# EFFECTS OF INTRADAY TRADE ON NORNED

Commissioned by
Norwegian Water Resources and Energy Directorate

R-2011-005

## Document details



| | |
|---|---|
| Econ Report no. | R-2011-005 |
| Project no. | 5Z100089 |
| ISBN | 978-82-8232-157-0 |
| ISSN | 0803-5113 |
| Internal codes | NDA/CSE/YQI/ERT/MTU/FGR/mbh, HAB |
| Report finish date | 6. June 2011 |
| Accessibility | Public |



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# TABLE OF CONTENTS

**EXECUTIVE SUMMARY .... 1**

**1 INTRODUCTION .... 3**

1.1 Problem definition and methodology .... 3

**2 THE DUTCH ELECTRICITY MARKET .... 5**

2.1 Background .... 5

2.2 Key players .... 7

2.3 Market and trading overview .... 8

2.4 APX Power NL .... 9

2.4.1 Members .... 9

2.4.2 Trading costs .... 12

2.4.3 APX Power NL day-ahead market .... 13

2.4.4 APX Power NL intraday market .... 18

2.5 Other intraday trading possibilities .... 22

2.5.1 Cross-border intraday trade .... 23

2.6 Balancing markets .... 23

2.6.1 Primary reserves .... 23

2.6.2 Secondary and tertiary reserves .... 24

2.6.3 Imbalance settlement .... 25

2.6.4 Prices and volumes .... 26

2.6.5 Membership and participants .... 30

2.7 Market concentration .... 31

2.7.1 Activity and liquidity on Dutch markets .... 31

**3 THE NORWEGIAN ELECTRICITY MARKET .... 33**

3.1 Background .... 33

3.2 Key players .... 35

3.3 Market and trading overview .... 35

3.4 Nord Pool Spot .... 36

3.4.1 Members .... 37

3.4.2 Trading costs .... 38

3.4.3 Nord Pool Spot day-ahead market Elspot .... 39

3.4.4 Nord Pool Spot intraday market Elbas .... 43

3.5 Balancing markets .... 47

3.5.1 Primary reserves .... 47

3.5.2 Tertiary reserves ..... 48
3.5.3 Imbalance settlement ..... 49
3.5.4 Prices and volumes ..... 49
3.5.5 Membership and participants ..... 54
3.6 Market concentration ..... 54
3.6.1 Activity and liquidity on the Norwegian markets ..... 55

**4 SUMMARY OF KEY DIFFERENCES BETWEEEN NORWAY AND THE NETHERLANDS ..... 57**

**5 MARKET COUPLING ..... 59**
5.1.1 Market coupling in the Nordics ..... 59
5.1.2 Market coupling in the Netherlands ..... 60

**6 ANALYSIS OF THE EFFECTS OF INTRADAY TRADE ON NORNED ..... 61**
6.1 Introduction ..... 61
6.2 Incentives to trade intraday ..... 61
6.2.1 Intraday trade in case of no congestion ..... 62
6.2.2 Intraday trade in case of congestion ..... 62
6.3 What if analysis ..... 65
6.3.1 Methodology and use of data ..... 65
6.3.2 Selection of cases ..... 66
6.3.3 Case analysis general structure ..... 71
6.3.4 Case 1 ..... 72
6.3.5 Case 2 ..... 74
6.3.6 Case 3 ..... 76
6.3.7 Case 4 ..... 78
6.3.8 Case 5 ..... 80
6.3.9 Case 6 ..... 82
6.3.10 Case 7 ..... 84
6.3.11 Case 8 ..... 86
6.3.12 Summary of what-if case analyses ..... 89
6.4 Effect of dynamics ..... 91
6.5 Interdependencies between the different time frames ..... 91

**REFERENCES ..... 95**

**APPENDIX 1: MEMBERSHIP LIST NORD POOL SPOT ..... 97**

**APPENDIX 2: OVERVIEW OF SUPPLY AND DEMAND CURVES ..... 107**

# EXECUTIVE SUMMARY


## *Abstract*

*In this report we study the effects of introducing intraday trade on the NorNed cable between Norway and the Netherlands, effectively increasing the geographical scope of the existing intraday markets in both countries, by analysing the effects on the incentives of existing and potential new market participants. The analysis of the effects on incentives is mainly based on a fundamental analysis of resource prices in the two countries, using the day-ahead supply curves in both countries. It also includes an analysis of the dynamics of trade, interdependencies between the different market time frames (day-ahead, intraday and balancing stage) and price behaviour. In addition we describe the day-ahead, intraday and balancing markets of the two countries and identify factors in the market designs which may affect the incentives for intraday trade.*


## *Background*

According to the Congestion Management Guidelines in appendix 1 to the EU Regulation 1228/2003 on Cross-Border exchanges in electricity, mechanisms for the intraday congestion management of interconnector capacity should have been established by 1 January 2008 on existing interconnectors.

The TSO co-owned interconnector NorNed between Norway and the Netherlands has so far been operated without a mechanism for intraday congestion management. This is mainly due to the time which has been needed to establish an implicit auction for the day-ahead market on the interconnector. The implicit auction (an interim tight volume coupling model) has been implemented since January 12th 2011, and the next step in line is the establishment of an intraday congestion management mechanism on the interconnector.

## *Problem statement*

The Norwegian Water Resources and Energy Directorate, or NVE, as the regulator for the Norwegian power market, is responsible for the overall functioning of the Norwegian power market. NVE therefore wants to gain an understanding of the effect of opening the NorNed interconnector for intraday trade on the existing intraday markets in Norway and the Netherlands. In addition, as the intraday markets are closely connected to the other time frames for electricity trade (day-ahead markets and balancing markets), NVE also needs to understand how such an integration could affect these markets. A better understanding of the effects of the implementation of intraday trade on NorNed will help NVE in their efforts to provide for an efficient regulation of the intraday trade on the interconnector and the general power market.

To increase their understanding of the effect of opening the NorNed interconnector for intraday trade, NVE has therefore defined the following three areas which they would like answered:

- A description of the Dutch power market, with particular reference to the intraday market and balancing market
- A comparison of the Dutch power market with the Norwegian power market in the relevant aspects
- An analysis of the effect of introducing intraday on NorNed, with particular reference to competition and price behaviour in all relevant markets

In this report, we address these three issues in the same line of order as established by NVE. The analysis of the effect of introducing intraday trade on the interconnector is mainly based on a what-if analysis of a selection of cases, where we analyse what would have been the optimal market solution to supply the total demand from day-ahead and intraday/real-time stage, given that this information had been known at day-ahead. The what-if analysis of the different cases is a fundamental analysis based on the resource prices in the two countries. We thereafter comment on the dynamics of trade, inter-dependencies between the inter-temporal market places and price behaviour, and how this may affect trade.

*Conclusion*

The conclusions of the above analysis can be summarized in three main points.

1. We find it likely that trade will be based on fundamental differences in resource prices between the two countries or trade areas (as both countries are part of a larger intraday market).
2. We find it likely that market coupling at intraday stage will increase competition and liquidity in the intraday market. We do not study the trade potential or volumes in this report; however we still find that that the underlying effect is likely to be an increase in competition and liquidity, as the potential per se increases.
3. Finally, more intermittency in the future is likely to increase the potential for trade.

# 1 INTRODUCTION

According to the Congestion Management Guidelines in appendix 1 to the EU Regulation 1228/2003 on Cross-Border exchanges in electricity, mechanisms for the intraday congestion management of interconnector capacity should have been established by 1 January 2008 on existing interconnectors. The cross-border integration of intraday trade and trade in balancing products have reached a larger focus in the EU during the latter years, as integration of forward and day-ahead markets have been moving forward. The number of order on which markets have received the most attention so far is due to the larger size, and therefore larger importance, of the integration of forward and day-ahead markets.

The intraday and balancing markets have in a European perspective suffered from a lack of competition, and a further geographical expansion of such markets is therefore seen as potentially beneficial. In addition, the coupling of markets with different levels and cost of flexibility, will likely lead to an overall lower cost for the provision of flexibility and potentially an increase in system security.

To support in the integration of the markets and increased efficiency of the power markets, the EU is currently working on the development of Framework Guidelines for Congestion Management and Capacity Allocation. There they among other set up recommendations for the design of the intraday congestion management mechanism. A final draft guidelines has been completed after a process of public consultation and will be taken forward by ACER. The focus areas are on creating the possibility to trade with energy as close to real-time as possible, based on implicit continuous trading including pricing of intraday capacity.

The TSO co-owned interconnector NorNed between Norway and the Netherlands has so far been operated without a mechanism for intraday congestion management. This is mainly due to the time which has been needed to establish an implicit auction for the day-ahead market on the interconnector. The implicit auction (an interim tight volume coupling model) has been implemented since January 12$^{th}$ 2011, and the next step in line is the establishment of an intraday congestion management mechanism on the interconnector.

## 1.1 PROBLEM DEFINITION AND METHODOLOGY

The Norwegian Water Resources and Energy Directorate, or NVE, as the regulator for the Norwegian power market, is responsible for the overall functioning of the Norwegian power market. NVE therefore wants to gain an understanding of the effect of opening the NorNed interconnector for intraday trade on the existing intraday markets in Norway and the Netherlands. In addition, as the intraday markets are closely connected to the other time frames for electricity trade (day-ahead markets and balancing markets), NVE also needs to understand how such an integration could affect these markets. A better understanding of the effects of the implementation of intraday trade on NorNed will help NVE in their efforts to provide for an efficient regulation of the intraday trade on the interconnector and the general power market.

To increase their understanding of the effect of opening the NorNed interconnector for intraday trade, NVE has therefore defined the following three areas which they would like answered:

- A description of the Dutch power market, with particular reference to the intraday market and balancing market

- A comparison of the Dutch power market with the Norwegian power market in the relevant aspects
- An analysis of the effect of introducing intraday on NorNed, with particular reference to competition and price behaviour in all relevant markets

In this report, we will address these three issues in the same line of order as established by NVE. We will first describe the Dutch and Norwegian power markets in two separate chapters, and in the chapter on the Norwegian power markets provide a comparison with the Netherlands in relevant aspects. We will summarise the most important differences in an own chapter. The analysis of the effect of introducing intraday trade on the interconnector will mainly be based on a what-if analysis of a selection of cases, where we analyse what would have been the optimal market solution to supply the total demand from day-ahead and intraday/real-time stage, given that this information had been known at day-ahead. The what-if analysis of the different cases is a fundamental analysis based on the resource prices in the two countries. We will thereafter comment on the dynamics of trade, interdependencies between the inter-temporal market places and price behaviour, and how this may affect trade.

# 2 THE DUTCH ELECTRICITY MARKET

## 2.1 BACKGROUND

The Netherlands is a medium-sized electricity market in Europe in terms of domestic demand. Access to large indigenous sources of natural gas has led the Dutch generation mix to be dominated by gas-fired power stations and cogeneration units. As such, the Netherlands depends on fossil-fuel generation capacity more than any other western European country, and the total fossil fuel generation accounts for about 89% of the generation mix.

The Netherlands has historically been one of the biggest net electricity importers in Europe, with imports sourced primarily from Germany and France (via Belgium) and then, since May 2008, also from Norway through the NorNed cable. Last year however, there was a decrease in net imports and over a number of months from October 2009 the Netherlands became a net exporter. In 2009, gross imports accounted for around 5% of domestic consumption, versus around 15% to 20% in previous years.

Table 2.1 summarises the key physical characteristics of the Dutch electricity market.

*Table 2.1 Key facts and figures for the Dutch electricity market*

| Data category | Situation in 2009 | Comments |
|---|---|---|
| Domestic consumption | 113 TWh[1] | 4.3% decrease from 2008 |
| Domestic production | 108 TWh | 32% from cogeneration plant; 8% renewable |
| Trading | 29 TWh on Day-Ahead market | OTC still accounts for most trades |
| Interconnection flows | Net imports of 4.9 TWh | 15.5 TWh of imports;<br>10.6 TWh of exports |
| Peak demand | 20 GW | Import capacity of just under 5 GW |
| Installed capacity | 26.5 GW[2], | 87% is gas and coal-fired |
| Trilateral coupling (FRA, BEL, NET) | Single price in all three day-ahead markets for 57% of traded hours | Common Belgian-Dutch price in 85% of traded hours |

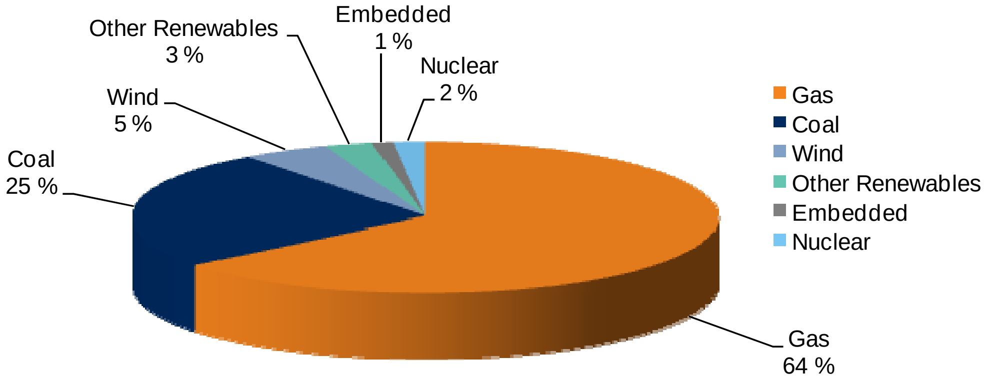
Source: EnergieNed, ENTSOE-E, APX-ENDEX, TenneT, Elia and Pöyry Management Consulting analysis

Figure 2.1 below presents a breakdown of the installed capacity in the Netherlands by fuel type. The nuclear capacity comes from one single power plant (Borssele).

[1] Including network losses

[2] ENTSO-E Memo 2009.

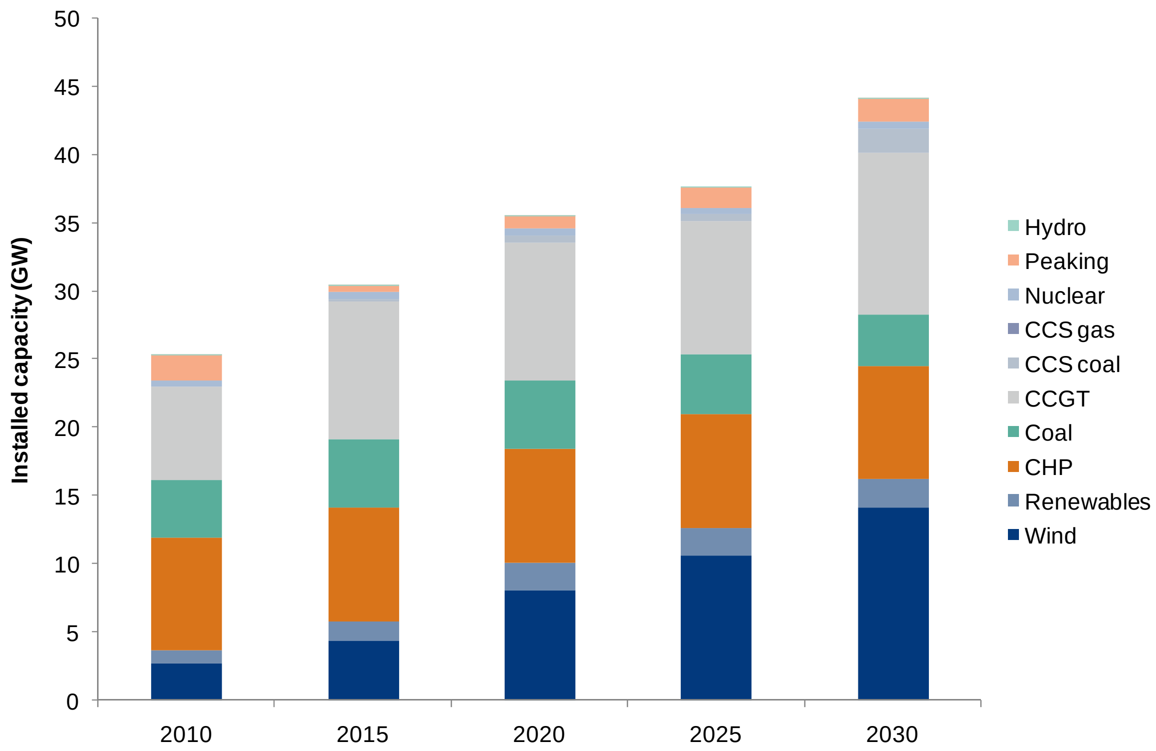
*Figure 2.1 Installed capacity by fuel type in the Netherlands (2009)*




Source: Pöyry Energy Consulting analysis

The future generation capacity in the Netherlands is expected to increase, with a main driver being climate change policies and targets. Figure 2.2 below shows Pöyry's latest projections of Dutch installed capacity through until 2030 in the so-named Central or base scenario.

*Figure 2.2 Pöyry Central projection of Dutch installed capacity (GW)*




* CCS = carbon capture and storage

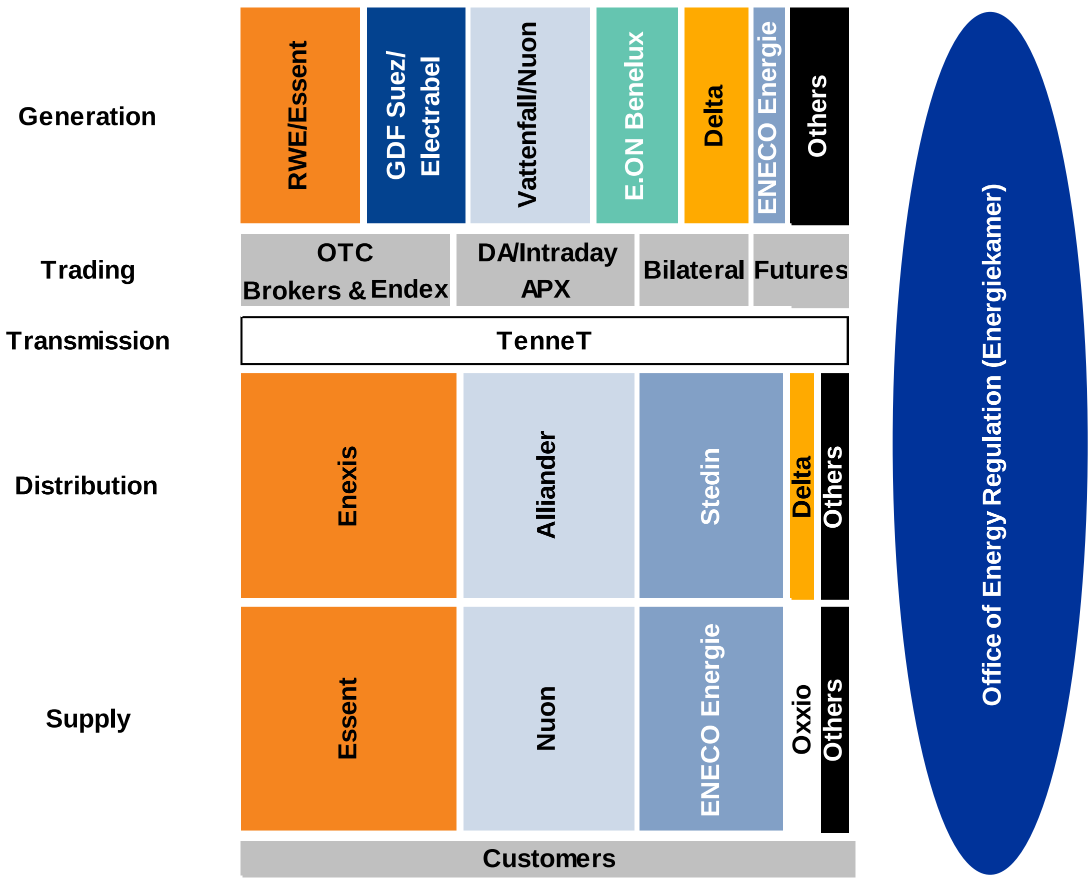
** Peaking = Plants which typically runs less than 10%. Includes OCGTs, thermal engines and steam turbines

Source: Pöyry Management Consulting analysis

## 2.2 KEY PLAYERS

Figure 2.3 below shows the structure of the Dutch electricity market. The sizes of the boxes indicate market shares, and the colours indicate ownership (historical or present). Nuon (Vattenfall), Essent (RWE), Electrabel (GdF Suez) and E.ON are the four major market players and are all vertically integrated. Essent and Nuon have unbundled and divested their distribution activities completely (ownership in distribution indicated in the figure is historical). In 2009, the two largest Dutch utilities, Nuon and Essent, were each acquired by Vattenfall and RWE, respectively. The four biggest generation companies are now each under the ownership and control of a major multi-national utility.

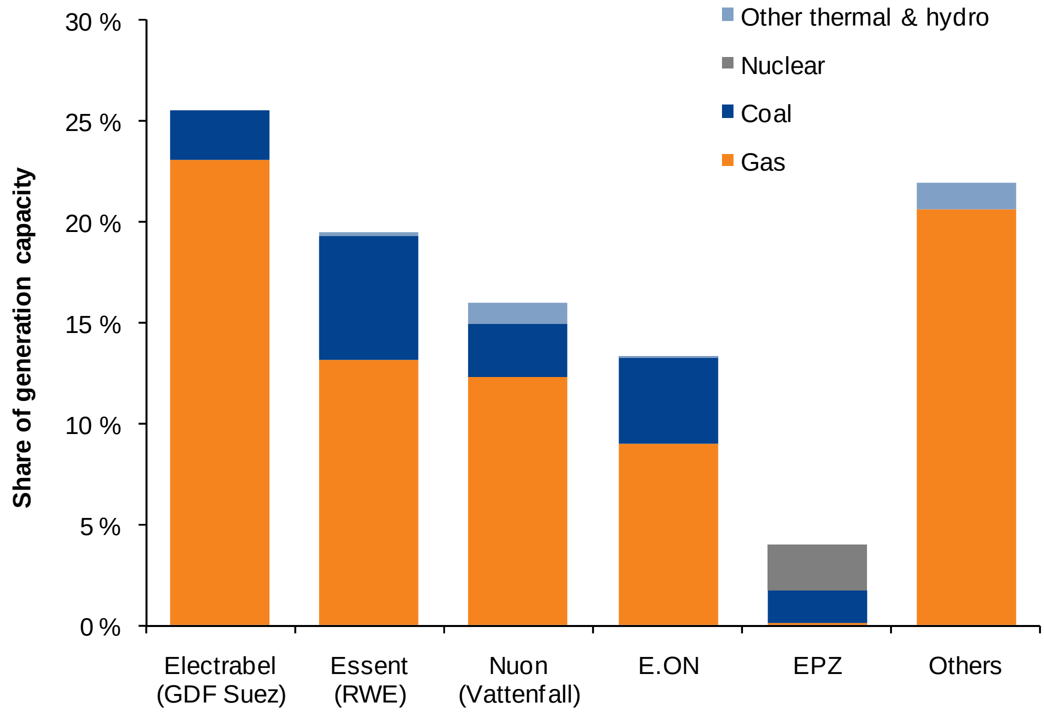
*Figure 2.3 Dutch electricity market structure*




Source: PlattsPowerVision, Office for Energy Regulation (Energiekamer) and Pöyry Management Consulting analysis

Figure 2.4 shows the distribution of generation capacity (excluding wind) by fuel type between the main players. As can be seen, the four major players own approximately 74% of the generation capacity (excluding wind). Else, the generation assets of each owner tend to be clustered geographically, reflecting the Dutch generation market's history of vertically integrated local monopolies.

