system balancing' is about the division of roles and responsibilities between different TSOs in the various balancing market processes. The variable 'national vs. supranational regulation' is about the existence and content of national and international legal rules on balance management.

With regard to the three main balancing market pillars, the most important variables for integration relate to balancing service provision. The 'regional distribution of reserves' is about the specific distribution of reserve capacity among control areas, and on a larger scope within the synchronous area. In the ENTSO-E synchronous zone, this is governed by guidelines in the ENTSO-E Operational Handbook [8]. 'Regional balancing service market arrangements' is about the main alternative regional market arrangements that have large implications for balancing market design and performance. The main arrangements are [5]-[7], [9]:

- Area Control Error netting, the combination and redistribution of ACEs of two neighbouring control areas with opposite system imbalances
- BSP-TSO trading, enabling BSPs to bid into foreign balancing service markets
- Additional voluntary pool, a regional balancing service market where TSO share bids on a voluntary basis

- Common Merit Order List, the merging of the control area bid ladders into one regional bid ladder

Finally, 'cross-border capacity reservation' concerns if and to what degree interconnection capacity is reserved for balancing purposes. Typical values for this variable may be e.g. 'None', 'Daily' or 'Long term'.

Table III: Relevant design variables for balancing market integration

Variables	Explanation
General	
o Definition of balancing regions	A balancing region can correspond to one control area or multiple control areas with some common balance management functions
o Organizational structure of system balancing	Division of roles and responsibilities between different TSOs and possible administrators
o National vs. supranational regulation	Form and content of regulation on national and supranational level
Balancing service provision	
o Regional distribution of reserves	The distribution of the physical reserves between control areas and behind often congested interconnections
o Regional balancing service market arrangements	Main market arrangements for the exchange of balancing services
o Cross-border capacity reservation	The reservation of cross-border capacity for balancing purposes

There are two fundamental barriers to the integration of balancing markets: integration requires a certain level of harmonization of rules and there should be available cross-border capacity for the exchange of balancing services.
The harmonization of at least some design variables is necessary before it is possible to start with integration. As a minimum, the control areas should have the same PTU and similar bid requirements. Also the procurement mechanisms should be compatible. Although the Nordic experience has shown that there can be a considerable degree of integration between balancing markets without full harmonization, there is no doubt that harmonization creates a more level playing field and less arbitrage opportunities and a better functioning market.
In order to make the exchange of balancing services physically possible, there must be available cross-border capacity in the desired direction. International interconnections are often congested, and there is resistance to the reservation of cross-border capacity for balancing services [3], [7]. Increasing interconnection capacities is expensive and takes many years. It is therefore obvious that limited interconnection capacity can be a serious impediment to the integration of balancing markets. On the other hand, congestion occurs necessarily only in one direction at the same time, leaving ample opportunities for downward regulation in the congested direction and upward regulation in the opposite direction.
There are also practical complications concerning the definition of balancing regions, regional distribution of reserves, and regional balancing service market arrangements.
With respect to the definition of balancing regions, the merging of control areas reduces the required reserves according to ENTSO-E Policy 1, which defines the recommended amount of reserves as a function of the square root of the maximum load in the control area [8] leading to a lower requirement for the combined region. This may be one of the advantages of integration, but if many control areas integrate this may lead to a significant reduction of the

