Balance Responsibility and Imbalance Settlement in Northern Europe – An Evaluation

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Abstract— **In liberalized power markets, balance responsibility and imbalance settlement are two closely related elements that constitute the heart of a balancing market (which is actually an institutional arrangement establishing market-based balancing). This paper aims to compare balance responsibility and imbalance settlement in the Nordic region, Germany, and the Netherlands. For this purpose, an overview is given of existing design variables and variable values in Northern Europe. Furthermore, the effects of different variables and values on four identified performance indicators have been rated with the support of a causal diagram of the balancing system. We conclude that different design variables create large differences in balancing market performance in Northern Europe, with the Program Time Unit, the scope of balance responsibility and the main imbalance pricing mechanism having the largest impact.**

Index Terms**—balancing market, balance responsibility, imbalance settlement, balancing market design**

I. INTRODUCTION

MAINTAINING the continuous balance between electricity production and consumption is a system operation task of the Transmission System Operator (TSO) of a power system. We define a 'balancing market' as an institutional arrangement that establishes market-based balancing. A balancing market consists of three main elements. These are balance responsibility, balance regulation, and imbalance settlement, where balance regulation concerns the provision of balancing resources by market parties, and the other two elements concern making market parties responsible for balancing.

Balance responsibility holds that so-called Balance Responsible Parties (BRPs) are obliged to submit an energy program on the day before the day of delivery. In the imbalance settlement process, the BRPs are penalized with an imbalance price for deviation from this energy program, which gives them an incentive to balance their portfolio. Thus, these two balancing market elements are closely related, and form the heart of a balancing market.

In this paper, we compare balance responsibility and imbalance settlement in the Nordic region (Norway, Sweden, Finland and Denmark), Germany, and the Netherlands, which we will refer to as 'Northern Europe'. Our main goal is to explore the content and relevance of balancing market design. The evaluation of present differences in balance responsibility and imbalance settlement in Northern Europe will shed light on this.

First, Section II presents the main balance responsibility and imbalance settlement design variables. Then, Section III provides an overview of the present values of these variables among the North-European regions. Subsequently, Section IV presents a causal diagram of the balancing system, which identifies the basic system variables and causal relationships in the balancing market. From this, four performance indicators for balance responsibility and imbalance settlement are derived. In Section V, the effect of different variable values on these performance indicators are rated, which enables the evaluation of the different design variables and of present differences in Northern Europe. Finally, Section VI summarizes the findings and offers recommendations for further research.

II. DESIGN VARIABLES

From an extensive literature study on balancing markets, we have identified fourteen main design variables, six for balance responsibility and six for imbalance settlement. These design variables are listed in Table 1, and are explained below.

The first balance responsibility variable that is actually omnipresent in balancing markets is the *Program Time Unit (PTU)*. The PTU is the time unit for which energy programs are submitted on the day ahead by the BRPs to the TSO and the unit for which bids of regulation power are sent to the TSO (which is outside the scope of this paper).

The *scope of balance responsibility* indicates to what extent the market is made responsible for balancing by defining the nature and role of Balance Responsible Parties in the power system.

Looking at the process of notification, two important deadlines for BRPs are discernable. The first is the *gate closure time (GTC) for the first energy program*, i.e. the deadline for the submission of a first energy program by the BRP to the TSO. This deadline falls generally one day before

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Manuscript received April 23, 2009. This work is funded by the Next Generation Infrastructures Foundation, and part of the international project 'Balance Management in Multinational Power Markets'.

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the actual day of delivery, the ‘preparation day’, and applies to all PTUs for the day of delivery. It enables the TSO to check the day ahead system balance.

The second deadline is the *gate closure time (GTC) for the final energy program*, the time at which programs become binding and unchangeable. After the final GTC, the TSO becomes responsible for balancing. Usually, it is possible for BRPs to submit altered energy programs after the first GTC, for example when they have concluded new transactions or better consumption forecasts become available. The final energy program will be used for imbalance settlement.

In correspondence with the different power market functions of production, consumption and trade there can exist different types of balance responsibility for different functions. In other words, there can exist different *types of balances* in a balancing market. If not, there is a ‘total balance’, including production, consumption, and trade.

A last balance responsibility variable is concerned with the question whether or not it is allowed for BRPs to have energy programs without a net imbalance of zero, or in other words, to have an *open portfolio position* instead of a *closed portfolio position*. If a closed position is obligatory, energy programs with a net imbalance will be rejected by the TSO.