*Figure 2.4 Share of installed generation capacity by fuel*




Source: PlattsPowerVision and Pöyry Management Consulting analysis

## 2.3 MARKET AND TRADING OVERVIEW

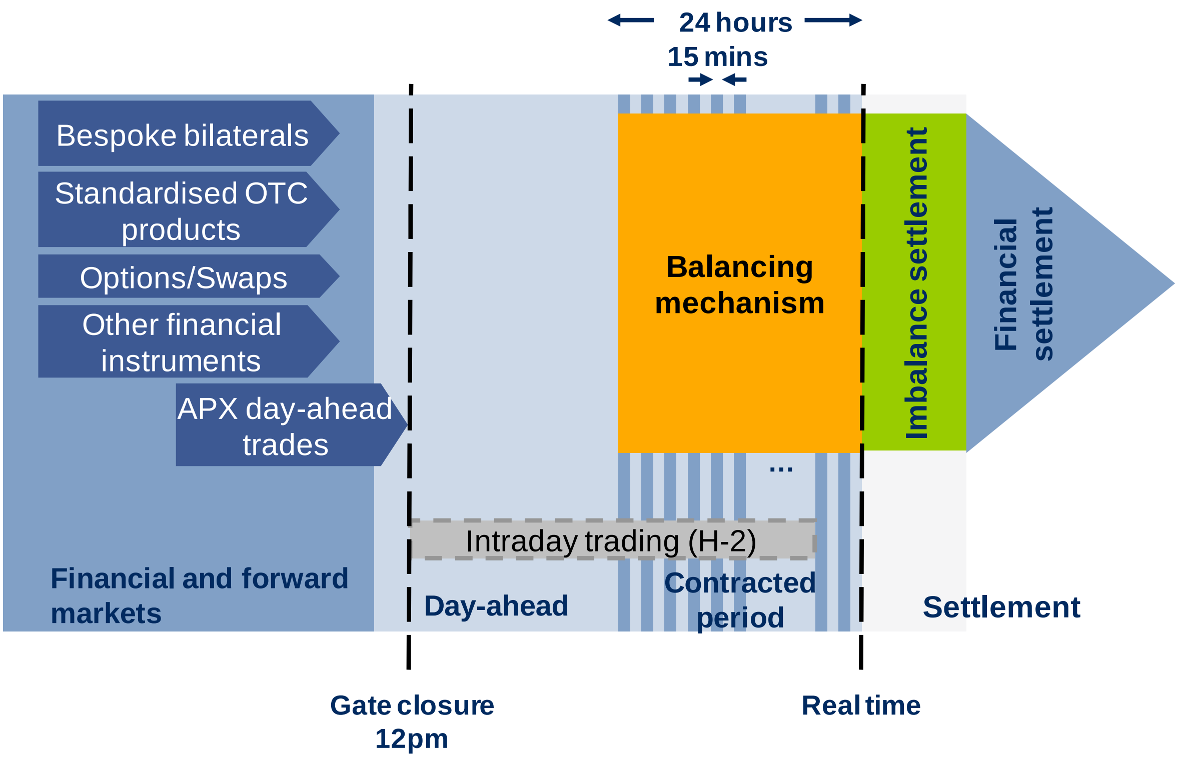
Figure 2.5 below provides a simplified overview of the Dutch market arrangements.

Electricity in the Netherlands is traded both bilaterally, and in organized markets through the Dutch power exchange, APX Power NL. The bilateral markets include both standardized bilateral contracts (over the counter - OTC) and non-standardized contracts. It is possible to trade physical power bilaterally both up to day-ahead time frame and during intraday time frame. APX Power NL runs the day-ahead, strips and intraday markets. The day-ahead market is coupled with other European countries (we will return to this below) and the intraday market is in the process of being so. Finally, the balancing market is operated by the TSO, TenneT, to handle real-time imbalances in demand and supply.

APX-ENDEX operates the Dutch power exchange and also ENDEX Power NL which provides an OTC futures market. APX Power NL also runs a brokered OTC market.

In the figure, APX day-ahead trades include the day-ahead and strips markets.

*Figure 2.5 Dutch wholesale market arrangements*




Source: Pöyry Management Consulting

## 2.4 APX POWER NL

APX Power NL was established in 1999 and is an independent fully electronic exchange which allows anonymous trading on the Dutch power spot market. APX Power NL provides members with standardised products to sell and purchase, and it acts as the central counter party in all electricity trades. Membership of APX Power NL allows participation in any of the APX NL markets (day-ahead, strips and intraday) and is necessary to trade in either of them.

APX Power NL is owned by APX ENDEX, which is again owned by TenneT Holding B.V., owner of the Dutch TSO TenneT, N.V. Nederlandse Gasunie, a gas infrastructure company and owner of Gas Transport Services (GTS), the Dutch Gas TSO, Elia N.V., the Belgian electricity TSO and Fluxys Europe B.V., the Belgian gas TSO.

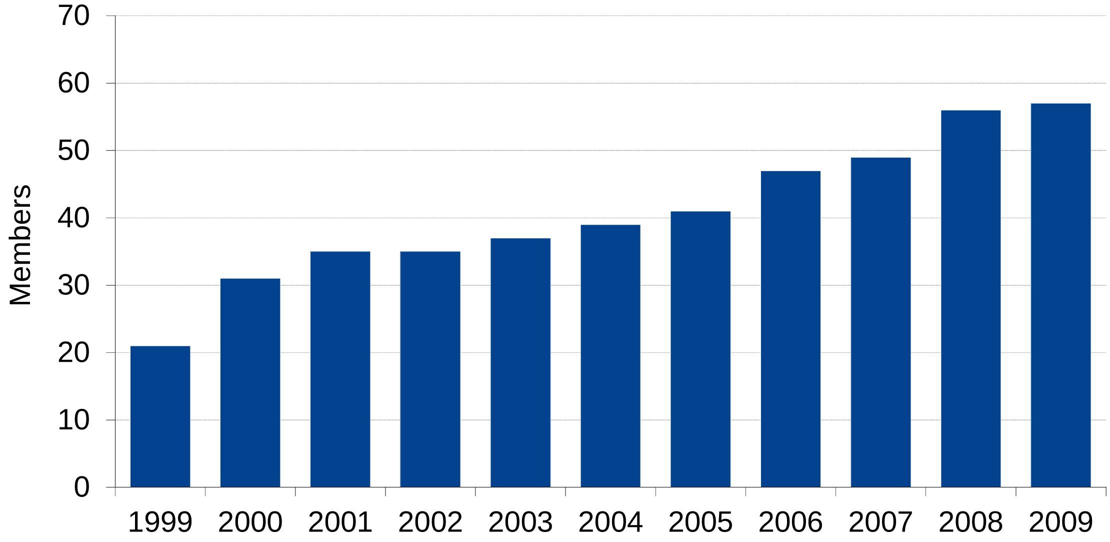
TenneT Holding B.V. holds 56.1%, N.V. Nederlandse Gasunie 20.9%, Elia N.V. 20% and Fluxys Europe B.V. 3% of the shares of APX-ENDEX.

### *2.4.1 Members*

Trading and clearing membership in APX Power NL can be either as full member or as light member. It is also possible to have a view-only membership. A full member has full access rights as a customer, while a light trading member will have a trading member trading on their behalf. It is necessary as a trading or light trading member to either hold also a clearing membership or have someone represent you as clearing member. The latter option is currently not in use by any participant. The terms clearing and light clearing membership else correspond to type of trading member.

The amount of members in APX Power NL market currently numbers around 60. The evolution of market membership, from 1999 which was the first year of operation, is shown in Figure 2.6 below. Membership numbers have grown steadily over the past ten years, and increased threefold from 20 to just fewer than 60 in this time frame. Typical market users include distributors, producers, traders, brokers and industrial parties. Table 2.2 provides a recent list of APX Power NL members.

*Figure 2.6 Historical APX Power NL membership*




Source: APX-ENDEX

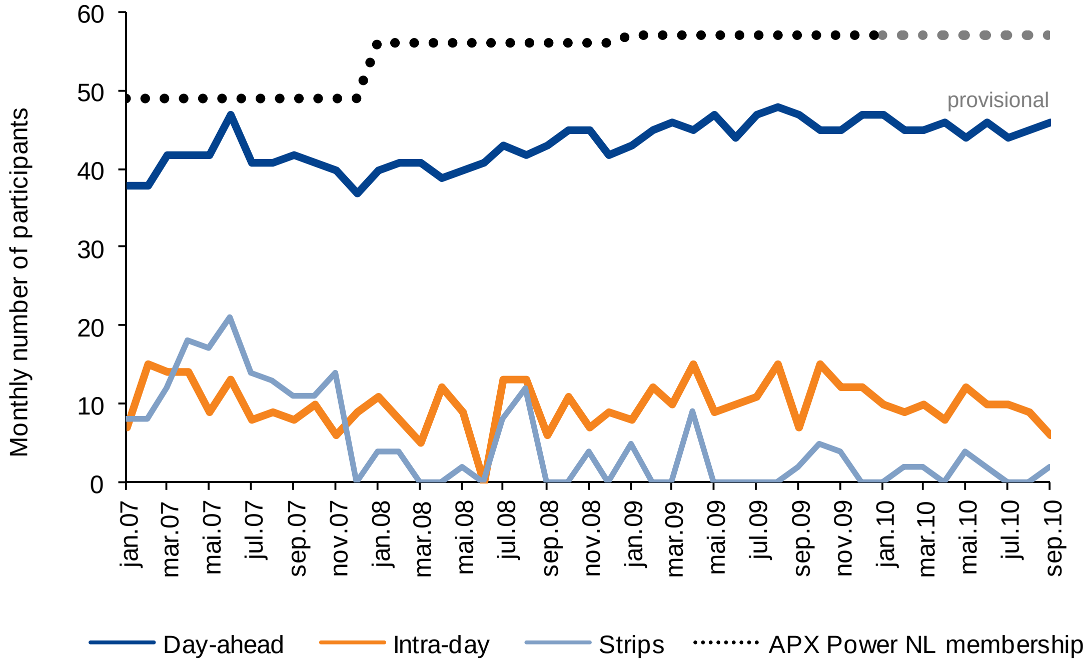
Not all APX Power NL members regularly participate in each of the available markets. In general, participation rates are the highest by far on the day-ahead market, which is the core function of APX Power NL and, as described later, sees the greatest trading volumes. The strips and intraday markets have a much lower participation rate which is around one quarter the level on the day-ahead market. Trading on the intraday market is likely to be of most interest for parties who are involved with physical delivery of power, rather than for financial players. Figure 2.7 presents a comparison of the number of active day-ahead and intraday market participants in each month since the beginning of 2007 (the annual membership level is also overlaid for comparison).

*Table 2.2 Participants on APX Power NL*

| | |
|---|---|
| Accord Energy Ltd | Gazprom Marketing & Trading Ltd |
| Afval Energie Bedrijf | Gunvor International BV. |
| Agder Energi Produksjon AS | Iberdrola Generación SAU |
| Alpiq Swisstrade AG | IMC Energy Trading BV |
| Anode BV | J. Aron & Company |
| AVR Afvalverwerking BV | Mercuria Energy Trading SA |
| Barclays Capital | Merrill Lynch Commodities (Europe) Ltd |
| Bergen Energi Nederland BV | Morgan Stanley Capital Group Inc |
| BNP Paribas SA | Nidera Handelscompagnie BV |
| Citigroup Global Markets Ltd | Norske Skog Parenco BV |
| Danske Commodities AS | ORCEM BV |
| De Vrije Energie Producent BV | Oxxio Nederland BV |
| Delta Energy BV | RWE Supply & Trading GmbH |
| Deutsche Bank AG | RWE Supply & Trading Netherlands BV |
| Dong Naturgas AS | RWE Supply & Trading Switzerland SA |
| E.ON Energy Trading SE | Scholt Energy Control BV |
| EDF Trading Ltd | Shell Energy Europe Ltd |
| EGL AG | SPE SA |
| Electrabel SA | Statkraft Markets GmbH |
| EnBW Trading GmbH | The Royal Bank of Scotland PLC |
| Endesa Trading SA | Total Gas & Power Ltd |
| Eneco Energy Trade BV | Trianel GmbH |
| Enel Trade SpA | Utility Support Group BV |
| Energi Danmark AS | Vattenfall Energy Trading GmbH |
| Energie Data Maatschappij BV | Vattenfall Energy Trading Netherlands NV |
| ESD-SIC BV | Vitol SA |
| Ezpada sro | |

Source: APX-ENDEX

*Figure 2.7 Active participants each month on the APX Power NL day-ahead, strips and intraday markets (since 2007)*




Source: APX-ENDEX and Pöyry Management Consulting analysis

### 2.4.2 Trading costs

A summary of APX Power NL trading costs, both fixed fees and transaction fees, can be found in Table 2.3 and Table 2.4. The entrance and technology fees are one-off payments, whereas the membership fee is payable on an annual basis. Full trading members are able to access APX Power NL systems directly to place bids, and the technology fee covers the costs of the relevant software from APX Power NL. Transaction fees are variable costs payable according to the volume and types of trades.

A party will have to pay both for a trading membership and a clearing membership, the latter either directly or through someone representing you, where in case payment will be an issue between the relevant parties. As noted above, this solution is however not used by any party.

*Table 2.3 APX Power NL fixed fees* ***(as of November 2010)***

| Membership type | Entrance fee | Membership fee | Technology fee |
|---|---|---|---|
| Trading membership | €5,000 | €28,500 | €5,000 |
| Light trading membership | – | €750 | – |
| Clearing membership | – | €3,000 | – |
| Light clearing membership | – | €750 | – |

Source: APX-ENDEX

*Table 2.4 APX Power NL transaction fees (€/MWh, as of November 2010)*

| Transaction type | Day-ahead | Intraday | Strips initiator* | Strips aggressor* |
|---|---|---|---|---|
| Trading | 0.07 | 0.095 | – | 0.01 |
| Clearing | 0.01 | 0.01 | 0.01 | 0.01 |

* N.B. a market initiator is the price giver; a market aggressor is a price taker.

Source: APX-ENDEX

### *2.4.3 APX Power NL day-ahead market*

*General*

The day-ahead market is the core activity of APX Power NL. Trading takes place on one day for delivery the next day. Trading on the day-ahead market allows APX Power NL members to achieve a balance of their purchase and sale portfolios on an hour-by-hour basis. The day-ahead market is essentially based on a two-sided auction model, and market members submit their orders electronically to APX Power NL. On the basis of submitted bids, demand and supply are compared on a daily basis, and a merit order is compiled.

Since 9 November 2010, the Netherlands participates in market-coupling through price coupling within the Central Western European Market Coupling (CWE) area, which includes Belgium, France, Germany and Luxembourg. This means that the day-ahead market prices in the Netherlands are determined in parallel to those in the other CWE countries, according to an agreed algorithm. From earlier, the Netherlands was already participating in market-coupling with France and Belgium (the trilateral coupling - TLC).

Market participants submit their purchase or sales orders at midday (12.00pm CET) for each hour of the following day. At market gate closure, all potential trades are then aggregated by hourly periods and ranked according to price. For each hour, the intersection of the aggregated supply and the aggregated demand curve determines the market results (i.e. the market clearing price and the market clearing volume). After this fixing is performed, the market results are made available to participants. When there is insufficient interconnection capacity to ensure price equality across the region, then more than one price emerges. Contracts are then created which require participants in each country to deliver to, or to withdraw, from the network they are connected to the volume of electricity in accordance with their contracts.

The day-ahead market is further coupled to the Nordics through loose-volume coupling between the Nordics and CWE, which we will return to in a separate chapter.[3]

*Day-ahead market products*

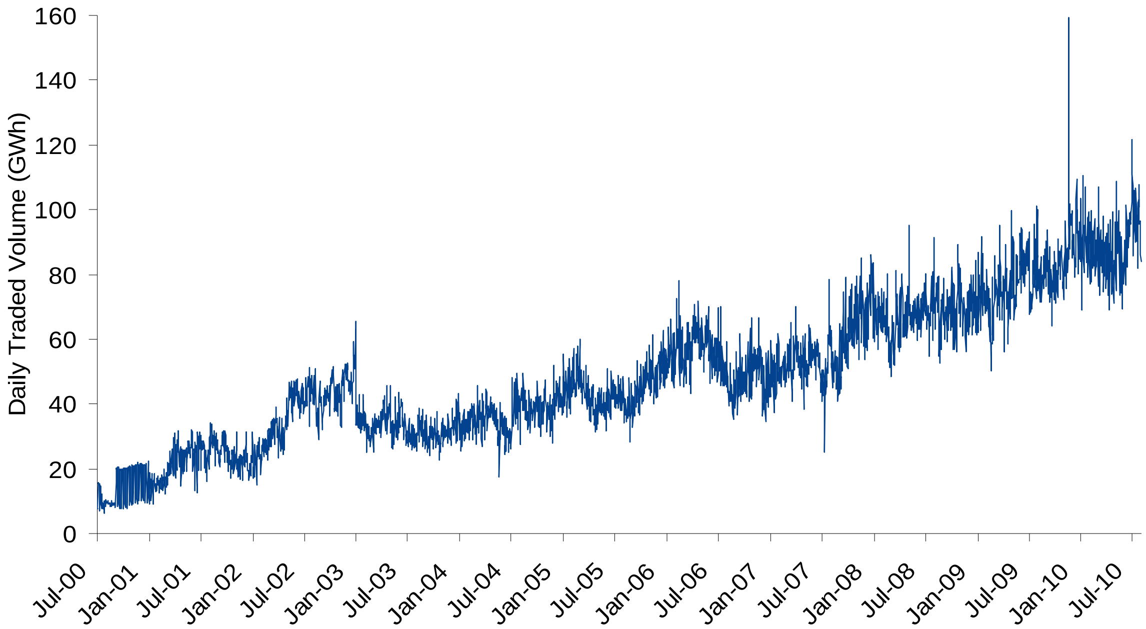
Both standard hourly block contracts, and flexible block contracts, can be traded on the day-ahead market. Standard hourly instruments are traded for each hour of the delivery day and are referred to by APX Power NL as Spot Limit Orders. A set of freely-definable consecutive hourly instruments can also be traded; these are known as Spot Block Orders. Spot Block Orders apply to a consecutive number of single hours and execution is subject to the fulfilment of a maximum payment condition (buy side) or a minimum income condition (sell side).

[3] This loose-volume coupling solution includes the market coupling between the Netherlands and Norway on the NorNed cable.

*Traded volumes*

The volumes traded on the APX Power NL day-ahead spot market have grown steadily since its inception. Figure 2.8 shows the daily traded volumes on the APX day-ahead market from January 2000 to July 2010. The yearly total day-ahead volume traded reached 29 TWh in 2009, up by 17% year-on-year from 25 TWh during 2008. The volumes traded on the APX day-ahead market in 2009 accounts for about 26% of annual electricity consumption of 113 TWh in the Netherlands.

*Figure 2.8 Daily traded volumes on the APX Power NL day-ahead market (GWh)*




Source: APX-ENDEX

Table 2.5 provides a summary of key performance data for the APX Power NL day-ahead market, on an annual basis, for the years 2004-2009. The ratio of day-ahead traded volumes and domestic consumption provides an important measure of market liquidity. This metric has clearly increased in the Netherlands in recent years, from 17% in 2007 reaching 26% in 2009.

*Table 2.5 Day-ahead market performance summary*

| Year | Total volume (TWh) | Average price €/MWh | Domestic consumption (TWh) | Day-ahead share of total consumption (%) |
|---|---|---|---|---|
| 2004 | 13.4 | 31.6 | 113 | 12% |
| 2005 | 16.1 | 52.3 | 115 | 14% |
| 2006 | 19.2 | 58.1 | 116 | 17% |
| 2007 | 20.6 | 41.6 | 118 | 17% |
| 2008 | 24.8 | 70.1 | 118 | 21% |
| 2009 | 29.0 | 39.2 | 113 | 26% |

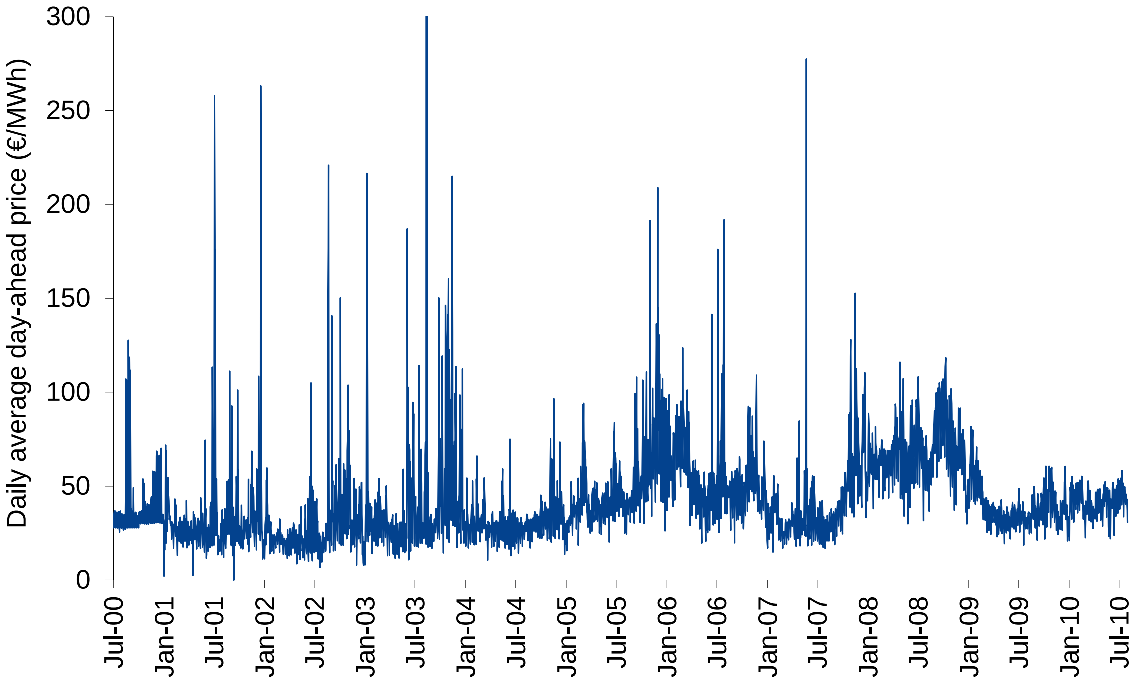
Source: APX-ENDEX

### *Day-ahead prices*

The price in the day-ahead market is set as the marginal price. The minimum price and maximum price allowed for a bid is respectively minus €3,000/MWh[4] and €3,000/MWh, while the minimum bid volume in each hour is 0.1MW. APX Power NL introduced negative prices on the day-ahead market as of 16 December 2009 as a result of the growth of renewable energy production (the price had previously been floored at zero).