total reserves in the system and the recommended reserve amounts may have to be reviewed. Another complication is that the merging of control areas turns congested cross-borders into internal tie lines. The new balancing region may thus have several congested internal tie lines, and this must be handled in an efficient way in the balancing management.
The regional distribution of reserves is interlinked with the harmonization variable of reserve requirements. It is important that the necessary reserves in the combined balancing region are distributed in such a way that their availability is ensured given the actual congestion. Of course this is closely related to the previous variable. A solution will have to combine the procurement of reserve capacity within several areas with sophisticated secondary control algorithms. Such algorithms would have to handle the optimal use of available balancing resources within a congested balancing region, i.e. when selecting such resources from the bid ladder, bids causing congestion would be skipped.
Probably the biggest complication with respect to integration lies in the shaping of the regional balancing service arrangements. A stepwise approach e.g. as in the Nordic system or as proposed (and already partially implemented) for the German control areas in [10] has obvious advantages, giving TSOs and market participants in the cooperating control areas the opportunity to adapt to closer integration over time.
Regulatory challenges are related to paving the way for overcoming these barriers and solving the practical complications. More direct challenges are posed by the variables 'Organizational structure of system balancing' and 'National vs. supranational regulation'. With an increasing degree of balancing market integration, exchanges increase, and interrelations between system operators become more important as well. At some stage of integration, this will probably require a 'regional system operator' that coordinates the regional balancing, in interaction with the system operators responsible, who remain the main system responsible for their control area(s). This regional operator could be a new role of an existing TSO, or a new legal entity.
Related to this organizational structure is the national and supranational legal and regulatory landscape. With increasing integration, the introduction of a supranational code on regional balancing market design and functioning becomes more and more required. Although it might be possible to retain and harmonize national rules and regulations, this does not really tackle the 'regulatory gap' of cross-border issues in balance management. This notion is mentioned by ERGEG, who states that it must be clear which regulator has which competences, who handles conflicts, and who may approve or veto changes of balancing market rules [2]. The supranational legislation should be consistent with the legislation in the involved countries and be transparent.
A possible regulatory development is illustrated in Figure 3.

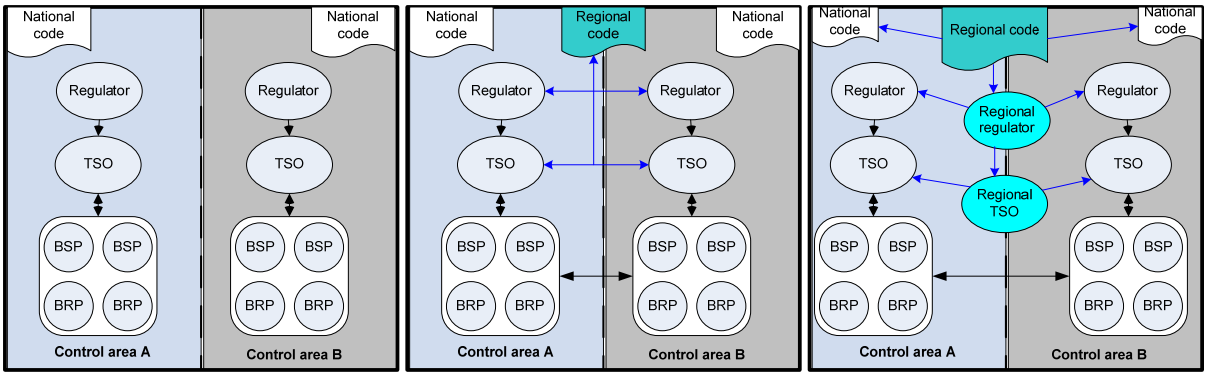

Figure 3: Regulatory regimes for an increasing degree of balancing market integration

5. CONCLUSIONS

Harmonization focuses on the equalization of rules for balance responsibility and imbalance settlement, and increases the equality of Balance Responsible Parties, not only in balancing service markets, but also in day-ahead and intraday markets. Integration focuses on the facilitation of cross-border balancing service exchange, improving competitiveness in those markets. Generally, integration requires at least some degree of harmonization.

The discussion of important design variables for balancing market harmonization reveals that the overall regulatory challenge is posed by the decision-making problem. Because of the variety of design options, differences in national system and market conditions, and different preferences, TSOs and regulators will not easily reach agreement on balancing market harmonization. The largest practical complications can be expected from the harmonization of the Program Time Unit, product definitions, reserve requirements, and bid requirements.

The discussion of important design variables for balancing market integration has shown that next to the existence of the same decision-making problems, there are some more practical barriers. These are related to the technical realization of cross-border balancing energy exchange of secondary control services, to the reservation of interconnection capacity for balancing service exchange, to the definition of control areas and balancing regions, to regional distribution of reserves, and to regional balancing market arrangements. However, all these translate (at least partly) into regulatory challenges: new rules, roles and responsibilities must be defined to establish a well-performing regional balancing market successfully.

Viewing the novelty, uncertainty and variety existent in balancing market design, it will take some time before balancing markets in Europe will be harmonized and integrated. On the other hand, experience from the Nordic system and Germany illustrates that the challenges may be overcome. Meanwhile, decision-makers should keep questioning what degree of balancing market harmonization and integration would best contribute to the EU goals of transparency, equality, and competitiveness.

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