TABLE I
DESIGN VARIABLES FOR BALANCE RESPONSIBILITY & IMBALANCE SETTLEMENT

Balancing market elements	Balancing market variables
Balance responsibility	Program Time Unit (PTU)
	Scope of balance responsibility
	GTC first energy program
	GTC final energy program
	Types of balances
	Closed/open portfolio position
Imbalance settlement	Frequency of settlement
	Main imbalance pricing mechanism
	Regulation states
	Single/dual pricing
	One/two-price settlement
	Alternative imbalance pricing

In the imbalance settlement process, the deviation of the actual net energy exchange from the planned net energy exchange is settled between the TSO and BRPs by means of an imbalance price. This price is usually based on the clearing price in the regulation power market, and differs per PTU. BRPs with a negative imbalance normally pay the imbalance price to the TSO whereas BRPs with a positive imbalance receive the imbalance price from the TSO[1]. For each MWh of deviation, a BRP must pay the relevant imbalance price (expressed in €/MWh).

The sooner imbalances are settled, the quicker BRPs are faced with the financial consequences of imbalances. The variable *frequency of settlement* indicates how often the actual payment process is executed, in which the imbalance payments between each BRP and the TSO are netted over the entire payment period.

The determination of the imbalance price based on the regulation power market price essentially means a transfer of the balancing costs to the Balance Responsible Parties. The *main imbalance pricing mechanism* is directly dependent on the regulation pricing mechanism, i.e. the mechanism used to determine the regulation power market prices. If ‘marginal pricing’ is used for pricing regulation power, the imbalance price can be equaled to this marginal regulation power price. However, if ‘pay-as-bid pricing’ is used, in general the main imbalance pricing mechanism applied is ‘average pricing’, i.e. the weighted average of the bid prices of the activated bids becomes the imbalance price.

The remaining imbalance settlement variables also have to do with the determination of the imbalance price, the most important aspect of imbalance settlement. *Regulation states* represent specific states of the system imbalance for a PTU, which influences the determination of the imbalance price. Often, the regulation state for a PTU is just the ‘main direction’ of balance regulation: the direction of the net system imbalance, which is positive when more upward regulation was needed during a PTU to restore the system imbalance than downward regulation, and vice versa. Then, the imbalance price will be based on the price of regulation power in the main direction.

The application of *single pricing* for imbalance pricing is very much related to the use of the ‘main direction’ of the system imbalance. According to [1], single pricing is applied when either the price for upward regulation or the price for downward regulation from the regulation power market is used for imbalance pricing for all PTUs. When *dual pricing* is applied, both regulation prices can be used for imbalance pricing in the same PTU, depending on the regulation state (see the explanation for the Netherlands in Section III).

The variable of *one/two-price settlement* makes imbalance pricing even more difficult. With two-price settlement, BRPs with an imbalance in the same direction as the ‘main direction’ of the system imbalance are faced with the day-ahead market price as the imbalance price. So, if the main direction is upward (positive), BRPs with a positive imbalance receive the spot market price[2].

Finally, there may exist special rules for imbalance pricing under specific, security-endangering circumstances. We will call this *alternative imbalance pricing*.

III. OVERVIEW FOR NORTHERN EUROPE

Based on a literature study, a survey of balance responsibility and settlement for the different North-European regions has been established. See Table II. The design variables explained in the former section have been outlined for the different regions. For the Nordic region, both the former values and the new values as from January 1st 2009 are listed, as this gives more information about possible designs. We will here elaborate on the variable values that require explanation.

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[1] This can be seen as the selling of ‘balancing power’ when a BRP has a positive imbalance and the buying of ‘balancing power’ when he has a negative imbalance, as put forward by [3].

[2] If the regulation state is positive, the system was ‘short’ and upward regulation was needed (on a net basis).