Figure 2.9 shows the day-ahead prices on the APX between July 2000 and July 2010.

*Figure 2.9 Daily average APX Power NL day-ahead prices to July 2010 (€/MWh, nominal money)*




Source: APX-ENDEX

On a daily average basis, the majority of day-ahead prices in the years 2000-2010 lie in the range €20/MWh to €100/MWh. Prices occasionally spike to levels as high as €300/MWh on a daily average basis, usually due to short-term 'friction' in supply or demand conditions. The frequency of price spikes has decreased in recent years compared with the period 2000-2004. These years saw very high price spikes particularly in the summer months when capacity margins can become tight due to low plant availability, partly driven by low availability of cooling water.

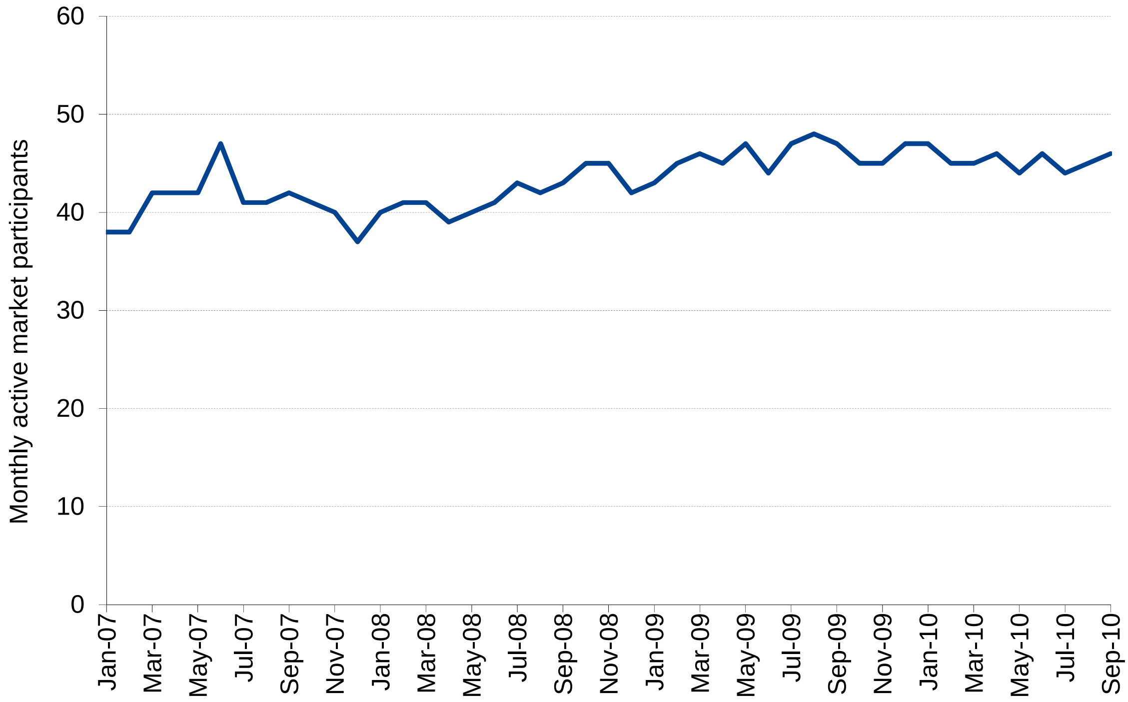
The general price level in a particular year is largely driven by underlying generation market fundamentals such as the cost of coal, gas, oil and, since 2005, carbon. The prevailing capacity margin in the market is also an important driver, with a tight capacity margin inducing higher prices since (i) more expensive plant is required to run at the margin in order to meet demand; and (ii) scarcity often leads to an increased mark-up above the short-run marginal costs of generation emerging in the wholesale price.

[4] APX-ENDEX annual report 2009.

### *Membership and participants*

Compared to total APX Power NL membership of just fewer than 60, Figure 2.10 shows that the number of members active on the day-ahead market in any one month has consistently remained around 45 since January 2009. Over the timeframe 2007-2010, on average the monthly day-ahead participation rate of APX market members has been around 80%.

*Figure 2.10 Monthly number of active APX NL day-ahead participants*




Source: APX-ENDEX

### *APX Power NL Strips market*

APX Power NL also operates a strips market where participants can trade different power strip products continuously up to day-ahead. The market was established in September 2006 at the same time with the intraday market at interest by market parties. It is meant as an alternative market to OTC trading of week-ahead products (due to Dutch law the products traded at the Strips market cannot be traded by ENDEX, and is therefore traded on APX Power NL instead). The Belgium power exchange, Belpex[5], also used to have a similar market, but closed it down due to small volumes. As the market is not very relevant in this context, we will describe it more briefly.

The strips market opens for trading either two days or one weekend before delivery depending on the product. Table 2.6 shows the available products on the strips market in addition to when trading for the different product opens. The strips market operates under a pay-as-bid pricing regime. The minimum price in the market is €0.01/MWh and the maximum price is €3,000/MWh.

5 Fully owned by APX-ENDEX since October 2010.

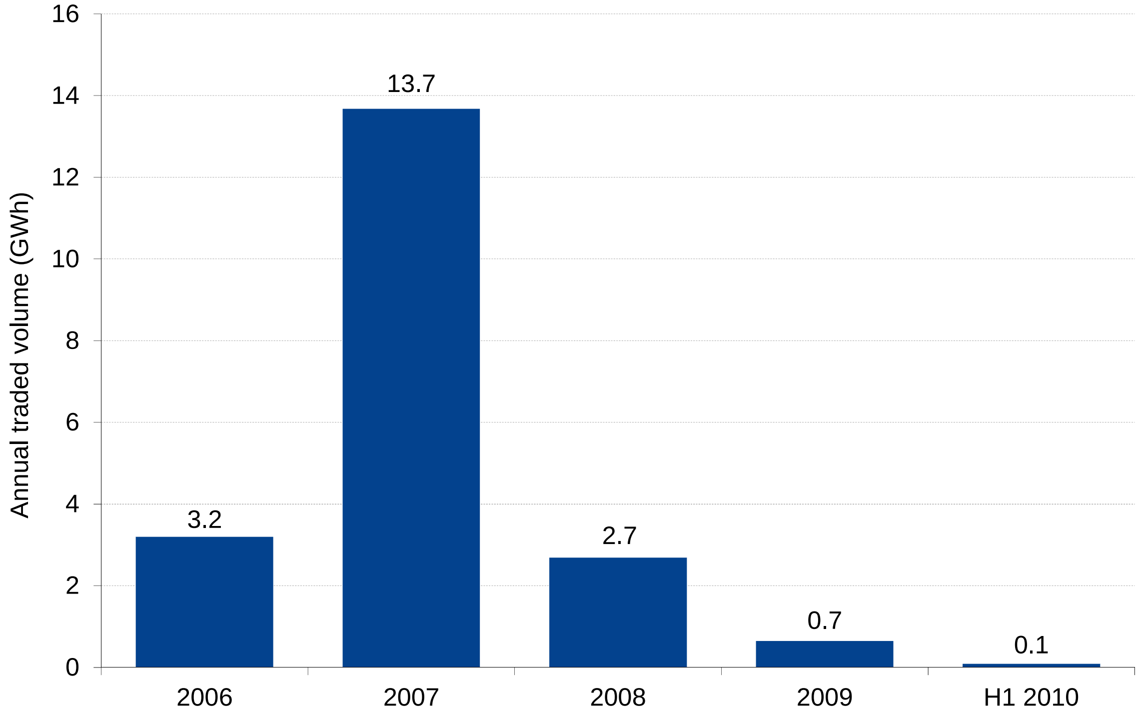
*Table 2.6 APX Power NL strips market products*

| Contract | Period | Hours | Opens for trading |
|---|---|---|---|
| Base day | 00:00-24:00 | 24 | 2 days prior to delivery |
| Peak day | 08:00-20:00 | 12 | 2 days prior to delivery |
| Off-peak day | 00:00-08:00 + 20:00-24:00 | 12 | 2 days prior to delivery |
| Base weekend | 00:00 Sat-24:00 Sun | 48 | 1 weekend ahead |
| Peak weekend | 08:00-20:00 Sat + 08:00-20:00 Sun | 24 | 1 weekend ahead |
| Off-peak weekend | 00:00-08:00 Sat + 20:00-24:00 Sat + 00:00-08:00 Sun + 20:00-24:00 Sun | 24 | 1 weekend ahead |

Source: APX-ENDEX

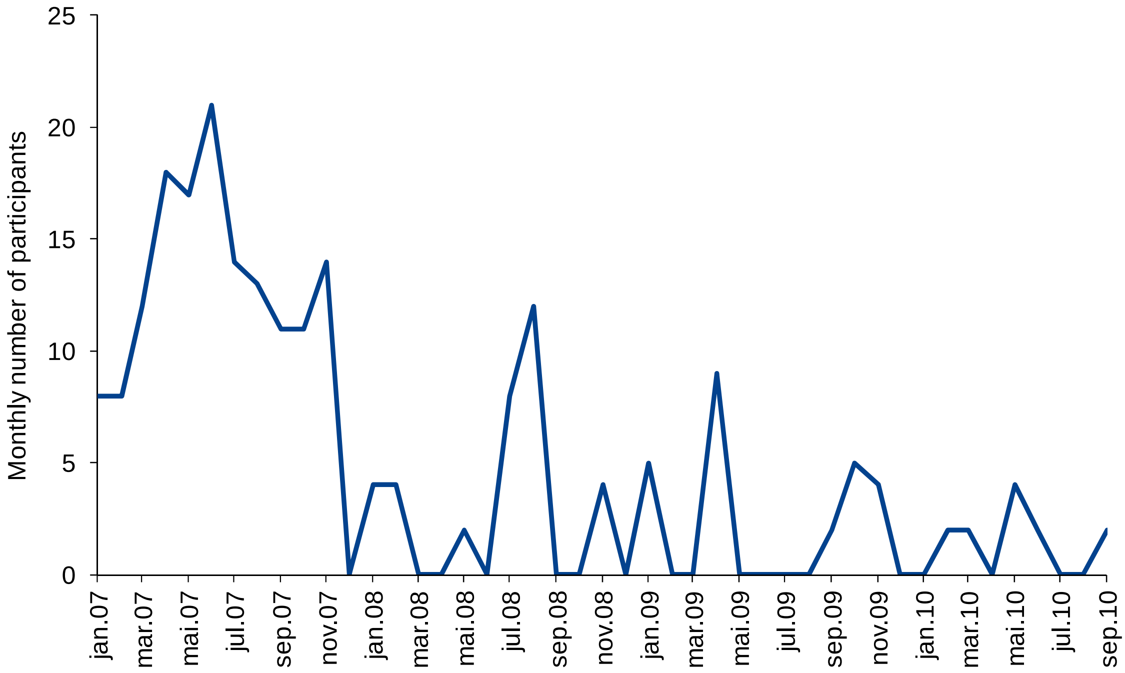
Trading is very thin on the strips market, with very low volumes, which has also seen a steep decrease from 2007 until today. This is shown in figure 11 below. Also, the amount of active participants trading on the Strips market has fallen quite steeply since end of 2007 in accordance with the traded volumes, as can be seen in figure 12 below.

*Figure 2.11 Annual traded volumes on the strips market (GWh)*




Source: APX-ENDEX

*Figure 2.12 Monthly intraday active market participants (since 2007)*




Source: APX-ENDEX

### 2.4.4 APX Power NL intraday market

*General*

APX Power NL also opened their intraday market in September 2006 after interest by market parties in the product. The intraday market opens for trading after gate closure for the APX day-ahead market, and the intraday products can be traded until two hours prior to delivery. The trading is undertaken during two time periods, depending on whether the trade relates to products to be delivered on the same day or the next (the market is not open 24 hours). Trading is else continuous and orders can be entered, amended and cancelled as long as they have not been matched.

Traders use the intraday market to optimise their position in order to reduce the risk of imbalance prices charged by TenneT. The intraday market sees the greatest volumes in the early afternoons when traders fine-tune their positions to avoid anticipated imbalance charges that can quickly rise to very high levels in the Netherlands. The intraday market is also an important tool in portfolio management.

Each trade in the intraday market needs to be notified to TenneT through sending in revised E-programmes (we will comment further on the concept of E-programmes later). If either of the parties in the trade however, fails to do so, or does so incorrectly, the changes in E-programmes will be rejected, effectively cancelling the deal if corrective measure is not undertaken. This implies some risk for the traders.[6]

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[6] It is possible to send in revised E-programmes again in case of rejection; however it is the time aspect (close to real-time trading) which induces the risk. APX Power NL has had a cash-out compensation mechanism in case TenneT did not approve of modification. Whether this mechanism still exists we have not been able to verify. Finally, the requirement for external consistency for E-programmes is to be removed, effectively taking away this risk.

The APX NL intraday market is about to change structure in two important aspects. One is trading platform, where the market will change to the NordPool Spot's Elbas platform in February 2011. This also means that the market will become open 24 hours a day. In addition, the geographical scope of the market will expand, as the intraday market of Belpex will be integrated with that of APX NL. That means both that the transmission capacity between Belgium and the Netherlands has been given to the exchanges by the respective TSOs, and that the trading in Belpex will also use the Elbas trading platform.

### *Intraday products*

Table 2.7 below summarises the available intraday products. The 15 min product (PTE) corresponds to the balancing interval for imbalance settlement, while the 1 hour block corresponds to the time interval of the day-ahead market.

*Table 2.7 APX Power NL intraday market products*

| Contract | Period | Hours | Opens for trading |
|---|---|---|---|
| PTE (15 mins) | 96 instruments of 15 mins/day | 0.25 | Day ahead |
| 1 hour block | 24 blocks of 1 hr/day | 1 | Day ahead |
| 2 hour block | 12 blocks of 2 hrs/day | 2 | Day ahead |

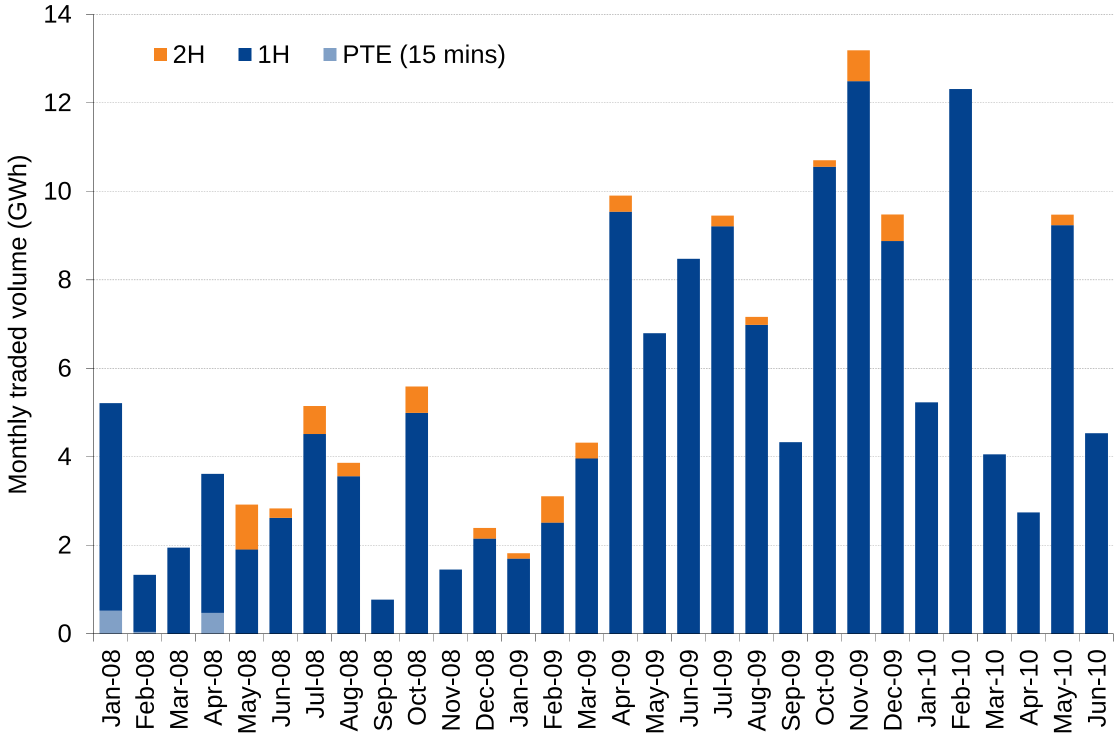
Source: APX-ENDEX

### *Intraday volumes*

Historically, intraday trading in the APX intraday market has tended to be very illiquid. In principle, there should be a strong incentive for market players to fine-tune their position on the intraday market because of the unpredictable and substantial costs which can be occurred through imbalance costs in the Dutch market. However, in the early years of intraday trading this apparent incentive failed to translate into significant market volumes. A reason might be that the total size of the Dutch electricity market has been too small to give sufficient liquidity for an intraday market, which will naturally consist of quite small volumes in relation to day-ahead time frame. Opening hours may also be a factor.

Figure 2.13 shows the monthly traded volume for each of the products available on the APX Power NL intraday market from January 2008 until June 2010, while Table 2.8 shows a summary of annual traded volumes for each product. These show that, in 2009, liquidity increased on the intraday market compared to previous years, although this growth has slowed in the first half of 2010. By far the most traded contracts on the intraday market are one hour blocks, which accounted for almost 96% of total volume in 2009.

*Figure 2.13 Monthly traded volume by product on the APX intraday market (GWh)*




Source: APX-ENDEX

*Table 2.8 Annual intra-day traded volumes by product (GWh)*

| | Product | | | |
|---|---|---|---|---|
| | PTE (15 mins) | 1H | 2H | Total |
| 2008 | 1 | 33 | 3 | 37 |
| 2009 | 0 | 85 | 3 | 89 |
| H1 2010 | 0 | 38 | 0 | 38 |

Source: APX-ENDEX

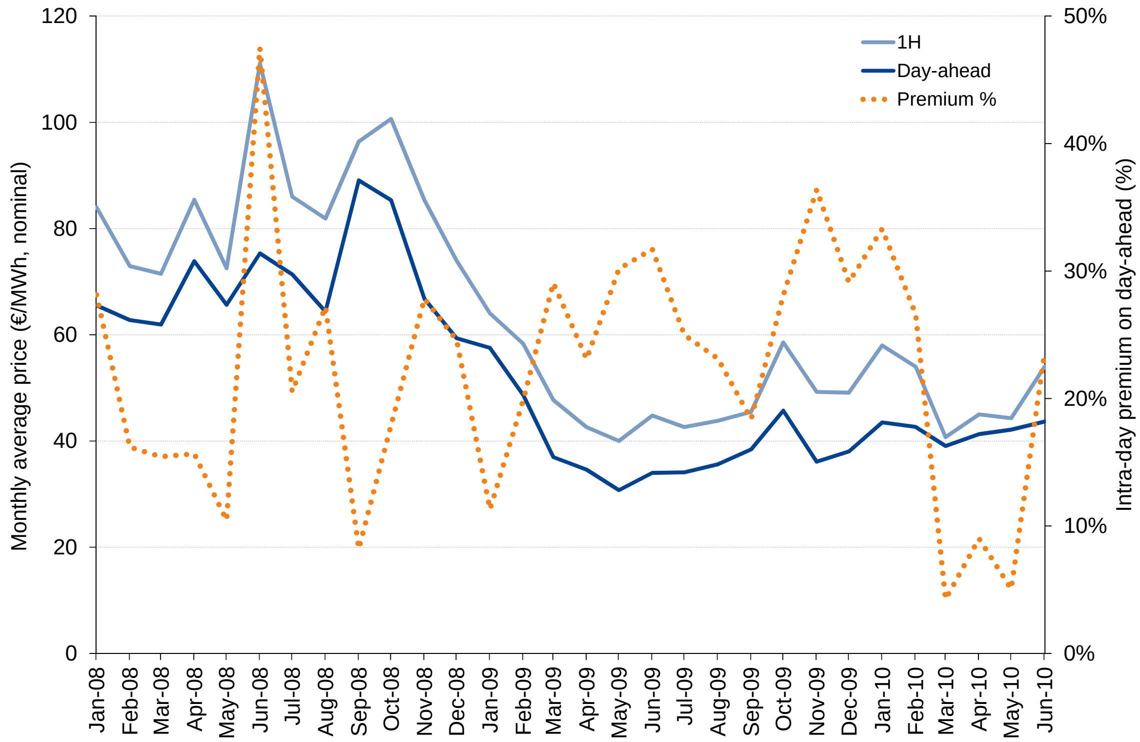
### *Intraday pricing*

The continuously traded intraday market operates under a pay-as-bid pricing regime. As in the day-ahead market, APX Power NL also introduced negative prices on its intraday market as of 16 December 2009 due to renewables (the price had previously been floored at zero.) The minimum price is set at minus €3,000/MWh[7], and the maximum price is €3,000/MWh.

Figure 2.14 compares the monthly average traded price for intraday one hour blocks with monthly average day-ahead prices since 2008. The intraday and day-ahead market prices are very well correlated. The intraday market trades on average at a price premium compared to the day-ahead market: over the last couple of years the monthly average premium has risen as high as 50%, with the average value residing at 22%. Figure 2.15 compares hourly prices on the intraday and day-ahead markets for 2009, which emphasises the fact that intraday prices tend to be higher than day-ahead prices.

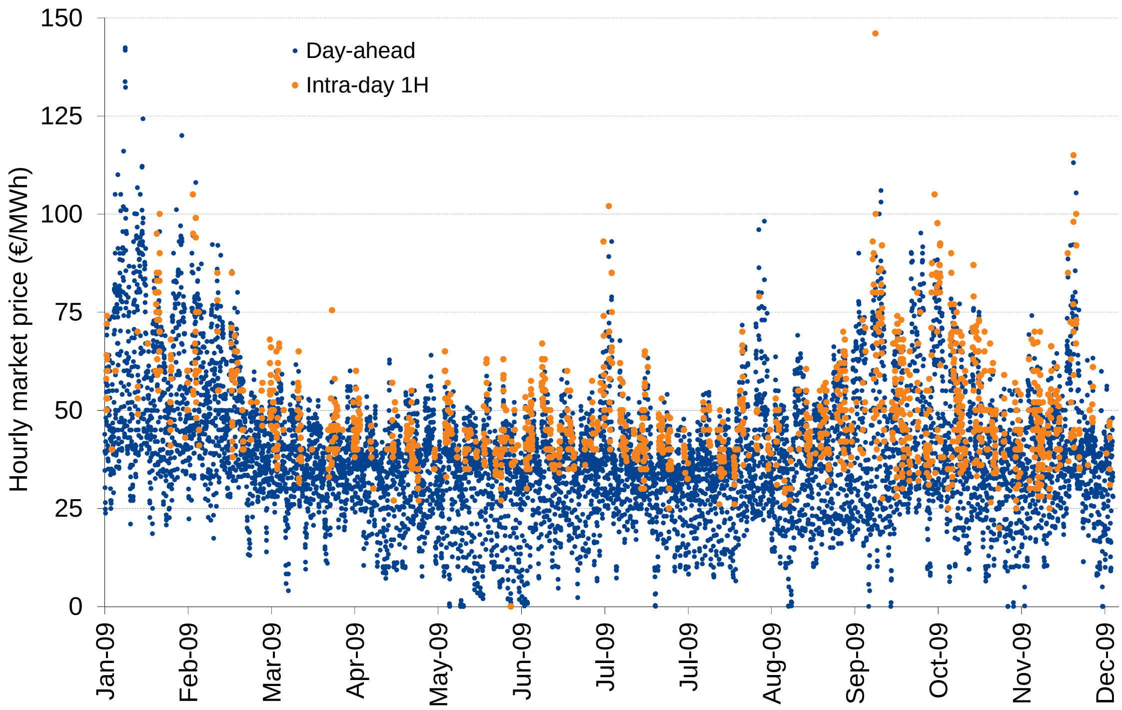
[7] APX-ENDEX annual report 2009.

*Figure 2.14 Comparison of intraday and day-ahead monthly average prices*




Source: APX-ENDEX

*Figure 2.15 Hourly intraday and day-ahead market prices in 2009 (€/MWh)*

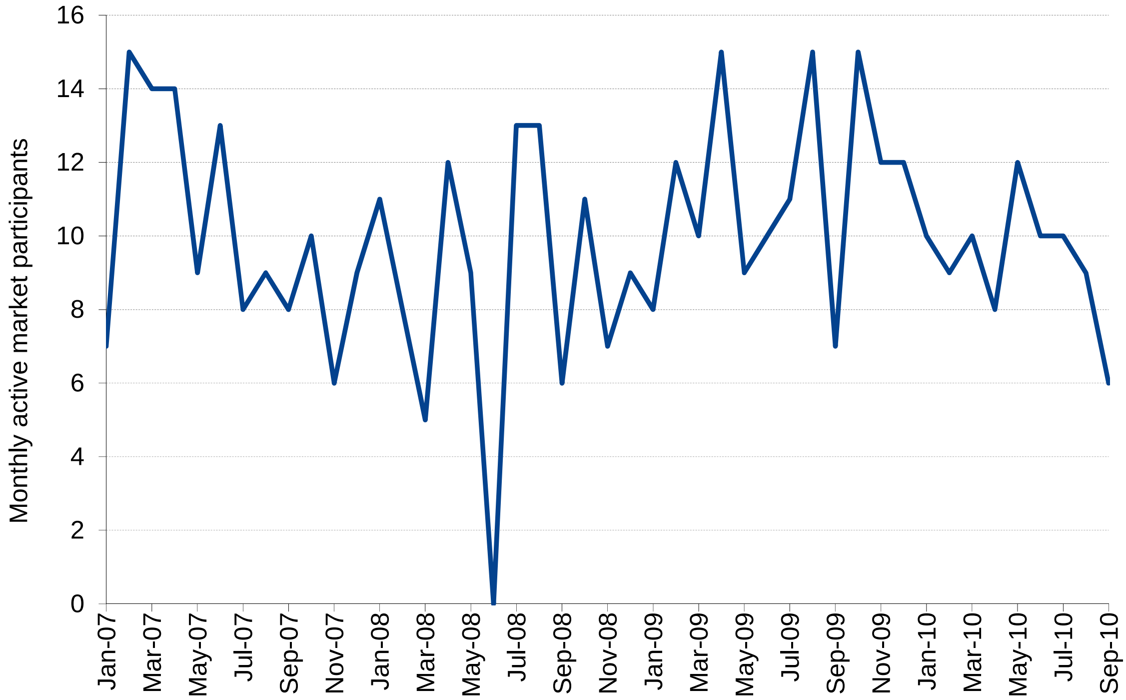



Source: APX-ENDEX

*Membership and participants*

Figure 2.16 presents the monthly number of active intraday market participants since 2007. Over this period of time, the average monthly number of active intraday participants has been 10, in contrast to 43 on the day-ahead market over the same period. In terms of the total number of APX Power NL members, the participation rate in the intraday market has run at around 18% since 2009. Players on the intraday market tend to be those who are concerned with the physical delivery of power, rather than financial players who would be likely to, if necessary, unwind their position in advance on the day-ahead market.

*Figure 2.16 Monthly intraday active market participants (since 2007)*




Source: APX-ENDEX

## 2.5 OTHER INTRADAY TRADING POSSIBILITIES

Intraday may also be traded bilaterally within the Netherlands or traded cross-border with Germany and Belgium. Cross-border trade with Belgium is then to be integrated into the APX intraday market, as stated above.

As with the exchange-based trading, each bilateral intraday trade within the Netherlands needs to be notified to TenneT through sending in revised E-programmes. Again, if either of the parties in the bilateral trade however, fails to do so, or does so incorrectly, the changes in E-programmes will be rejected, effectively cancelling the deal if corrective measure is not undertaken. This also implies some risk for the bilateral traders.[8]

[8] The requirement for external consistency for E-programmes is to be removed, effectively taking away this risk.

### 2.5.1 Cross-border intraday trade

Intraday allocation of capacity is offered explicitly on interconnectors between the Netherlands and Germany and, to be history, on interconnectors between the Netherlands and Belgium.

The allocation method used for the interconnectors with Germany is based on a first-come, first-served with capacity provided for free. The available intraday transfer capacity is published daily on the Intraday Capacity Allocation website (www.intraday-capacity.com) no later than 21:00 hours on the preceding day. A capacity request in respect of a given hour of usage must be submitted or, as the case may be, amended no later than 75 minutes before the hour of delivery, whilst obtained capacity has to be nominated at the latest one hour before usage. In the event that obtained capacity has not been fully nominated completely, the participant will be seen as in imbalance in the imbalance settlement. Obtained capacity is firm once it is allocated.

To participate in this particular market, a participant must be either a Programme Responsible Party (PRP) in the Dutch TenneT system and/or the German equivalent (a Balance Responsible Party) in the German TenneT system (formerly E.ON) or the German Amprion system (formerly RWE). A participant is also required to designate a fixed couple of nomination agents, whereby the participant must be one of these.

The allocation method used for the interconnector with Belgium, which is about to be replaced, was based on capacity being offered in both directions at a number of times during the day (known as “gates”). It was also based on a different principle in that obtained capacity results in a right to nominate this capacity whereas on the German - Dutch border this results in an obligation to nominate capacity. Intraday capacities allocated to participants were firm and managed under the Use It Or Lose It (UIOLI) principle.

The allocated intraday capacity was provided free of charge for the nomination agents. In accordance with the ‘use it or lose it’ principle, capacity that was not nominated within the gate period is lost without compensation and made available for the next gate. The participants requesting and obtaining capacity had to sign the Participation Agreement in the rules for intraday allocation at the Belgian-Dutch interconnection. In addition, to be appointed nomination agent for nominations submitted to Elia or TenneT, the concerned market party had to first have concluded a PRP contract with TenneT and/or the Belgian equivalent (an Access Responsible Party) with Elia.

## 2.6 BALANCING MARKETS

The TSO TenneT is responsible for maintaining the instantaneous balance of supply and demand on the Dutch electricity network, and for resolving constraints which may occur on the transmission network. In order to carry out this function, TenneT operates a market for regulating and reserve power in the Netherlands (or respectively secondary and tertiary reserves according to UCTE definitions). TenneT also uses primary reserves in the balancing of the network.

The bidding procedure for regulating and reserve power was changed in 2010.

### 2.6.1 Primary reserves

The purpose of primary reserves is to stabilise frequency disruptions across the European high-voltage grid. Primary reserves are provided by connected production parties with capacity of 5 MW or more. TenneT controls primary reserves by means of the primary control system, which is an automated device installed locally at the power station. The device automatically instructs small deviations in power output and ensures a constant ratio between system frequency changes and output. All generators with capacity greater than 60 MW are required to provide 1% of their nominal capacity as primary reserve. Compensation is not provided by TenneT for the provision of primary reserve.

### *2.6.2 Secondary and tertiary reserves*

Secondary and tertiary reserves for balancing are procured in the same market but defined as different products. The products are differentiated according to activation time and activation duration.[9]

Parties connected to the Dutch grid whose contracted and allotted transport capacity exceeds 60 MW are obliged to bid in the balancing market. They must make available to TenneT, in the form of bids, any excess power they are capable of generating or any reduction in output they are able to make; or any amount by which they are able to reduce their consumption. Other connected parties of <60MW capacity are allowed to bid in the balancing market, but are not obliged to do so.

Secondary reserves are obtained by TenneT from a number of contracted suppliers, in addition to other suppliers who may offer secondary reserves on a voluntary basis. Contracted suppliers can also offer additional capacity in excess of the contracted quantity. Few official details are publically available regarding the tendering and bidding process for contracted secondary reserves and how this is compensated.

Secondary reserve is the main product for balancing the grid real time.

*Balancing market operation*

The balancing market for power is based on 15-minute time intervals. The mechanism of the Dutch balancing market involves suppliers of secondary and tertiary reserve tendering bids on a daily basis for specified deviations from their intended position. The bids are given initially at 14:45 pm day-ahead and are firm until the time the initial E-Programmes are approved if not otherwise requested by Tennet. Thereafter the bids are open to revision until one hour before the clock hour of the balancing interval in question. Bids must be integer megawatt values – for upward power within 4 to 100 and downward power within minus 4 to minus 100. The price must be in the range of minus €100,000/MWh to €100,000/MWh.

If TenneT is required to bring the system into balance using secondary or tertiary reserves, these bids are called in accordance with a ladder system which means that the best-priced bids are activated first. A single bid price ladder is drawn up combining both the secondary and tertiary reserves for balancing. Marginal pricing is used so that positive bids are settled at the price of the highest bid used and lowest price for negative bids. Very significant discrepancies can occur between bid prices and the day-ahead market price for electricity when supplies are scarce.

A supplier of downward regulating power will normally pay compensation to TenneT if their bid is called. Such a supplier will typically already have sold the energy to some other party, and will therefore save on fuel and other costs by not having to generate. The bid price for regulating power downwards may also be negative, i.e. with TenneT paying for

[9] The bidding system is also used to receive bids for reserve power for ”other purposes”, which is used for resolving internal and external congestion and mutual support between TSOs. These bids are treated separately from the products for system balancing after having been received. The market for reserve power for “other purposes” represents an alternative market to the intraday market or trading for market participants.

the energy supplied to the provider. This would mean that the supplier incurs costs from not producing. Upward regulating power prices are positive.

### *2.6.3 Imbalance settlement*

TenneT uses a Program Responsibility (PR) mechanism to ensure the system is balanced. All responsible PR parties are obliged to set out their physical transactions for each hour in the form of E-programmes to TenneT. A PR party may represent others. The initial E-programme needs to be submitted prior to 14 pm day-ahead. For trades outside of APX Power NL markets (bilateral trades at the day-ahead stage), the E-programme has to specify the counterparty with which that it has traded. For all trades through APX Power NL, they will be the counterparty. As a PR party, it also submits E-programmes to TenneT. This is to ensure the anonymity of parties trading through the APX. TenneT confirms all E-programmes at no later than 17:30 day-ahead. The programmes can be adjusted after the initial approval for the following day, but must be forwarded to TenneT at least two hours before delivery. The revised E-programmes are subject to approval by Tennet. Any deviation from the final approved E-programmes are defined as imbalances and settled with TenneT by the relevant PR party. E-programmes that are internally or externally inconsistent are not approved by Tennet (at initial stage or amended). Under the Dutch system code[10], PR parties are not allowed to intentionally place themselves in a position of imbalance at this point (we will return to this below).

Any party that has deviations from its nominated E-programmes will be cashed-out based on imbalance prices. Imbalance prices are derived from the marginal price for either the supply of extra power to meet demand, or the price paid to generators to reduce output.

Tennet has defined seven regulation states for the Dutch power system, whereof the far most common states are +1 or -1. These are the system being respectively short or long. If the system is short, parties who are also short are cashed-out at the highest accepted bid price plus the incentive component, which are referred to as PRP shortage prices. Parties who are long however, will receive the highest accepted bid price minus the incentive component. If the system is long, parties who are also long will receive the lowest accepted bid price minus the incentive component, which are referred to as PRP surplus prices. Parties who are short however, will be cashed out at the lowest accepted bid price plus the incentive component.

In the other operating stages, the imbalance settlement will be different. In case of no regulation, the imbalance price is set as the mid-price between the lowest bid price at the upward and the highest price at the downward regulating side adjusted with the incentive component depending on the party being short or long. In case of regulation which cannot be defined as the system being either short or long, a party who is short will be cashed-out the highest accepted bid price plus the incentive component, and a party who is long will be paid the lowest accepted bid price minus the incentive component.

The incentive component is however almost always zero. It is set weekly and is based on the size of inadvertent exchanges with other countries.

The imbalance pricing system will therefore in practice remunerate those parties who are short or long in the right direction.

[10] http://www.energiekamer.nl/engels/electricity/decisions_electricity/codes.asp

*Balancing market incentives*

The principle which underpins the imbalance pricing system in the Netherlands is the use of a market-led imbalance price which correlates with the true variable costs of sourcing regulating, reserve and emergency power.

According to TenneT, the design of the imbalance pricing system is intended to generate a number of market incentives:

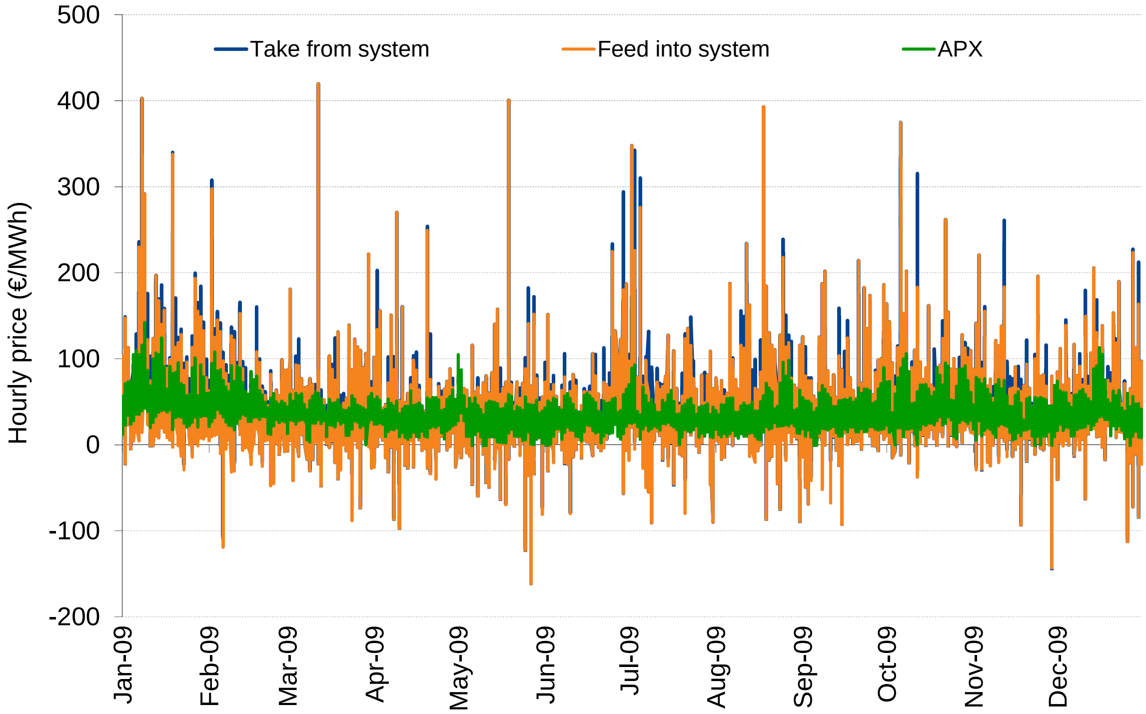
- At the preparatory stage (day-ahead):
  - incentive to minimise imbalance;
  - any imbalance should be inadvertent; and
  - the risk of bidding should be less or equal to the risk of not bidding in the balancing market.
- At the implementation stage (real-time):
  - discourage actions which disrupt system balance;
  - incentivise actions which restore system balance; and
  - the risk of requested actions should be less or equal to the risk of unrequested actions.

The second point above is important. There is a clear and explicit incentive in the system to passively provide balancing power which helps restore system balance. Tennet also provides approximately real-time data on the system balance and volumes and prices for actual up- and down regulation undertaken by Tennet. The reason is to provide for cheaper balancing.

### 2.6.4 Prices and volumes

Figure 2.17 illustrates how the PRP shortage prices or ‘take from system’ prices and PRP surplus prices referred to as ‘feed into system’ prices compare to the APX price during 2009 (each is charted as an average in each hour).

*Figure 2.17 Imbalance prices in the Netherlands during 2009 (nominal €/MWh)*




Source: TenneT, APX-ENDEX and Pöyry Energy Consulting analysis

The chart illustrates the point that imbalance prices are highly volatile, which is reinforced by the standard deviation from the mean for each price summarised in Table 2.9. This means that the imbalance costs can be quite substantial for players in the Dutch electricity market. The desire to avoid unpredictable imbalance prices has resulted in some growth in intraday trading on APX Power NL, although liquidity on the intraday market is arguably still low given the significant imbalance risks.

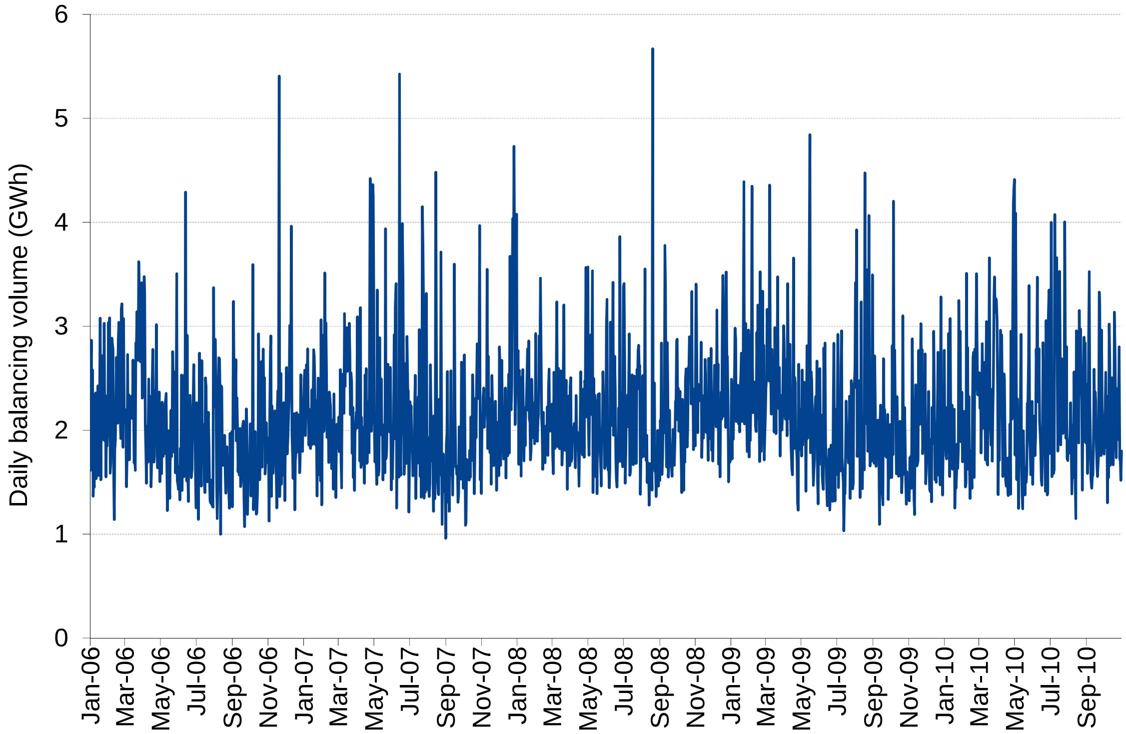
*Table 2.9 Summary of imbalance prices in 2008 (€/MWh, nominal)*

| €/MWh | Average | Standard deviation |
|---|---|---|
| APX | 39.37 | 16.27 |
| Take from | 42.95 | 37.45 |
| Feed into | 38.32 | 35.32 |

Source: TenneT, APX-ENDEX, Platts and Pöyry Management Consulting

Figure 2.18 shows the daily power volumes called (activated) by TenneT for the purposes of system balancing since 2006. This volume includes the activation of both secondary and tertiary reserve. Although balancing volumes are relatively volatile on a daily basis, over this timeframe, the average daily balancing volume has remained at around 2GWh. Annual total balancing volumes since 2006 are shown in Figure 2.19. The average level for the years 2006-2009 is 776GWh. This compares with annual Dutch consumption of 113TWh in 2009 when balancing volumes were 0.7% of the level of national consumption.