TABLE II
OVERVIEW OF BALANCE RESPONSIBILITY AND IMBALANCE SETTLEMENT IN NORTHERN EUROPE

Balancing market variables	Norway	Sweden	Finland	Denmark	Harmonization Nordic region as from January 1st, 2009	Germany	Netherlands
Balance responsibility							
Program Time Unit (PTU)	60 minutes					15 minutes	15 minutes
Scope of balance responsibility	entire market	entire market	entire market	most of wind power by TSO		outsourcing of imb. settlement; renewable energy by TSO	entire market; full or trade accreditation
GTC for first energy program	19:00 D-1 / W-1[a]	16:00 D-1	16:30 D-1	15:00 D-1		14:30 D-1	13:00 D-1
GTC for final energy program	on agreement / afterward[a]	one minute before	20 minutes before	one hour before	45 minutes before	45 minutes before / 16:00 D+1[b]	one hour before
Types of balances	total	consumption, production, planned	total	consumption, production, trade	production, consumption (incl. trade)	total	total
Closed/open portfolio position	not applicable	open / closed [c]	not applicable	closed		closed	closed
Imbalance settlement							
Frequency of settlement	weekly	bi-monthly	monthly	monthly		monthly	weekly
Main imbalance pricing mechanism	marginal					average	marginal
Regulation states	main direction					main direction	variation-based
Single/dual pricing	single					single	dual
One/two-price settlement	one	two	two	two	two (produc.); one (consum.)	one	one
Alternative imbalance pricing	none	during shortage situations	during shortage situations	none		violation of imbalance settlement criteria	incentive component

[a] for production / trade
[b] for inter-area / intra-area energy exchanges
[c] before 2009 / as from 2009

The Nordic region

Since 2002, a common regulating power market exists in the Nordic balancing region [2], which consists of Norway, Sweden, Finland and Denmark. Balance responsibility and imbalance settlement were however rather different among the Nordic countries. For this reason, Nordel proposed some first harmonisation steps for several balancing market elements in 2007, which became effective on January 1st 2009. These include a final gate closure time of 45 minutes before the PTU of delivery, a production balance to which two-price settlement is applied, and a consumption balance (including trade) to which one-price settlement is applied [3].

Regarding regulation states, the Nordic region makes use of the ‘main direction’. This is related to the use of single pricing: the imbalance price for a PTU is the regulation power market price in the same direction as the ‘main direction’ of the system imbalance [2], [4].

Sweden and Finland use alternative imbalance pricing in shortage situations, which are PTUs in which fast active disturbance reserve or other special reserves are activated for balancing purposes [4]. Norway and Denmark do not have special imbalance pricing rules in shortage situations.

Germany

In contrast with the Nordic region, balance regulation in the German balancing region has mainly taken place inside the four different balancing areas, each operated by a separate TSO. However, common tenders for the reservation of balancing reserves appear to have been installed recently [5], among which a common tender for minute reserves on December 1st 2006 [6].

The scope of balancing responsibility in Germany includes two peculiar features. First, it is possible for a BRP to transfer the responsibility for imbalance settlement to another BRP [7]. This feature is probably related to the use of ex-post trading (see below). Second, TSO are obliged to take up balance responsibility energy following the Renewable Energy Law, which includes wind power and solar power. This way, the imbalance costs for renewable electricity production are socialized [8].

The GTC for the final energy program is stated to be 45 minutes before the PTU of delivery, but if the program merely contains intra-area exchanges the GTC is at 16:00 the day *after* delivery instead [8]. This enables so-called ‘ex-post trading’, i.e. the trading of individual imbalances between BRPs in order to mutually reduce these imbalances. Ex-post trading thus reduces the imbalance costs for BRPs. Because the different areas should be balanced and the inter-area exchanges should be controlled, this is not allowed for area-surpassing energy programs.

Finally, alternative imbalance pricing is used in Germany when ‘the TSO notices a wrong usage of regulating power', measured by the violation of several imbalance settlement criteria. These include a frequent significant imbalance, striking shortage at times of a high power exchange price and vice versa, clear and one-sided financial optimization of imbalance cash balances, and no equalized quarterly-hour load balances for BRPs. According to the conceptual Balance Agreement from 2006, the TSO penalizes the BRP for the relevant PTUs by not giving any compensation for positive imbalances and charging the double power exchange price for negative imbalances [7].

The Netherlands

The Netherlands forms a single balancing region and thus has its own, uniform balancing market rules.

A complex definition of regulation states is applied in the Netherlands. According to the Dutch System Code, the regulation state for a PTU is 0 if neither upward nor downward regulation is called; it is +1 if only upward regulation is called, and it is -1 if only downward regulation is called. However, if both upward and downward regulation are called, the regulation state is, depending on the sequence of ‘balance delta’s’ (which represents the minute-by-minute actual regulation volume), either -1, +1 or +2 [9], [10].

In the Netherlands, dual pricing is applied. When the regulation state is +2, the imbalance price for negative imbalances (BRP shortages) is based on the upward regulation price and the imbalance price for positive imbalances (BRP surpluses) is based on the downward regulation price [10].