*Figure 2.18 Daily balancing activated volumes (GWh)*




Source: TenneT

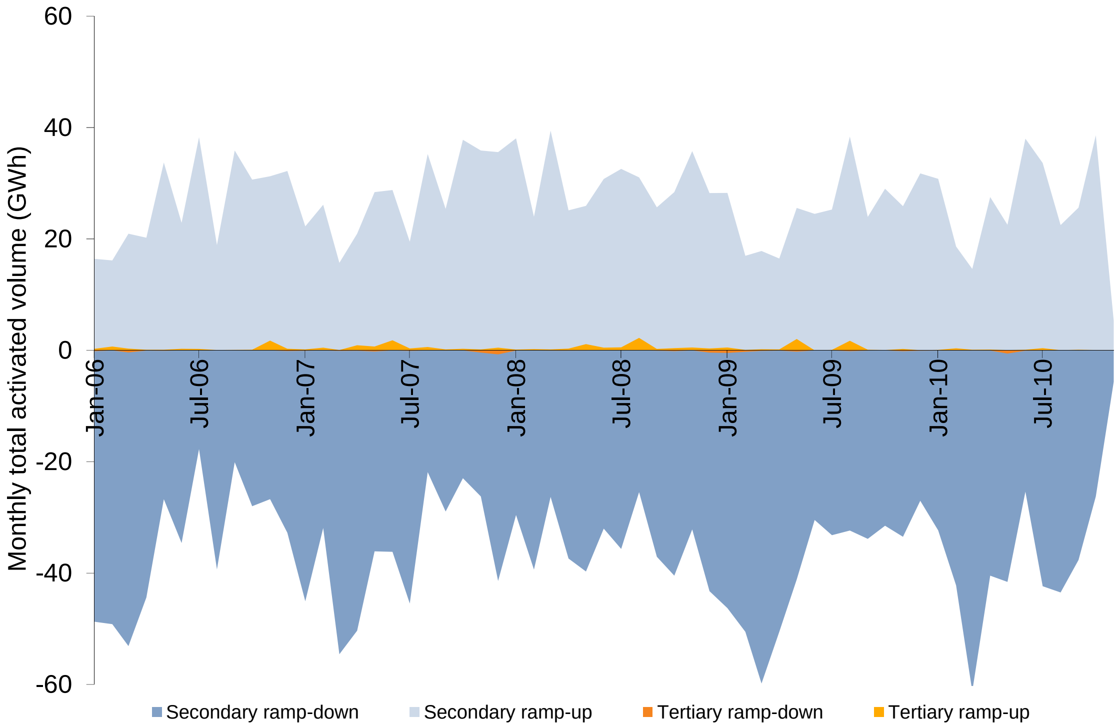
*Figure 2.19 Annual total balancing volumes (GWh)*

| Year | Balancing volume (GWh) |
|---|---|
| 2006 | 747 |
| 2007 | 783 |
| 2008 | 793 |
| 2009 | 782 |
| 2010* | 671 |

* Year to October
Source: TenneT

Figure 2.20 presents monthly total balancing volumes since 2006, but in this case broken down into secondary and tertiary reserve components, and by balancing direction (ramp-up or ramp-down). The chart shows that total activated volumes for secondary reserves are much larger than for tertiary reserves. On average since 2006, tertiary reserves have accounted for only 1% of activated volume in the balancing market. Although the monthly volumes of either ramp-up or ramp-down power vary quite significantly from month to month, the overall balancing volume varies less; the average monthly volume was 64GWh over the time period shown. On the whole, ramp-down volumes are slightly higher than ramp-up volumes: ramp-down power accounts for around 57% of total secondary and tertiary reserve activated volume.

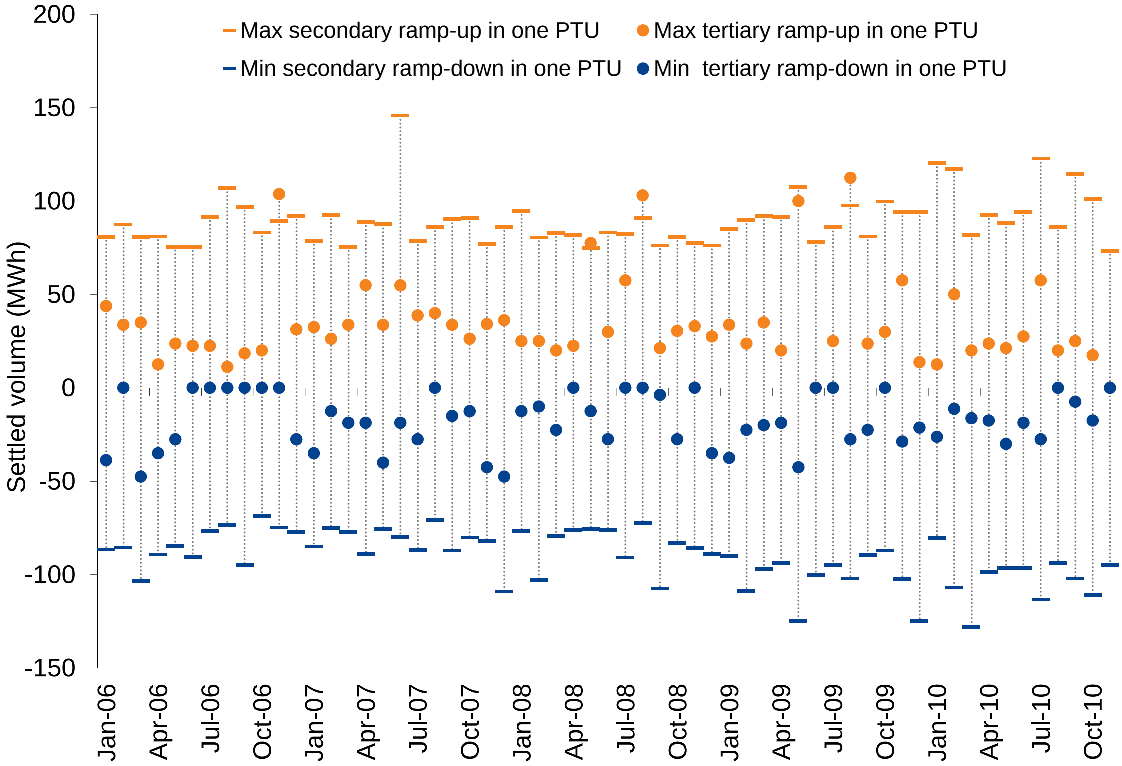
*Figure 2.20 Monthly total balancing activated volumes (GWh)*




Source: TenneT

Although total activate volumes of tertiary reserve are low compared with secondary reserves, there is a much smaller difference in the maximum ramp-up or ramp-down activation in any one quarter-hour (PTU). Figure 2.21 shows the maximum activated ramp-up or ramp-down volume activated by TenneT for both secondary and tertiary reserve for each month since 2006. In fact, in some months (e.g. August 2008 and August 2009), the maximum tertiary reserve ramp-up exceeds that for secondary reserve. In general, however, maximum tertiary and secondary reserve activation levels remain at similar levels from month to month.

*Figure 2.21 Maximum activated volume in a single quarter hour by month (MWh)[11]*




Source: TenneT

### 2.6.5 Membership and participants

As already stated, regulating power is obtained by TenneT from a number of contracted suppliers, in addition to other suppliers who may offer this on a voluntary basis. Contracted suppliers can also offer additional capacity in excess of the contracted quantity. Few official details are publically available regarding the tendering and bidding process for contracted secondary reserves and how this is compensated. It is neither public information how many suppliers who are contracted.

The amount of active participants in the regulating and reserve market is also not public information. It is however not unlikely that regulating power is largely supplied by the primary players in the Dutch generation market, who are then, at least in part, also likely to be contracted.

11 To translate the volumes into per hour, it is necessary to multiply the given volume by four.

## 2.7 MARKET CONCENTRATION

In its latest energy market monitoring report (September 2008)[12], NMa reported that liquidity in the Dutch electricity market was generally developing in a favourable direction as of the end of 2007, in particular on the day-ahead APX market. Some concern was still held about liquidity on the OTC market, however. At that time, three measures was seen as necessary to improve the functioning of the electricity market: increase available import capacity, remove impediments to connect new power plants to the grid and improvement of the functioning of the gas markets.[13] On the two first points, improvement has been seen since the report (CWE and CWE/Nordic market coupling and connection of new power plants).[14]

On a more general note, it is stated in the report that “although there is a clear correlation between the high concentration in supply and the level of the electricity price and there are indications that production companies use their strong market position to influence the market outcomes, no proof has been found to confirm this suggestion”.[15] As understood, it is in particular during peak hours where producers may encounter limited competitive pressure. Data in the report for 2007 indicate the following percentages of hours with a pivotal player: All hours: 34%, Peak hours: 70%, Off-peak hours: 4% and Super peak hours 80%.[16]

Also, the report calculates the HHI index for capacity in the Netherlands for all hours to be 2076 excluding imports and 1592 including imports.[17] The latter figure places the Netherlands as moderately concentrated.

### *2.7.1 Activity and liquidity on Dutch markets*

Figure 2.22 compares total annual volumes for the three markets since 2006. Traded volumes in the Dutch day-ahead market are much larger than those in either the intraday or balancing markets. As already discussed, liquidity on the day-ahead market has seen a favourable development with an increase in traded volumes and a quite high stable amount of active participants. The traded amount on the intraday market have had some positive development however more instable. The number of active participants is also quite variable, but on average at about 23% of that in the intraday market.

[12] Monitor Energy Markets 2007’; NMa, September 2008 (latest information available).

[13] See page 6 of the report.

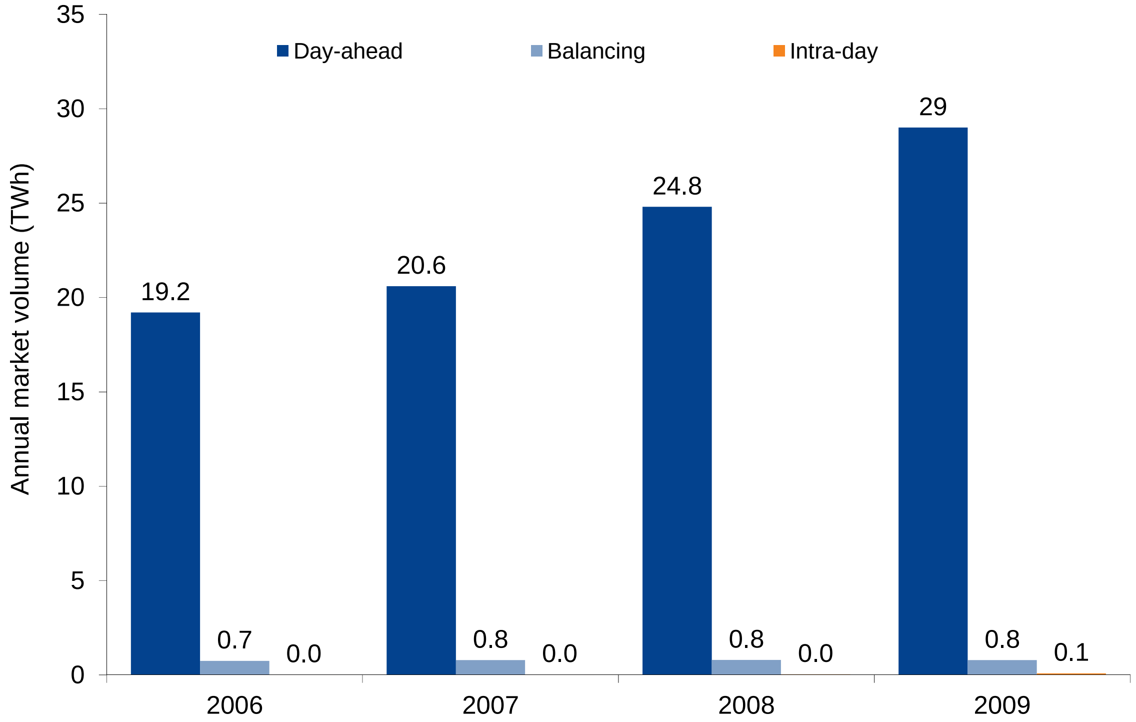
[14] Potential development in the gas market has not been analysed.

[15] See page 6 of the report.

[16] See page 96 of the report.

[17] See page 96 of the report.

*Figure 2.22 Comparison of historical Dutch market volumes (TWh)*




Source: APX-ENDEX, TenneT

# 3 THE NORWEGIAN ELECTRICITY MARKET

## 3.1 BACKGROUND

In comparison to the Netherlands, Norway is a larger electricity market in terms of domestic demand and installed capacity. The difference is however not very large. The production mix is though very different as the Norwegian electricity generation mix is highly dominated by hydro power. In total, hydro power accounts for about 96% of the installed capacity. As in the Netherlands, this is due to natural resources.

Whether Norway is a net exporter or importer of electricity depends on the hydrological situation. During the years 2000 to 2008, Norway was a net importer during four of these years and net exporter in the rest.[18] As part of a Nordic power market most of the power exchange is with the rest of the Nordic countries. Since 2008, Norway has also been connected with the Netherlands through the NorNed cable. The Nordic countries are further connected to Germany, Poland, Russia and Estonia.

Table 3.1 summarises the key physical characteristics of the Norwegian electricity market.

*Table 3.1 Key facts and figures for the Norwegian electricity market*

| Data category | Situation in 2009 | Comments |
|---|---|---|
| Domestic consumption | 123.8 TWh[19] | 3,4% decrease from 2008 |
| Domestic production | 132.8 TWh | 6,6% decrease from 2008 |
| Trading | 76,4 TWh on Day-Ahead market | Accounts for most of the physical market |
| Interconnection flows | Net exports of 9 TWh | 1.2 TWh of imports and 2.9 TWh of exports to the Netherlands |
| Peak demand | 23.9 GW | Import capacity of just over 5,5 GW |
| Installed capacity | 30,7 GW | 96% is hydro power |
| Market coupling within the Nordics | Single price in all of Nord Pool Spot 25% of traded hours | 9% in 2008 (record low). Price differences between areas within 6% of system price with exception of DK 2 |

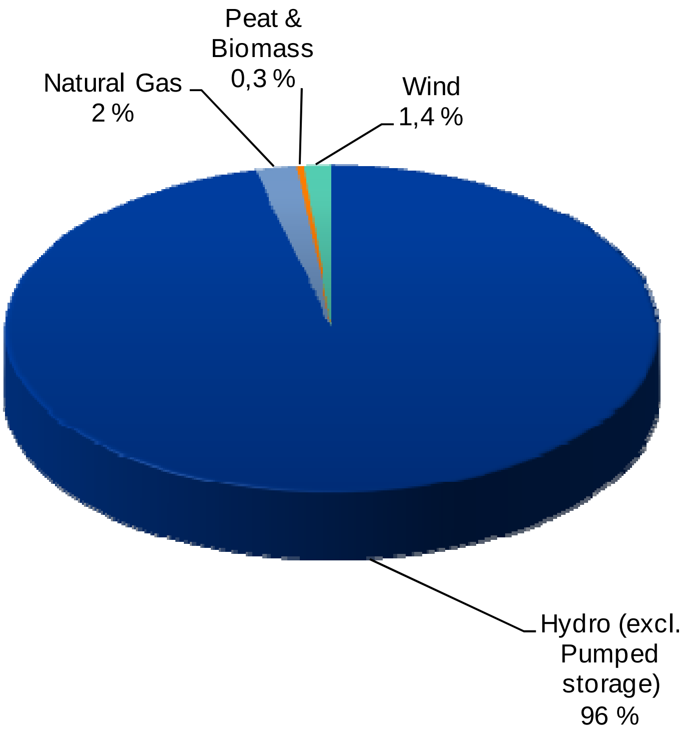
Sources: NVE, Nordel, ENTSO-E, Nord Pool Spot and Pöyry Management Consulting

Figure 3.1 below shows the share of installed capacity of the different production technologies in Norway. The generation structure in the Nordics, which Norway is then highly interconnected with, is however more varied and consists of hydro, nuclear, wind and various conventional thermal sources.

18 Source: SSB electricity statistics

19 Including network losses

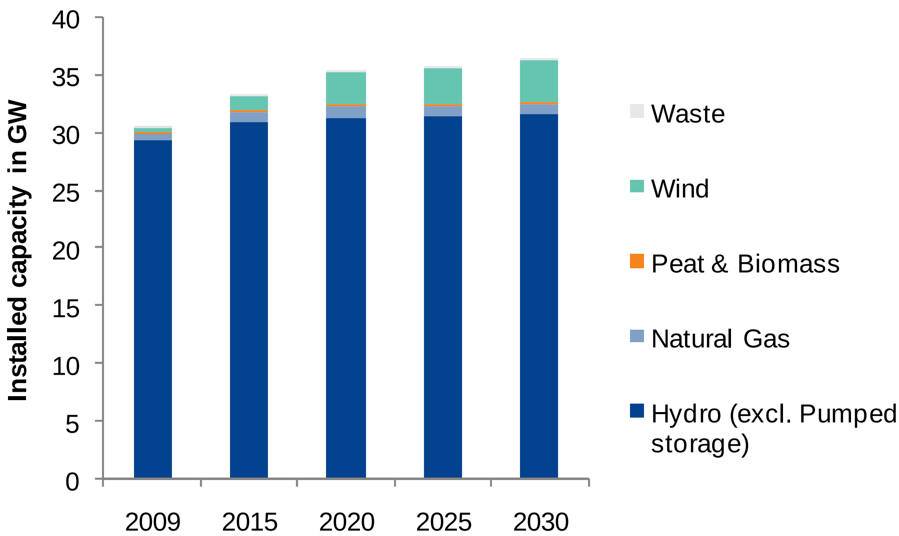
*Figure 3.1 Installed capacity in Norway in GW, 2009*




Source: Nordel

The future generation capacity in Norway is also expected to increase, with a main driver being climate change policies and targets also in Norway. Figure 3.2 shows Pöyry's projections of installed capacity in Norway. Further interconnector capacity outside of the Nordics is also being planned.

*Figure 3.2 Pöyry projection of Norwegian installed capacity (GW)*

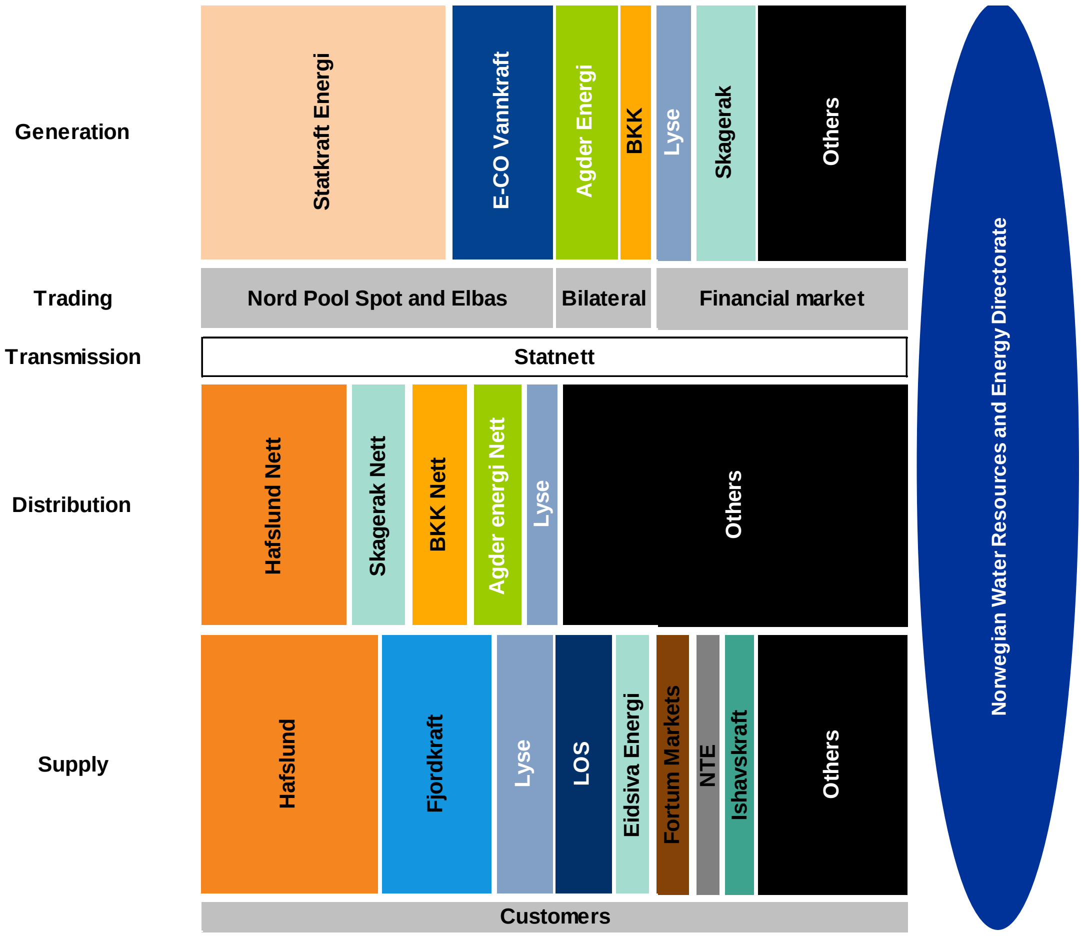



Source: Pöyry Management Consulting

## 3.2 KEY PLAYERS

Figure 3.3 below shows the structure of the Norwegian electricity market. The size of the boxes indicates market shares, and the colours indicate ownership. In the figures for generation below, production companies which are owned 100% by other production companies, have been included in the owner company. The figure below therefore does not illustrate the total market share of in particular Statkraft. Statkraft has large ownership shares in among other Skagerak Energi (66,62%), BKK (49,9%) and Agder Energi (45,5%), the latter three all shown independently in the figure below. Cross-ownership is quite normal in the Norwegian market.

*Figure 3.3 Norwegian electricity market structure*




Sources: Europower, Nord Pool Spot, Nasdaq OMX, company homepages/annual reports and Pöyry Management Consulting analysis

Ownership of Norwegian generation resources is largely public due to ownership rules regarding hydro power. As in the Netherlands, generation assets of many of the production companies tend to be more clustered geographically.

## 3.3 MARKET AND TRADING OVERVIEW

Figure 3.4 below provides a simplified overview of the Norwegian market arrangements.

Electricity in Norway is traded both bilaterally and in organized markets, the latter through the Nordic power exchange, Nord Pool Spot. However, in comparison with the Netherlands, where bilateral physical trade of electricity is very important, a much larger share of the physical market in Norway is traded on the day-ahead exchange. As in the Netherlands, the bilateral markets include both standardized bilateral contracts (OTC) and non-standardized type contracts.

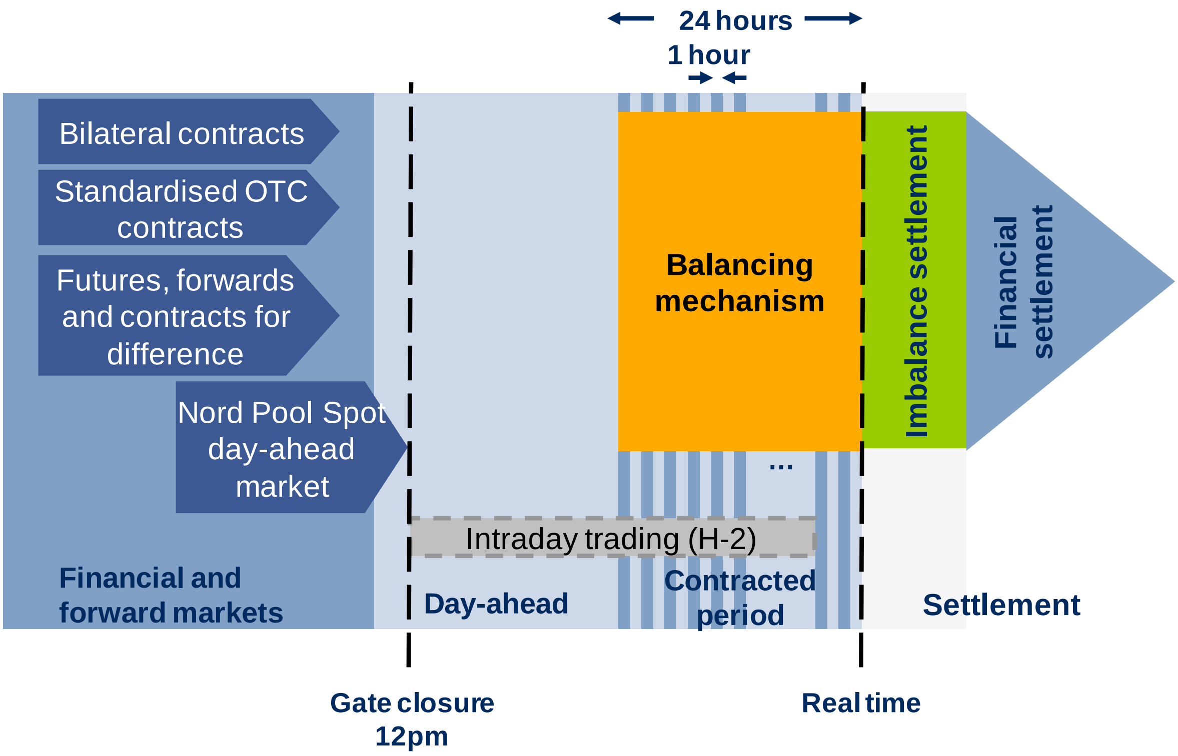
Physical bilateral trading has to be undertaken within price areas in Norway (to be explained below), as all transmission capacity between price areas has been given to the power exchange. Bilateral trading is possible both up to day-ahead time frame and during intraday time frame.

Nord Pool Spot runs the day-ahead market, Elspot, and the intraday market, Elbas in Norway, or more correctly, the Nordics. In addition, Estonia is included in Elspot, and both Germany and Estonia in Elbas.

The balancing market is operated by the TSO, Statnett, who is responsible for system operation.

Finally, NASDAQ OMX provides a financial market for the Nordics.

*Figure 3.4 Norwegian wholesale market arrangements*




Source: Pöyry Management Consulting

## 3.4 NORD POOL SPOT

Nord Pool Spot is the common power exchange for the Nordic countries, and is the largest electricity exchange in the world. It was established in 1992 as Statnett Marked AS, functioning as a Norwegian market only. Then in 1996, Sweden joined and the exchange changed name to Nord Pool ASA. Further, Finland joined in 1998 and finally Denmark in 2000. In 2002, Nord Pool Spot was established as a separate company separating it from the financial market (and clearing house).

Nord Pool Spot is owned by the Nordic TSOs, where Statnett and Svenska Kraftnät own 30% each and Fingrid and Energinet 20% each.

Nord Pool Spot provides a market place to producers, energy companies and large consumers on which they can anonymously buy or sell electrical energy. Nord Pool Spot is the central counter party in all trades, guaranteeing settlement for trade.

Membership in Nord Pool Spot gives access to both Elspot and Elbas, or only Elbas, depending on wish. A balance responsible agreement with Statnett, or agreement with such a party, is necessary to trade on the exchange.

### 3.4.1 Members

Membership in Nord Pool Spot can be either as a direct participant, trading and clearing representative, or clearing customer. A direct participant in Nord Pool Spot is a full member trading on own behalf. A trading and clearing representative however will trade on both own behalf and on behalf of others. A clearing customer is then represented by a trading and clearing representative. The structure of membership is a little different of that of APX NL, but both exchanges permit that members either trade directly or through another party.

The total amount of members in Nord Pool Spot, trading in either or both Elspot and Elbas is about 341 as of 2011. Total amount of members in Elspot is about 341 and in Elbas about 98.[20]

Table 3.2 shows how membership in Elspot and Elbas is divided between type of membership and by country of origin of the member.

*Table 3.2 Amount of members in Elspot and Elbas by country of origin and membership type (as of January 2011)*

| | Elspot | | | | Elbas | | | |
|---|---|---|---|---|---|---|---|---|
| | Direct | Clearing | Repr. | Total | Direct | Clearing | Repr. | Total |
| Norway | 40 | 85 | 3 | 128 | 17 | 3 | 2 | 22 |
| Sweden | 14 | 92 | 3 | 109 | 11 | 6 | 1 | 18 |
| Denmark | 8 | 9 | 0 | 18 | 4 | 1 | 0 | 6 |
| Finland | 19 | 23 | 1 | 42 | 19 | 2 | 1 | 21 |
| Estonia etc | 9 | 6 | 0 | 15 | 3 | 1 | 0 | 4 |
| Germany etc | 26 | 3 | 0 | 29 | 25 | 2 | 0 | 27 |
| Total | 116 | 218 | 7 | 341 | 79 | 15 | 4 | 98 |

*Repr.= Representative

Source: Nord Pool Spot and Pöyry Management Consulting analysis

In comparison to APX NL, the membership level of Nord Pool Spot is much larger, which is not unnatural as it covers a larger geographical area. Compared only to the membership level of Norway, APX NL also has a lower number of members, about half of the amount.

An overview of the different members in Nord Pool Spot is found in the appendix (the list is too large to be included here).

[20] According to membership lists on Nord Pool Spot's homepage as of January 2011.

### 3.4.2 Trading costs

A summary of the trading costs for Elspot and Elbas, both fixed and transaction fees, can be found in Table 3.3 and Table 3.4. There is a reduced fee for participants trading only in Estonia, which includes Elspot and Elbas, which is the same price as membership in Elbas only.

*Table 3.3 Elspot fees (as of 1. January 2011)*

| Membership type | Annual fixed fee | Variable trading fee (€/MWh) | Variable settlement fee (€/MWh) | Gross bidding (€/MWh) |
|---|---|---|---|---|
| Direct participants Elspot and Elbas | €15,000 | €0.03* | €0.0025 | 0.003 |
| Trading and Clearing representative Elspot and Elbas | €15,000 | €0.03 | €0.0025 | |
| Clearing customers Elspot | €1,500 | €0.03 | €0.0025 | |
| Additional area/portfolio | €1,500 | | | |

*0.13 for small direct participants
Source: Nord Pool Spot

*Table 3.4 Elbas fees (as of 1. January 2011)*

| Membership type | Annual fixed fee | Variable trading fee (€/MWh) | Variable settlement fee (€/MWh) |
|---|---|---|---|
| Direct participants Elbas | €10,000 | €0.08 | €0.0025 |
| Clearing customer Elbas | €10,000 | €0.08 | €0.0025 |
| View only license Elbas | €10,000 | | |
| Additional area/portfolio | €1,500 | | |

Source: Nord Pool Spot

Small direct participants at Elspot may choose to waive the annual fee and pay a higher variable trading fee instead. Total charges is then floored at 3 000 euro per year. Direct participants may choose to undertake so-called gross bidding, which implies giving separate bids for production and consumption (sell and buy bids) and thereby trade through the exchange, instead of submitting a net bid for the company. In 2007 a new fee structure was added to incentivize gross bidding for (especially) the large members. Membership is connected to a given bidding area, and there is a cost to be able to trade in an additional area. In this regard, Norway is seen as one bidding area and not as five (Norway is divided into five price areas or bidding areas, as we will return to below).

In Elbas, there are also fees for ancillary services connected to electronic transmission of data.

As can be seen, the fixed fee for trading in Elspot (with Elbas included) is higher than trading in Elbas only. However, the variable trading fee is higher in Elbas. Compared to APX NL, it is quite less expensive to trade on Nord Pool Spot; fixed fees for a full membership is half the price in Nord Pool Spot of that in APX NL. Nord Pool Spot however includes more members to share the costs.

### 3.4.3 Nord Pool Spot day-ahead market Elspot

*General*

The day-ahead exchange market is traded at Nord Pool Spot's Elspot market. Trading takes place at 12:00 on one day for delivery for 24 hours the next day. The price calculation is based on the balance between bids and offers from all market participants – finding the intersection point between the market's supply curve and demand curve (auction trading).

Elspot is the common power exchange for all the Nordics countries. It also includes a bidding area for Estonia. Interconnector capacity between the Nordic countries, and also capacity on certain connections within the Norwegian grid, has been given to the exchange by the respective TSOs. The interconnector capacity is then allocated implicitly in the day-ahead auction. A single unconstrained price is calculated for the whole area, named the system price. If congestion is discovered during the calculation of the system price, market splitting will occur, and two or more area prices will emerge.

Market participants submit their bids at 12:00 CET. The system price is calculated on the basis of all bids posted for the entire Nordic power exchange area. Separate calculations of prices are made for each delivery hour of the following day. The bids to buy and sell for each hour the following day are compiled by Nord Pool Spot into an overall curve for the demand and an overall curve for the supply. The intersection point of the two curves determines the unconstrained hourly system price, which apply as a reference price for the entire Nordic region. In situations where the unconstrained calculation shows that the contractual flow of power exceeds the limitations in the grid capacity between the bid areas, a new round of Elspot price calculations must be made to determine one or several area prices for the hours in question using market splitting.

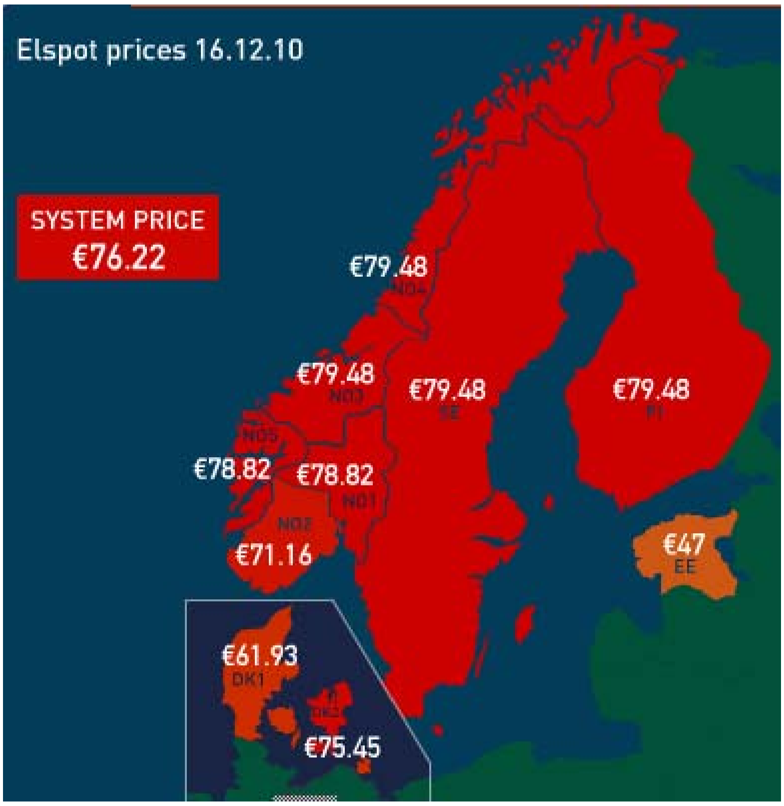
To achieve this, the total geographic market is divided into bidding areas, so that the bids entered by the participants are connected to a bidding area, equal to the price areas. The Norwegian grid is currently divided into five bidding areas. In the rest of the Nordic market, Sweden is currently one bidding area (but will be divided into four as of 11$^{th}$ November 2011), Finland is one bidding area and Denmark is divided into two bidding areas.

Figure 3.5 below illustrates the concept of system and area price, as well as showing the different price areas which currently apply.

The Nordic day-ahead market is further coupled to the Central Western European region through loose-volume coupling between the Nordics and CWE, which we will return to in a separate chapter.[21]

[21] This loose-volume coupling solution includes the market coupling between Norway and the Netherlands on the NorNed cable.

*Figure 3.5 System price, area prices and bidding areas in Elspot on 16.12.2010*




Source: Nord Pool Spot

### *Day-ahead market products*

Both standard hourly bids, flexible hourly contracts and block contracts, can be traded on the day-ahead market. The hourly bid is the most common type of bid. For the hourly bid, the participant selects the range of price steps for each hour individually. A block bid is a joint bid for several consecutive hours with a fixed price and volume for all the hours in the block. The participants can freely pick the start and stop hour of a block. The block bids are compared with the hourly bid prices within the block period and if the average price is higher than the bid price, the bid will be accepted in full. It is also possible to define links between block bids meaning that the evaluation and acceptance of one block bid is dependent on the acceptance of another block bid, and it is possible to link up to three block bids together. A flexible hourly bid is a sales bid for a single hour with a fixed price and volume. The hour is not specified, but instead the bid will be accepted in the hour with the highest price in the calculation, given that the price is higher than the limit set in the bid.

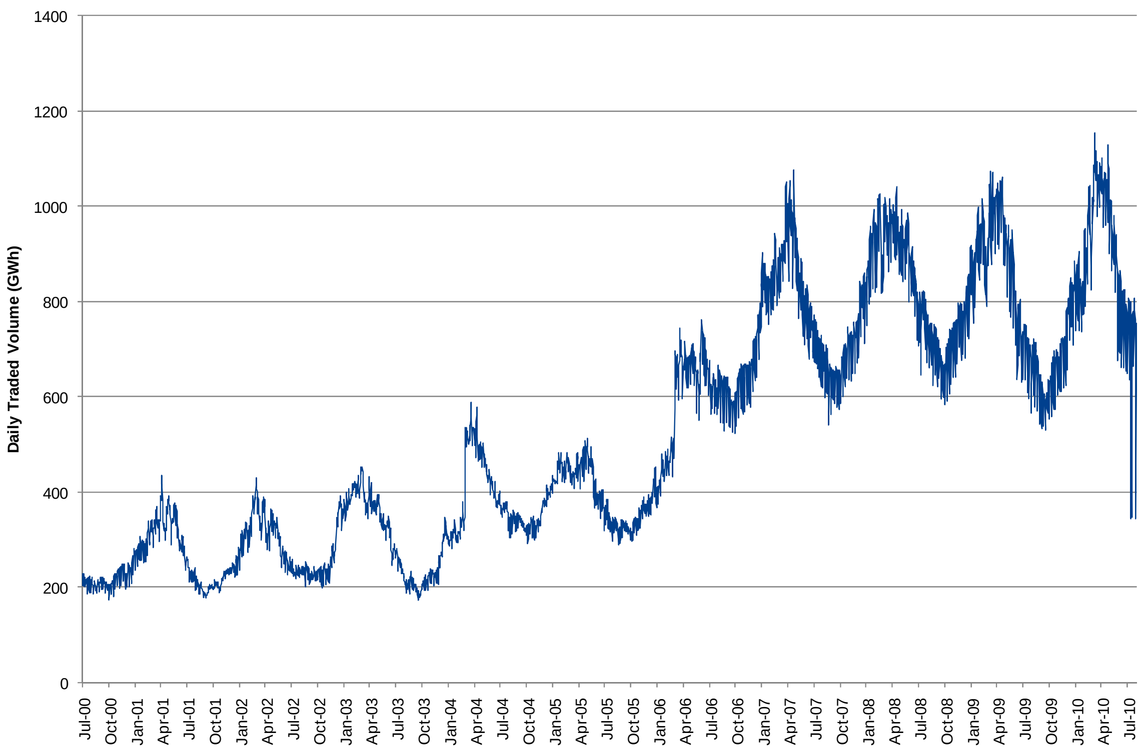
In comparison to the APX Power NL, both exchanges offer hourly and flexible block bids.

### *Traded volumes*

The volumes traded in the Elspot market have also grown steadily during the last ten years, even though the volumes have stabilized some since 2007. The large shift in daily traded volume in 2007 is due to the introduction of gross bidding. The traded volumes also exhibit a clear seasonal pattern. The daily traded volumes are about ten times as high in the winter season in the Nord Pool Spot day-ahead market in comparison to the APX NL day-ahead market. The volumes traded on Nord Pool Spot in 2009 accounts for about

72% of the total Nordic consumption, while the share for Norway is 66%. This compares to the level of the APX Power NL day-ahead market of 26% in 2009.

*Figure 3.6 Daily traded volumes on the Nord Pool Spot day-ahead market (GWh)*




Source: Syspower

Table 3.5 and Table 3.6 below provide a summary of key performance data for respectively the whole Nord Pool Spot day-ahead market and Norway.

*Table 3.5 Day-ahead market summary performance Nordic market*

| Year | Traded volumes (TWh) | Average price (€/MWh) | Domestic consumption(gross) (TWh) | Day-ahead share of total consumption |
|---|---|---|---|---|
| 2004 | 167 | 29 | 70 | 42% |
| 2005 | 175 | 29 | 79 | 45% |
| 2006 | 250 | 49 | 152 | 61% |
| 2007 | 291 | 28 | 177 | 61% |
| 2008 | 297 | 45 | 208 | 70% |
| 2009 | 286 | 35 | 206 | 72% |

Source: Nord Pool Spot, SSB and Pöyry Management Consulting analysis

*Table 3.6 Day-ahead market summary performance Norway*

| Year | Traded volumes (TWh) | Average price (€/MWh) | Domestic consumption(gross) (TWh) | Day-ahead share of total consumption |
|---|---|---|---|---|
| 2004 | 46 | 29 | 121 | 38% |
| 2005 | 53 | 29 | 126 | 42% |
| 2006 | 67 | 49 | 123 | 55% |
| 2007 | 73 | 28 | 128 | 57% |
| 2008 | 79 | 47 | 129 | 61% |
| 2009 | 82 | 35 | 124 | 66% |

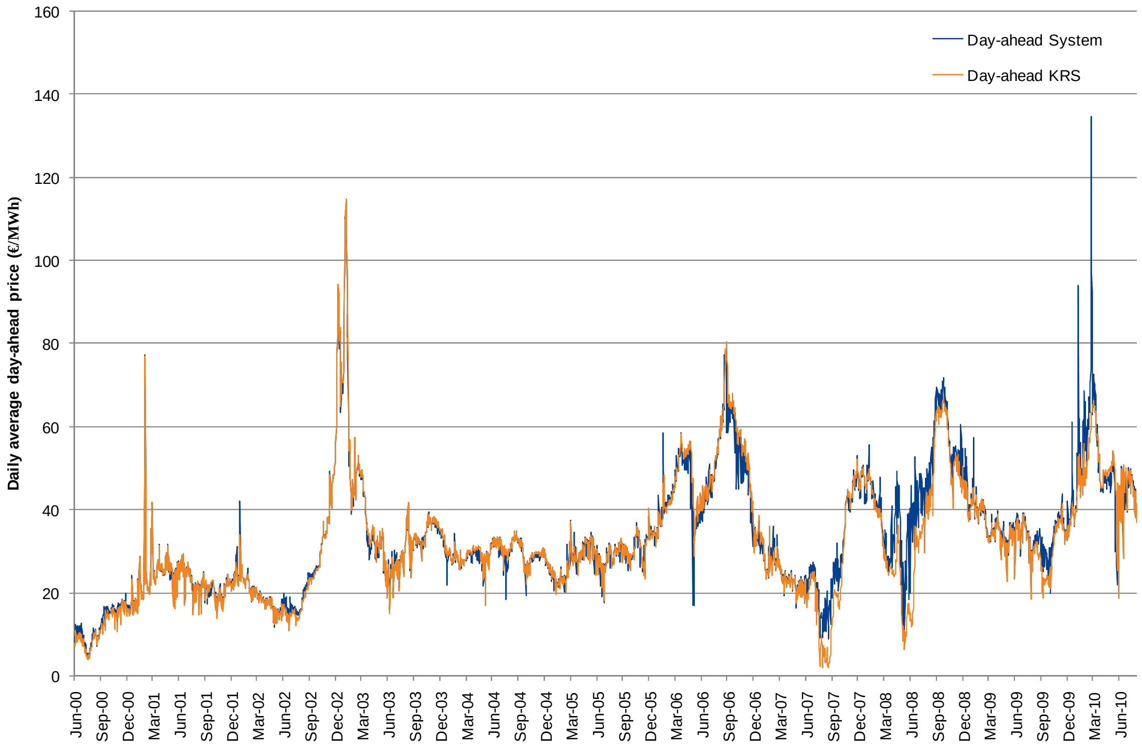
Source: Nord Pool Spot, SSB and Pöyry Management Consulting analysis

## *Day-ahead prices*

The price in the day-ahead market is set as a marginal price. The maximum price in a bid is 2000 Euro/MWh and the minimum price - 200 Euro/MWh. The minimum contract size is 0.1 MWh and the minimum price change between bid steps is 0.1 EUR. The negative price floor was introduced on the 30th of November 2009 after demand by participants due to renewables (wind), about the same time as in APX Power NL.

Figure 3.7 shows the daily average system price and the area price for the geographical area of Kristiansand, which is the geographical area where the NorNed cable is connected to the Norwegian grid. This price area is today defined as NO2.

*Figure 3.7 Daily average Nord Pool Spot day-ahead prices to July 2010 (€/MWh, nominal money)*




Source: Syspower

*Membership and participants*

There are currently about 341 participants in total in Elspot, whereof 128 participants in Norway. The table below shows how many participants are active in Nord Pool Spot based on amount of active participants on the 22th of December 2010. The number of active participants does not change much from day to day.

*Table 3.7 Active participants in Nord Pool Spot on 22.12.2010*

| Bidding area | Active | Portfolios |
|---|---|---|
| NO1 | 37 | 96 |
| NO2 | 43 | 96 |
| NO3 | 39 | 83 |
| NO4 | 32 | 69 |
| NO5 | 36 | 74 |
| SE | 32 | 129 |
| FI | 25 | 48 |
| EE | 5 | 11 |
| DK1 | 19 | 32 |
| DK2 | 12 | 22 |
| Total | 280 | 660 |

Source: Nord Pool Spot

Active participants refers to how many participants that are trading in each area, while portfolios refer to how many portfolios that are being traded. As can be seen, the total amount of active participants is high. The amount of active participants is approximately six times higher than in the APX NL day-ahead market. 187 active participants were trading in the Norwegian bidding areas this specific day.