Finally, a special kind of alternative imbalance pricing is applied in the Netherlands: the ‘incentive component’. This is an additive financial component that is included in the imbalance price at times of a reduced system performance level. This performance level is based on two criteria related to the amount and size of inadvertent exchanges with other countries and is checked weekly. If the performance level is not met, the incentive component becomes larger, leading to higher incentives for BRPs to be in balance. The component is reduced if the performance level is achieved, but cannot be lower than zero [9].

It is interesting that almost all of the design variables lack a uniform value in Northern Europe. The only exception is the portfolio position, which is a closed position in all three regions. This suggests that there is no clear ‘best value’ for the design variables of balance responsibility and imbalance settlement. In the next sections, we therefore will provide an evaluation of the different variable values.

IV. SYSTEM VARIABLES AND PERFORMANCE INDICATORS

The balancing market incentivizes market parties to feel responsible for, and contribute to, the balancing of the electricity system. Fundamentally, this is established by the balancing market rules giving market parties financial incentives to do so. In order to evaluate the effects of the design variables, we need a set of performance criteria, and knowledge about the balancing market mechanisms. Both are provided by the causal diagram of the ‘balancing system’ in Fig. 1.

Preparation for a specific PTU starts with the submission of energy programs. The more accurate these programs, the lower the net system imbalance will be, which means that less regulating power needs to be procured. This results in a lower ‘regulation price’ (regulation power market price), and therewith a lower imbalance price emerges for that PTU. Together with the lower BRP imbalance volumes, this will lead to lower imbalance costs for BRPs, which are settled after real-time. The imbalance costs form an indication of the financial risks BRPs are faced with for future PTUs; lower costs stimulate BRPs to diminish deviations from energy programs. This could be done by adaptation of energy programs before final gate closure time, improving predictions and increasing intraday trade, but also by increasing the amount of internal balancing. Internal balancing is real-time regulation by BRPs to reduce individual imbalance. An increase of internal balancing will also reduce the amount of offered regulating power (balancing bids), as BRPs keep the remaining, unused production capacity for themselves, instead of offering it on the regulation power market. The stability of the imbalance price actually represents the dynamics of the imbalance price, and thus does not really involve a causal relation.

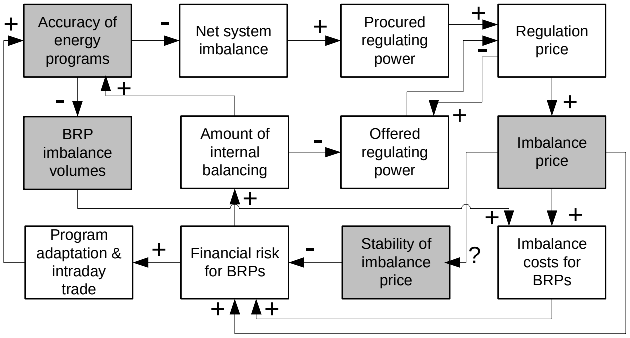

Fig. 1. Causal diagram of the balancing system, including the four identified performance indicators for balance responsibility and imbalance settlement (grey). A '+' means a positive causal relationship. The presence of several feedback loops makes this a dynamic system with mutually interdependent performance indicators.

From this representation of the balancing system, we identify four performance indicators for the evaluation of design variables for balance responsibility and imbalance settlement. These are the accuracy of energy programs, BRP imbalance volumes, the imbalance price, and the stability of the imbalance price.

The *accuracy of energy programs* is important for the TSO to ‘assess the expected network security and system balance situation and prepare for the required actions’ [11]. In the end, the TSO is responsible for balancing the system, and if all BRPs would stick to their energy program, this would not be a difficult task.

BRP imbalance volumes are important for the BRPs, as deviations from energy programs are settled with the relevant imbalance price. Whereas for the TSO the accuracy of programs at gate closure time is important, BRPs are interested in the final imbalance volumes, which are possibly different. This different actor perspective justifies the inclusion of this variable as a second performance indicator.

Thirdly, the *imbalance price level* determines the price paid per MWh of individual imbalance. The imbalance price is the main financial incentive in the balancing market. Market parties base their market strategies on the expected imbalance price level, taking into account the financial risk of imbalance.

Finally, the *stability of imbalance price* provides a performance indicator as well. If the imbalance price does not fluctuate much on a PTU-to-PTU basis, the stability of the imbalance price can be said to be high. An unstable imbalance price creates more uncertainty for BRPs, and therefore increases the financial risk for market parties.

Two important conclusions can be drawn from the system analysis above. First, there are several negative feedback loops in the balancing system, according to the causal diagram. These negative loops may lead to some stabilization of the values of the system variables, although the stochastic nature of the net system imbalance will lead to quite unpredictable fluctuation of the system variables on a PTU-to-PTU basis. This also holds for the performance indicators.

Secondly, we can see that one should not strive towards maximizing/minimizing the values of the performance indicators, but to 'optimal', balanced values. This holds especially for the imbalance price and the price stability. This is highly related to the quality of the incentives for BRPs, which is high when they reflect the balancing needs and costs.

V. EFFECTS ON PERFORMANCE

It may be easily observed that the balance responsibility design variables affect the accuracy of energy programs and thereby the BRP imbalance volumes, and that the imbalance settlement design variables influence the imbalance price and thus also the stability of the imbalance price. In order to evaluate the differences in balance responsibility and imbalance settlement in Northern Europe, we have rated the effects of the existing variable values on the performance indicators, by comparing different values with each other. See Table III.

An increase of the Program Time Unit from 15 minutes to 60 minutes has a very large positive effect on the accuracy of energy programs, and thus also on the BRP imbalance volumes: the accuracy increases, because instantaneous imbalances can be more easily evened out by BRPs. The imbalance price level is reduced as a result, although more weakly, due to the stabilizing effect of the feedback loops. However, the much larger PTU greatly reduces fluctuation of the imbalance price.

The effect of shifting balance responsibility for renewable energy to the TSO has been rated as very large for all four performance indicators. This is related to the large contribution of wind energy to the system imbalance. If the TSO takes responsibility, the wind power is 'removed' from the balancing market. The accuracy increases, and the imbalance price goes down.

A final design variable with a very large effect was found to be the main imbalance pricing mechanism. If marginal pricing is applied instead of average pricing, the imbalance prices will

TABLE III

RATING OF THE EFFECTS OF BALANCE RESPONSIBILITY AND IMBALANCE SETTLEMENT VALUES ON PERFORMANCE

Balancing market variables	Reference value	Rated value	Effect on performance indicators				Magnitude of effect
Performance indicators[a,b]			*A*	*V*	*P*	*S*	
Program Time Unit (PTU)	15 minutes	60 minutes	++	--	-	++	very large
Scope of balance responsibility	Entire market	Renewable energy TSO	++	--	--	++	very large
		Outsourcing imbalance settlem.	0	0	0	0	
		Full/trade accreditation	0	0	0	0	
GTC for first energy program	13:00 D-1	19:00 D-1	+	-	0	0	small
		W-1 for trade	0	0	0	0	
GTC for final energy program	45 min. before	60 min. before	-	+	+	0	large
		16:00 D+1	-	-	+	-	
Types of balances	Total	Production + consumption	-	+	0	0	small
Closed/open portfolio position	Closed	Open	-	0	0	0	small
Frequency of settlement	Weekly	Bi-monthly	0	0	0	0	very small
		Monthly	0	0	0	0	
Main imbalance pricing mechanism	Average	Marginal	++	--	++	--	very large
Regulation states	Main direction	Variation-based	+	-	+	-	large
Single/dual pricing	Single	Dual	+	-	+	-	large
One/two-price settlement	One-price	Two-price settlement	+	-	+	-	large
		Two-price (p) & one-price (c)	+	-	+	-	
Alternative imbalance pricing	None	Activation special reserves[c]	0/-	0/+	0/-	0/+	small
		Violation of settlement criteria	+	-	-	+	
		Incentive component[c]	0/+	0/-	0/+	0/-	

[a] A= accuracy of energy programs; V = BRP imbalance volumes; P = Imbalance price level; S = Stability of imbalance price

[b] rating of the (objective) effect of variable values on the performance indicators: ++ = very positive effect, + = positive effect, 0 = insignificant effect, - = negative effect, -- = very negative effect

[c] the impact of this variable value depends on the frequency of application of the alternative imbalance pricing: insignificant / significant

go up, which drives BRPs to reduce program deviations. Imbalance price stability decreases, because of applying the marginal regulation price as the imbalance price, which will show more fluctuation than the average accepted bid.

Subsequently, there are four design variables that have a large effect. Firstly, a small change in the final GTC can already have a large impact, because most imbalances occur unexpectedly, and a later GTC gives BRPs more time to reduce individual imbalance. If the final GTC is after real-time, BRPs can trade off imbalances with each other, which reduces BRP imbalance volumes, but also ex ante accuracy of energy programs, from the perspective of the TSO.