### 3.4.4 Nord Pool Spot intraday market Elbas

*General*

Elbas is a cross border intraday market based on continuous trading which covers the Nordic countries, Germany, and Estonia. The market has existed since 1999, and Norway as the last Nordic country joined the Elbas market on 4th of March 2009. An even more recent enterer is Estonia. Trading on Elbas for the following day opens 2 hours after the Nord Pool Spot day-ahead market Elspot is closed (14:00 CET) for the whole market, while it opens already at 08:00 CET in Germany. Germany is however then treated as a separate bidding area until approximately 14:00 CET, as the transmission capacities available for trading in the rest of Elbas is not known until that time. Otherwise, trading is open 24 hours. Trading can be undertaken up to one hour prior to delivery for all the countries with the exception of in Norway, where trading can be undertaken only up to two hour prior to delivery.

Initially, all available transmission capacity is given to the day-ahead market, Elspot, and only remaining capacity after Elspot is closed is given by the TSOs to the Elbas market. The trading participants will only see the bids which are available (taking into accounts bottlenecks) and the remaining capacities are updated after each trade. The participants are obligated to report the trades they have made on Elbas to the relevant TSO. In the case of Norway, this is to be reported for each trade.

According to Nord Pool Spot, Elbas is an alternative to the balancing market for all or some of the imbalance a power company may have after the day-ahead trades are final. Elbas reduces the risk of being in imbalance for power companies, because the price of an imbalance is known prior to the hour of delivery rather than afterwards. With high volatility in the balancing market unknown prices carry a great economical risk. The price spread on Elbas also offers opportunities for economical profit for all participants. The market also provides opportunity for better prices than in the day-ahead market as well as the balancing market.

According to analysis made by Nord Pool Spot based on weeks 1 to 15 in 2009, 25 % of the trading in Elbas was in general taking place about 60 to 90 minutes before delivery, which corresponds to 30 minutes before gate closure in Elbas, with the exception of Norway, where trading at that time is already closed. Trading in Norway was on average done 680 minutes before delivery, which would be around nine hours before gate closure. That was the longest time before delivery of the included countries. At this point of time however, Norway had just joined Elbas, which could affect the data.

Nord Pool Spot is providing APX NL and BELPEX (owned by APX-ENDEX) with their trading platform in Elbas, so that the interconnected intraday market between Belgium and the Netherlands is traded in the same platform.

### *Intraday products*

In Elbas, both hourly contracts and block contracts can be traded. For the hourly product, each of the 24 hours of the next day is defined as a product. Else, block bids can be made and can consist of a minimum of 1 hour and a maximum of 32 hours together (from trade opens after day-ahead until final delivery hour). The hourly bid can be partially accepted in the trading (if matches in price) while the block bid needs to be taken in its entirety. The block bid can therefore also be only for one hour.

With regards to the APX NL intraday market products, Elbas is the only to offer such a block bid.

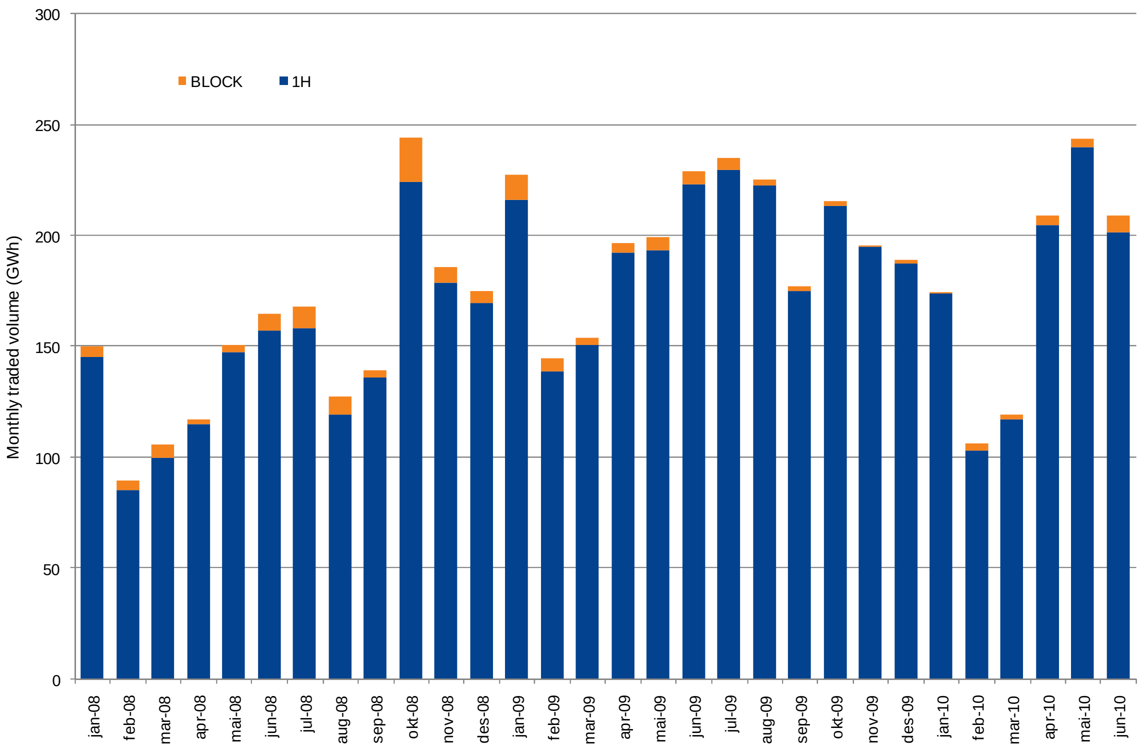
### *Intraday volumes*

The Elbas market is much more liquid than the intraday market of APX NL. The monthly traded volume can be up to nineteen times as high in the Elbas market as in the APX NL intraday. The total annual intraday volume traded in 2009 was almost twenty-seven times as high in Elbas as in the APX NL intraday. The Elbas market has existed for seven more years than the intraday market of APX NL, and in addition includes a much larger market area. According to data on Elbas from Nord Pool Spot for the 15 first weeks of 2009, the trading is also more concentrated closer to delivery time, increasing the likelihood of the participants finding a counter-part, and providing liquidity.

Figure 3.8 below shows the monthly traded volumes for each of the products available in Elbas from January 2008 until June 2010, while Table 3.8 shows a summary of annual traded volumes for each product. The average monthly traded volume during the time period was 175 GWh. As in APX, the one hour product is the most traded.

The total annual intraday volume in Norway in 2009 was 22.4 GWh, which is about 25% of the total annual volume traded in the APX NL intraday market that year. The APX NL volume however refer to a whole trading year, while trading in Norway started in March that same year. Sweden, Finland and Germany are the largest trading areas in Elbas at roughly the same volumes in 2009. As indicated above, 25 % of the trading is likely done less than two hours before delivery, effectively excluding Norwegian participants from this volume.

*Figure 3.8 Monthly traded volume by product on the APX intraday market (GWh)*




Source: Nord Pool Spot

*Table 3.8 Annual intraday traded volumes by product (GWh)*

| | Product | | |
|---|---|---|---|
| Year | 1H | Block | **Total** |
| 2008 | 1737 | 82 | **1819** |
| 2009 | 2339 | 51 | **2390** |
| H1 2010 | 1041 | 22 | **1062** |

Source: Nord Pool Spot

## *Intraday pricing*

The continuously traded Elbas market operates under a pay-as-bid regime. The minimum contract size is 1 MWh and the minimum price change between bid steps is 0.1 EUR. There is no maximum or minimum price in Elbas in contrast to the APX intraday market.

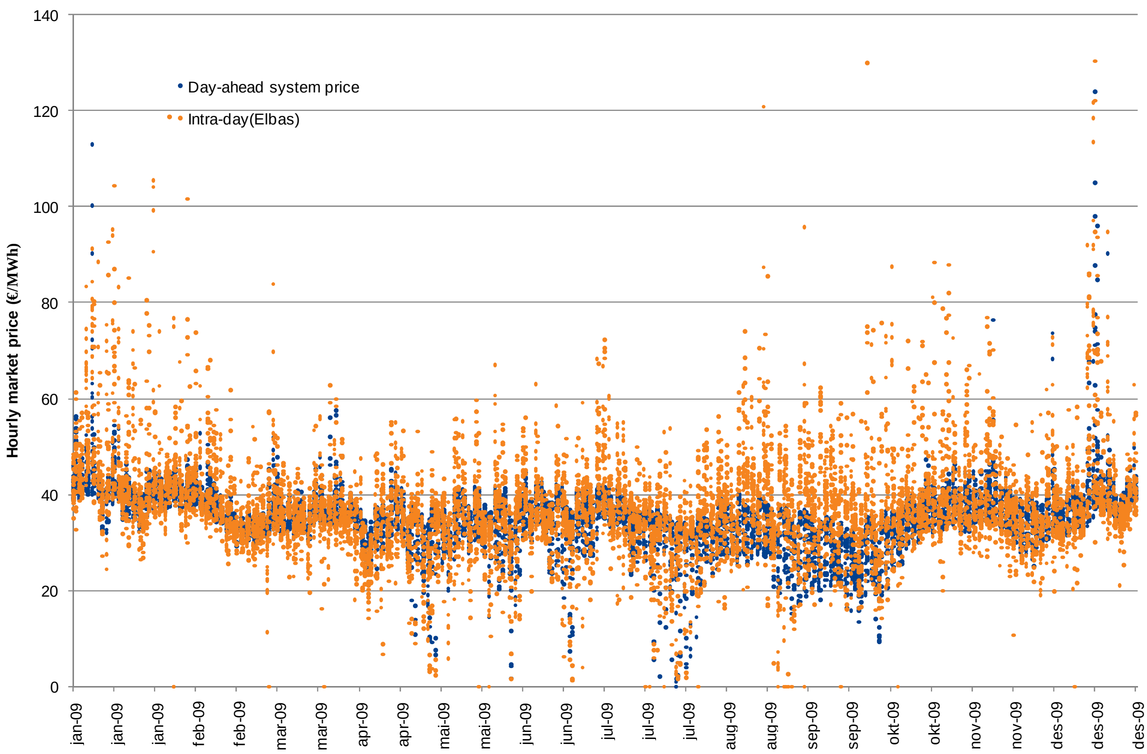
Figure 3.9 compares the monthly average traded price in Elbas with the monthly average system price and area price for Kristiansand. The intraday normally trades with a positive premium in relation to the system price, but monthly average prices Elbas prices have also fallen below the monthly average system price. This however is not the case in the APX intraday market. The average monthly premium in Elbas was on average 13% in the time period, and has been as high as 70% and as low as minus 7%. The maximum value in Elbas in this time period was higher than the maximum value in the APX NL intraday market by 20%, however the Elbas average is 9% lower.

Figure 3.10 compares hourly prices in Elbas with the hourly system price, which also indicates a premium, but quite less than in the APX NL intraday market, as indicated also by the averages compared above.

*Figure 3.9 Comparison of intraday and day-ahead monthly average prices*


Source: Nord Pool Spot and Syspower

*Figure 3.10 Hourly intraday and day-ahead market prices in 2009 (€/MWh)*

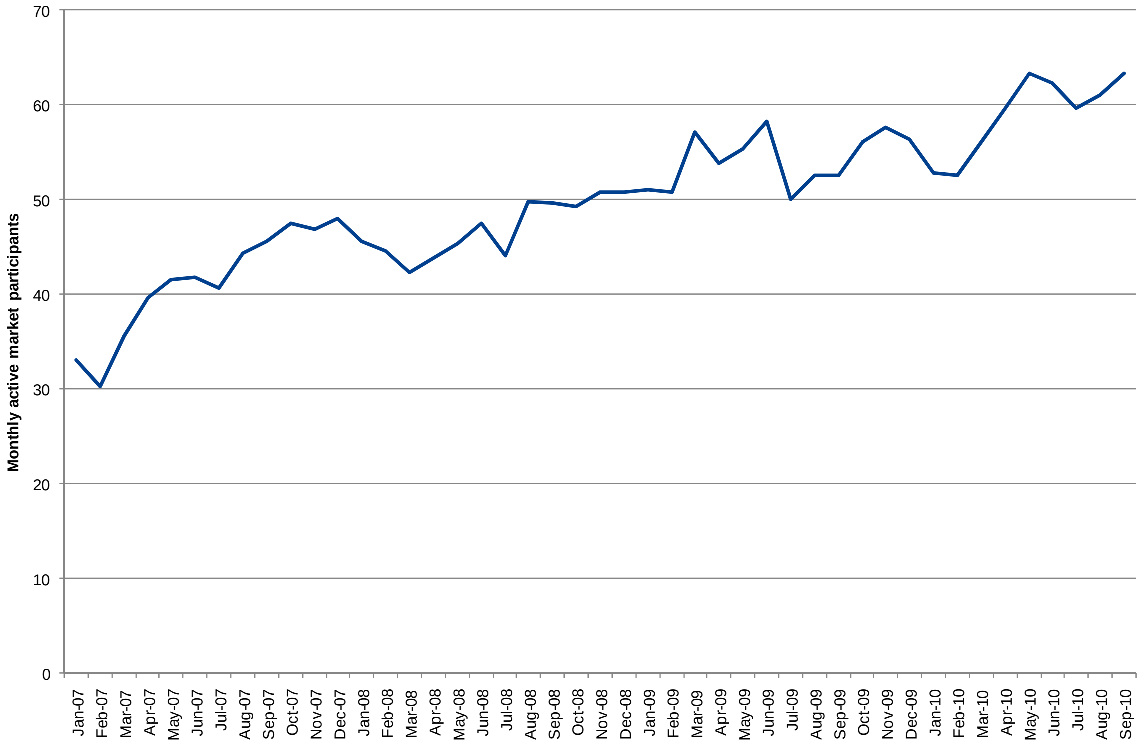



Source: Nord Pool Spot and Syspower

*Membership and participants*

There are currently about 98 participants in total in Elbas, whereof 22 participants in Norway. Figure 3.11 presents the monthly number of active market participants in Elbas since 2007. Over this time period, the average monthly number of active participants in Elbas has been 50. This compares to the monthly average of 10 in the APX NL intraday market. The participant rate has also been increasing steadily in Elbas during this period, while in the APX NL intraday market it has remained around the same level.

*Figure 3.11 Monthly intraday active market participants (since 2007)*




Source: Nord Pool Spot

## 3.5 BALANCING MARKETS

The TSO Statnett is responsible for maintaining the instantaneous balance of supply and demand on the Norwegian electricity network, and for resolving constraints which may occur on the transmission network. In order to carry out this function, Statnett operates a market for regulating power together with the other Nordic TSOs. The regulation power in question is however not secondary reserves, but tertiary reserves according to UCTE definitions.[22] Statnett also uses primary reserves in the balancing of the network.

### *3.5.1 Primary reserves*

Primary reserves are used for an automatic regulation of the frequency in the power system and are mainly provided by production units. All production units with a generator of over 10 MVA are obliged to provide primary reserves. Compensation is provided to the generators for the provision of primary reserve based on the costs of the generator and a

22 Secondary reserves will however be introduced in the future.

reasonable profit. In addition, Statnett has since 2008 operated a market to buy additional primary reserve. The market is divided into a weekly market and a daily market. The weekly market is run before the Elspot day-ahead market, while the daily market is run after Elspot day-ahead. Participation in the markets is voluntary. So far, the weekly market is functioning satisfactory, but the daily market is suffering from poorer liquidity. Finally, some bilateral agreements for delivery of primary reserves exist.

### 3.5.2 Tertiary reserves

Tertiary reserves are procured within a market which is common for the Nordic TSOs with respect to the sharing of a common merit order curve for tertiary reserves. In addition, Statnett assures access to tertiary reserves through a capacity market and bilateral contracts.

The capacity market for tertiary reserves, RKOM, includes both a week market and a season market. The role of the capacity market is to assure sufficient volumes in the single buyer market for tertiary reserves (RKM), which is mainly a need during the winter season. The season market is based on the same product as the week market, however in the season market the resources are bid in for the whole time period. The season market should preferable be run before the week market starts up.

The capacity volume to be acquired for the season market is decided at the start of a new winter season. The capacity volume to be acquired in the week market is decided each week. For the 2010/2011 season, a total of 499 MW has been bought in the season market divided on three defined geographical areas.

Gate closure for bids in the weekly market is every Friday at 12:00 CET and the market result is published by 14:00 the same day.

The bilateral agreements are long term agreements with includes contracts with both production and consumption units. In the future, it is expected that market solutions will replace the bilateral agreements.

Statnett operates the capacity markets under the target to have 2000 MW of tertiary reserves available as bids in the single buyer market for tertiary reserves (RKM).

#### *Balancing market operation*

The balancing market for power is based on hourly intervals. The mechanism of the Norwegian balancing market involves suppliers of tertiary reserve tendering bids on a daily basis for specified deviations from their intended position. Temporary bids for the next day must be placed before 20:00 pm. New and revised bids can be given up to 45 minutes before the hour of delivery. Bids must have a constant MW value of a minimum 25 MW (exception is given to small actors where the minimum bid value is 10 MW), and have a duration of at least an hour. Prices for up-regulation bids must be at least 5 NOK over the relevant spot area price for the geographical location of the bidder, and prices for down-regulations bids at least 5 NOK below the same spot area price. A maximum price of 5000 Euro for up-regulation bids also apply. If it is obvious that the pricing of bids within a limited geographical area is not socio-economically efficient, the TSO can suspend the bid and activate it at the relevant spot area price.

A common merit order with the other Nordic countries is established, and bids for up- and down-regulation are called based on price if available. Prices for up- and down-regulation are set for each hour for each elspot area/price area. The up- and down regulation price is based on marginal pricing, so that positive bids are settled at the highest price and negative bids at the lowest price. The up- and down regulation price will be affected in case of bottlenecks in the grid.

### 3.5.3 Imbalance settlement

The imbalance settlement was harmonised in the Nordics in September 2009. The management of imbalances is based on the concept of balance responsibility. The balance responsible parties need to sign a balance agreement with Statnett. An actor can be represented by another balance responsible party.

All producers need to send in their production plans by 19:00 each day. The production plan can thereafter be revised up to 45 minutes before the hour of delivery. In addition, Nord Pool Spot reports the volumes bought and sold per balance responsible party to the TSO. Bilateral agreements need to be reported by the selling party at the latest 45 minutes before the hour of delivery. The volumes are not checked against each other as is the case in the Netherlands through the E-programme, and any imbalance that a party may have will therefore not be discovered before in the settlement process. It is however not allowed to intentionally be in imbalance.

The imbalances are settled based on two separate balances, which is a production balance and a trading and consumption balance. The production balance is defined as actual production minus planned production adjusted for activated regulating power for production. The trading and consumption balance is defined as planned production plus actual consumption plus traded volumes before the real time hour, adjusted for activated regulation power for consumption.

The production balance is settled based on a two- price system. The two-price system gives balance responsible with production a stronger economic incentive to produce according to production plan. If a producer is short when the system is long, he will be settled at the appropriate spot area price. If a producer is short when the system is short, he will be settled at the up- regulation price. On the other hand, if a producer is long when the system is short, he will be settled at the appropriate spot area price. If a producer is long when the system is long, he will be settled at the down-regulation price. Summed up, this means that production imbalances which supports the system need is settled at the appropriate spot area price, while production imbalances which does not support the system is settles at the regulating market price.

The trading and consumption balance is settled based on a one-price system. Any imbalance is then bought or sold to the regulating power price in the main direction in the relevant price area. The one-price system will positively compensate imbalances which supports the need of the system. It is however not allowed to do so on purpose.

The imbalance settlement is quite different from that in the Netherlands. In the Netherlands it is possible to net imbalances between production and supply in another way as there is one balance only. In addition, in the Netherlands, passive contribution to system balancing for production and consumption is explicitly incentivized.

### 3.5.4 Prices and volumes

Figure 3.12, Figure 3.13 and Figure 3.14 illustrate the imbalance price for consumption in respectively Kristiansand/NO2, all the Norwegian price areas and all the Nordic countries. The data used is for 2010 as the imbalance settlement was harmonised in September 2009.

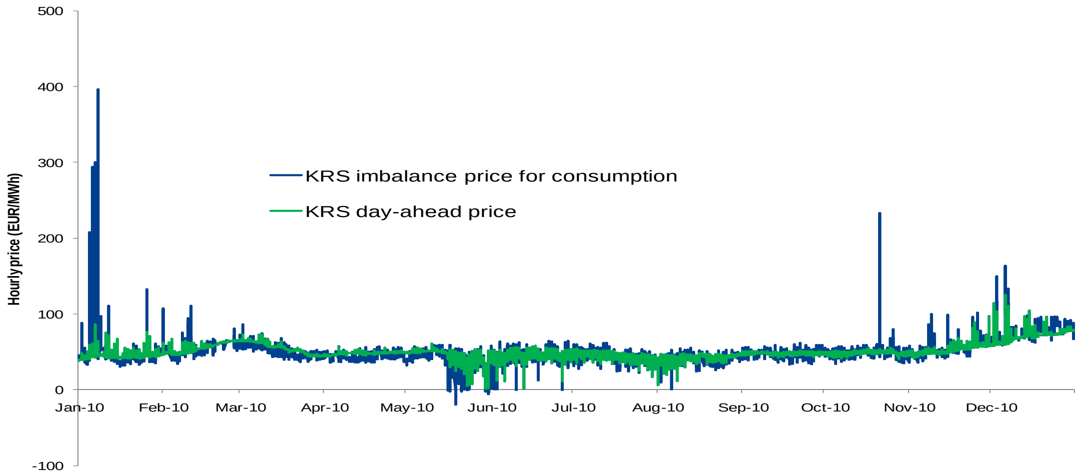
The charts illustrate that the imbalance prices are quite volatile also in the Nordics, however not quite so at the level of the Netherlands, at least how it was in the Netherlands in 2008 (the data are from different years which makes them harder to compare). The variation is also shown by the standard deviation from the mean summarized in Table 3.9. However, in 2010, the average spot price for all of Norway showed a higher standard deviation than the average imbalance price for consumption for all of Norway. The lower average for imbalance price consumption than the spot price is due to net down-regulation in all the areas in 2010.