The other three design variables with a large effect relate to imbalance settlement and are interrelated. The defined regulation states determine the potential for and impact of single/dual pricing and one-two price settlement. Variation-based regulation states, dual pricing and two-price settlement all lead to improved accuracy, because of the larger incentives given to BRPs through the higher imbalance prices. The resulting internal balancing and the more complicated pricing mechanisms will lead to lower price stability.

The remaining design variables are estimated to only have a small effect. The effect of the frequency of settlement is mainly psychological, as it does only influence the moments of settlement, not the total imbalance costs. The impact of alternative imbalance pricing largely depends on the frequency of occurrence of activation of special reserves, violation of criteria, or activation of the incentive component.

TABLE IV
BALANCING MARKET PERFORMANCE AMONG NORTH-EUROPEAN REGIONS

Performance indicator	Nordic region	Germany	Netherlands
Accuracy of energy programs	Very high	Moderately low	Moderately low
BRP imbalance volumes	Very low	Moderately high	Moderately high
Imbalance price level	Moderately low	Very low	Very high
Stability of imbalance price	Moderately high	Very high	Very low

Comparing the existing variable values for balance responsibility and imbalance settlement among the North-European regions with the rated effects in Table III, we can draw some conclusions on the expected differences in balancing market performance for these regions.

Adding up all effects of existing variable values for the North-European regions using Table III, we obtain an indication of differences in performance of balance responsibility and imbalance settlement in Table IV. As can be seen, the conducted evaluation indicates that the Nordic region shows a relatively high accuracy of energy programs and low BRP imbalance volumes. Germany has a relatively low imbalance price level and high imbalance price stability, whereas the Netherlands has a relatively high imbalance price level and low imbalance price stability. This suggests that the Nordic TSO has a relatively easy job in maintaining the system balance, whereas BRPs in the Netherlands are faced with relatively high financial risks.

VI. CONCLUSIONS

The overview of balance responsibility and imbalance settlement in Northern Europe has shown that there exist many different rules among countries for these two balancing market elements. An evaluation of the effects of the design variables on four performance indicators has revealed that these different rules can be expected to result in large differences in balancing market performance.

The most influential design variables are found to be the Program Time Unit, the scope of balance responsibility, and the main imbalance pricing mechanism. Viewing the effects and the existing variable values in Northern Europe, we expect the Nordic region to have a relatively high accuracy of energy programs, Germany to have relatively low imbalance prices, and the Netherlands to have relatively high imbalance prices. These can be used as hypotheses for the comparison of balancing market performance among different (North-European) balancing regions, using real balancing system data.

Furthermore, the evaluation has provided proof of the relevance of balancing market design. Although the balancing system forms a complex whole of variables and interrelationships, conscious design of balancing markets has the potential to improve balancing market performance.

In further research, we plan to add a quantitative analysis of balancing system data in order to analyze balancing market dynamics and performance. This would contribute to the creation of a solid theoretical basis on balancing market design, which will support the design process of balancing markets for improved performance.

REFERENCES

[1] O. S. Grande, G. Doorman, and B. H. Bakken, "Exchange of balancing resources between the Nordic synchronous system and the Netherlands / Germany / Poland," SINTEF, Feb. 2008.

[2] Nordel, "Common Balance Management in the Nordic Countries – Special print of the feature article in Nordel's 2002 annual report," 2002.

[3] Nordel, "Report on Proposed principles for Common Balance Management," Nov. 2007.

[4] NordREG "Development of a common Nordic balance settlement," Report 3/2006, 2006.

[5] Website for information about tendering of regulating power in Germany, www.regelleistung.net, viewed on February 7th 2009.

[6] S. Riedel and H. Weigt, "German Electricity Reserve Markets," Electricity Markets Working Papers WP-EM-20, Dresden Univ., 2007.

[7] Bundesnetzagentur, "Bilanzkreisvertrag über die Führung eines Bilanzkreises zwischen BKV und der ÜNB," concept, May 2006.

[8] Bundesregierung Deutschland, "Verordnung über den Zugang zu Elektrizitätsversorgungsnetzen (Stromnetzzugangsverordnung – StromNZV)," July 2005.

[9] TenneT, "The Imbalance Pricing System as at 01-01-2001, revised per 26-10-2005," Version 3.1, Aug. 2005.

[10] DTe, "System Code – Conditions within the meaning of Section 31, subsection 1 c of the Electricity Act 1998," informal translation, Sep. 2007.

[11] ETSO, "Balance Management Harmonisation and Integration – 4th Report," Jan. 2007.