*Table 3.9 Summary of imbalance prices in 2010 (€/MWh)*

| | Imbalance price consumption | | | Spot price | | |
|---|---|---|---|---|---|---|
| | KRS | Norway | Nordic | KRS | Norway | Nordic |
| Average | 50,67 | 53,30 | 52,93 | 50,82 | 55,24 | 53,06 |
| Standard deviation | 18,41 | 20,87 | 26,37 | 10,07 | 27,95 | 16,05 |

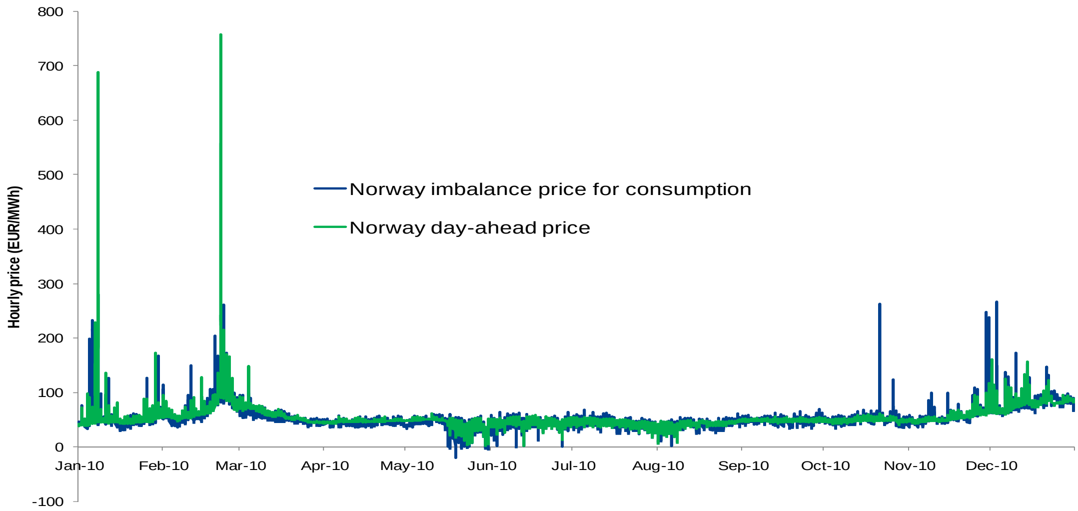
Source: Nord Pool Spot and Syspower

*Figure 3.12 Imbalance price consumption versus day-ahead price in Kristiansand (€/MWh)*



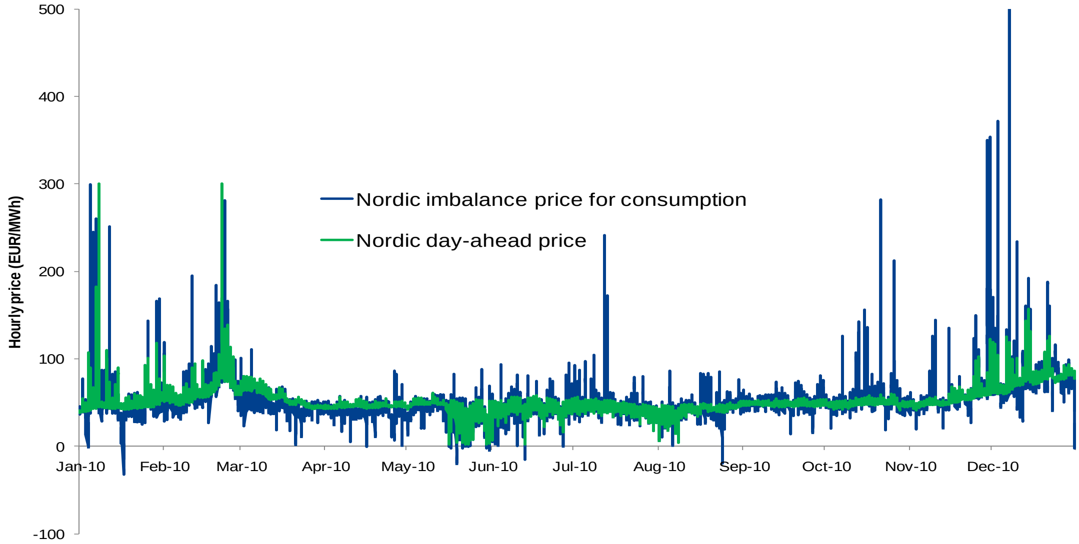

Source: Nord Pool Spot and Syspower

*Figure 3.13 Imbalance price consumption versus day-ahead price in Norway (€/MWh)*




Source: Nord Pool Spot and Syspower

*Figure 3.14 Imbalance price consumption versus day-ahead price in the Nordics (€/MWh)*

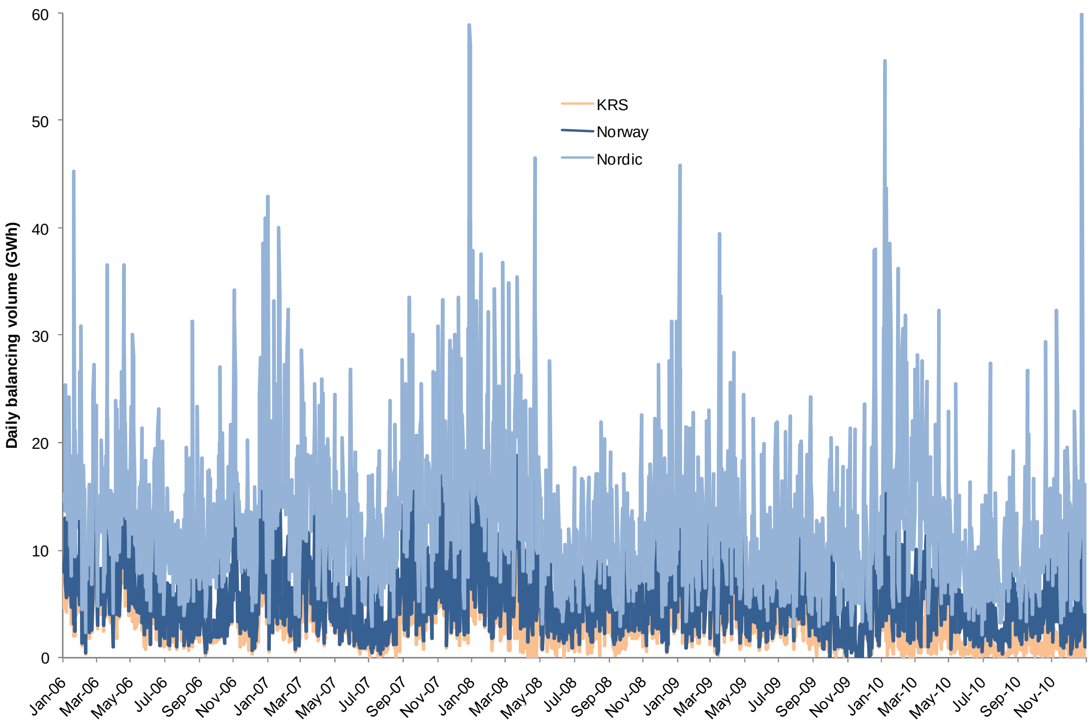



Source: Nord Pool Spot and Syspower

Figure 3.15 shows the daily activated regulating power or tertiary reserves in Kristiansand/NO2, Norway and the Nordics. The balancing volumes are also here quite volatile on a daily basis. The average daily balancing volumes in Kristiansand/NO2 is 4,2 GWh, which compares to the average daily balancing volume in the Netherlands of around 2 GWh, which is then the double. The average daily balancing volume in Norway is 6,1 GWh and in the whole Nordics 13,1 GWh. The average daily balancing volume in Kristiansand/NO2 and Norway can then be said to be quite high compared to both the Nordics and the Netherlands.

Annual total balancing volumes since 2006 are shown in Table 3.10. The average level for the years 2006-2009 is 1.7 TWh for Kristiansand/NO2, in Norway 2.3 TWh and in the Nordics 4.8 TWh. The average level for this time period for Kristiansand/NO2 still compares to about the double of that in the Netherlands (776 GWh), and a little more. The total balancing volume in Norway in 2009 was at the level of size of 1.6 % of the annual national consumption of 123.8 TWh.

*Figure 3.15 Daily balancing activated volumes in Kristiansand, Norway and the Nordics (GWh)*




Source: Syspower

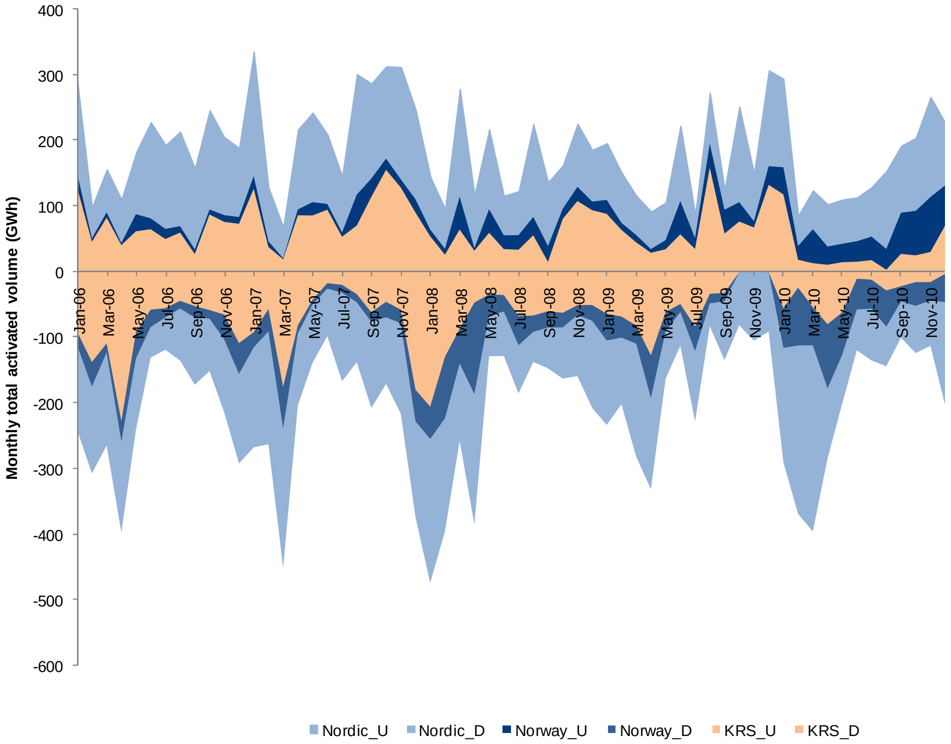
*Table 3.10 Annual total balancing volumes (GWh)*

| Year | KRS | Norway | Nordics |
|---|---|---|---|
| 2006 | 1 900 | 2 352 | 4 940 |
| 2007 | 1 926 | 2 407 | 5 504 |
| 2008 | 1 557 | 2 359 | 4 800 |
| 2009 | 1 448 | 1 992 | 4 128 |
| 2010 | 748 | 1 939 | 4 486 |

Source: Syspower

Figure 3.16 present monthly total balancing volumes since 2006, but in this case broken down in up- and down-regulation volumes, shown for Kristiansand/NO2, Norway and the Nordics. Although the monthly volumes of either up- or down-regulation volumes vary quite significantly from month to month, the overall balancing volumes varies less, like in the Netherlands. The average monthly balancing volume was 126 GWh in Kristiansand/NO2, 184 GWh in Norway and 398 GWh in the Nordics. The average monthly balancing volume in Kristiansand/NO2 keeps staying at about the double of the volume in the Netherlands (64 GWh).

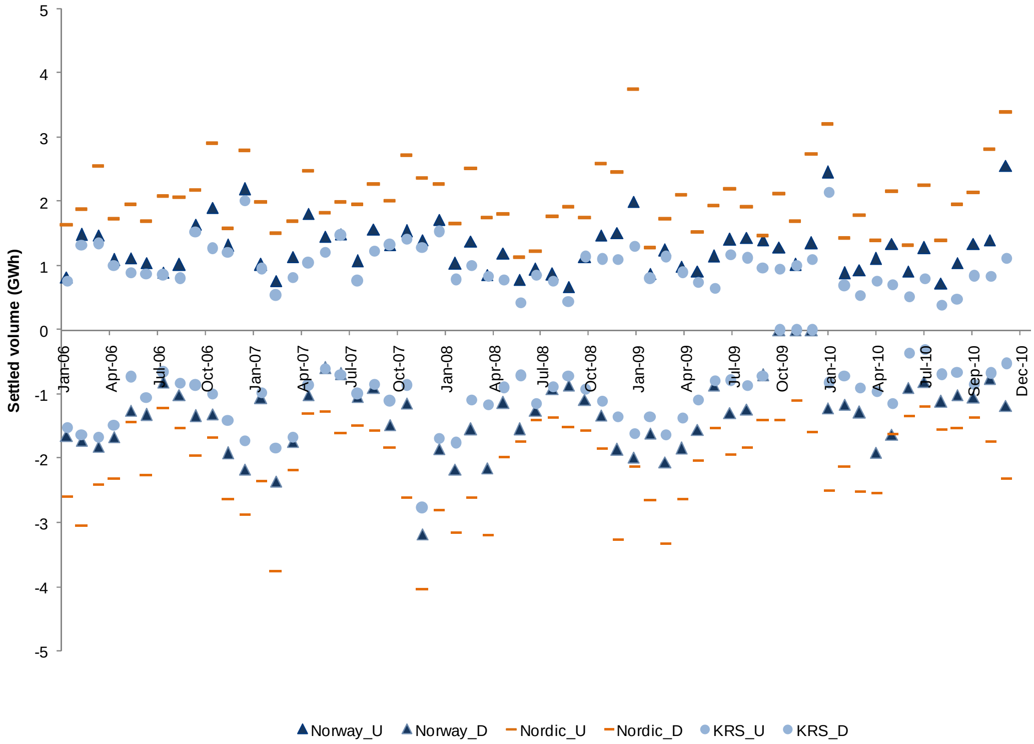
*Figure 3.16 Monthly total balancing activated volumes (GWh)*




Source: Syspower

Figure 3.17 shows the maximum activated volume of up- and down-regulation volumes in a single hour per month for Kristiansand/NO2, Norway and the Nordics. In general, the maximum activated volume of up- and down-regulation in a single hour per month stays around the same level but with some seasonal pattern.

*Figure 3.17 Maximum activated volume in a single hour by month (MWh)*




Source: Syspower

### *3.5.5 Membership and participants*

To bid in the single buyer balancing market (RKM) for tertiary reserves is voluntary. To participate in the balancing market it is necessary to be a balance responsible party. The amount of active participants in RKM is around 35 to 40 in Norway.

We have already described the process of contracting capacity for tertiary reserves above. The amount of bidders for the season market for 2010/11 was 11, which is the same as for the season of 2009/10. In 2009/10 a total of 8 actors were contracted, while in 2010/11 the number is 9. In the week market there are normally about 10 to 15 active participants.

The amount of bilateral agreements for tertiary reserves in 2009/10 was 5, and for 2010/11 it is 8.

The numbers on amount of contracted parties and active participants have been provided by Statnett.

## 3.6 MARKET CONCENTRATION

The Norwegian wholesale market for electricity is characterized by many companies. According to a report from 2006 there were 183 companies in total owning 622 hydro power plants (the figures may be older, however the market structure has been quite stabile since then so the general impression holds).[23] However, due to cross ownership, the market is much more concentrated than these figures would imply. Statkraft is by far the largest actor in the Norwegian wholesale market and accounts for about half of the

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[23] Excluding plants with a capacity of less than 1 MW.

production capacity in Norway including cross ownership depending on estimation method. Although older figures, in a report made by the Nordic competition authorities in 2003, the HHI index for Norway, increases from 1 600 to 3 300 taking into account cross ownership. There is also cross ownership of specific plants (not just companies as discussed above).

Due to bottlenecks in the grid, Norway is divided into price areas which may effectively increase the market shares of an actor within a given price area. This may cause situations where market participants may achieve a dominant position in the market and as such be able to increase the market price. The TSO Statnett is given the power to define the relevant price areas in the Norwegian grid. According to Statnett, they evaluate competition issues when setting the price areas.

The Norwegian Competition Authorities recommend in a report for 2009[24], that the level of concentration and cross ownership should be reduced, and that market concentration within a grid area should be an important factor when considering new grid capacity. Also, with regards to the end user market, there should be a clearer division between regulated grid activities and competition based sale of electricity.

Finally, an Econ report made for the Norwegian Competition Authorities in 2003, which describes different methods for measuring market power in the Norwegian wholesale markets, tested these methods on the hydrological year of 2002/2003. Applying the methods found behaviour which could not be explained as price taker behaviour, but which can neither be taken as a proof of strategic behaviour. The report further states that to investigate whether the market adaption found in the test application, is due to strategic behaviour or other issues, it would be necessary to study individual actors bidding behaviour in the spot market. The report also describes three possible strategies for using market power in a hydro system: withholding capacity in peak hours, changing the disposition of water over time (produce less in peak hours and more in off-peak hours or withholding capacity during one period to create shortage in a later period) and spilling of water.

Based on numbers from an annual review of the Commission on the progress of creating the internal gas and electricity markets, Norway is placed as highly concentrated with a HHI index of 1826 and the Netherlands as moderately concentrated with a HHI index of 1551 (corresponding to the figures from NMa from 2007 including imports, shown in the chapter on the Netherlands).

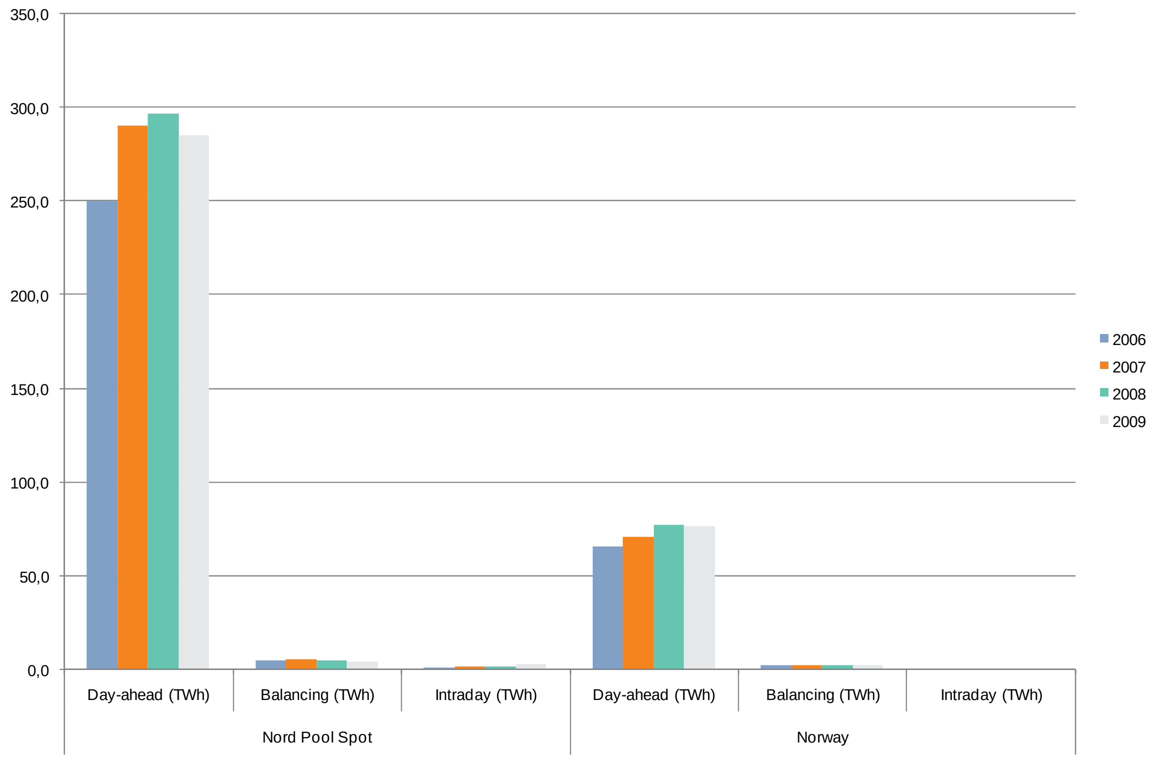
### *3.6.1 Activity and liquidity on the Norwegian markets*

Figure 3.18 below shows a comparison on historical market volumes in the day-ahead, intraday and balancing markets for Nord Pool Spot and Norway.

Nord Pool Spot as the world largest electricity market shows a strong liquidity in the day-ahead market. Also, the intraday market of Nord Pool Spot shows a strong position, trading volumes of 27 times that of APX NL in 2009. Finally, placing intraday trading in a context, Figure 3.19 shows that intraday traded volumes are in general very small shown by share of total trade in several European markets. This is also natural, as intraday markets are adjustment markets and not main trading markets.

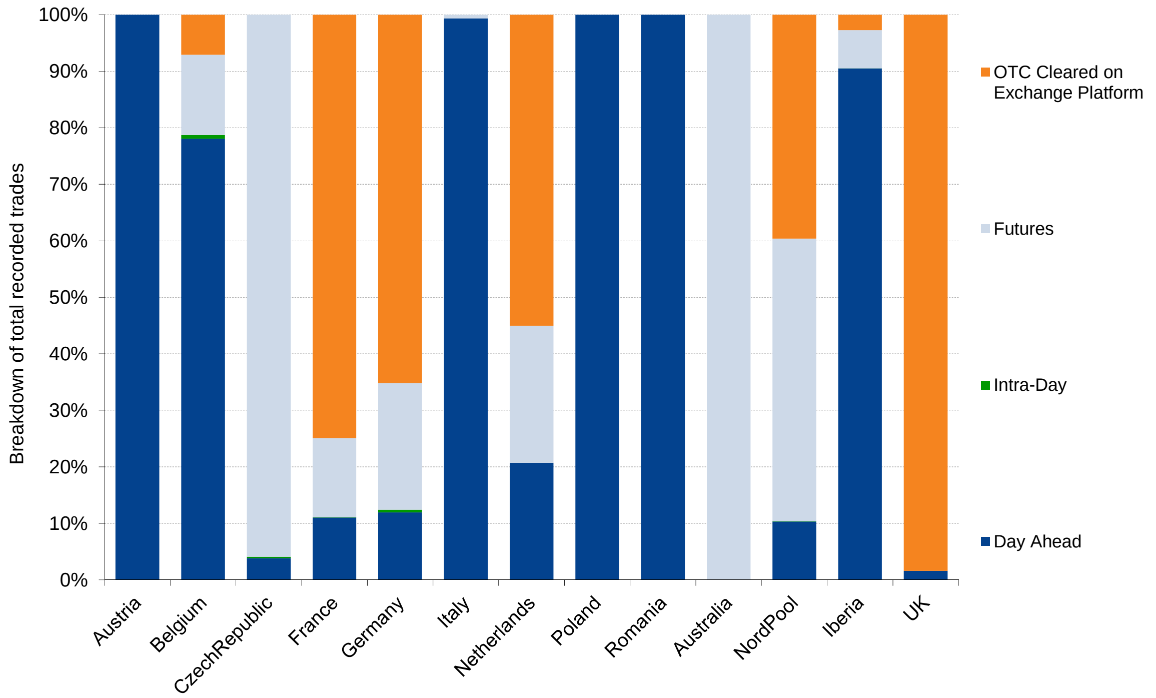
[24] Also source for much of the information in this section.

*Figure 3.18 Comparison of historical market volumes in Norway and Nord Pool Spot*




Source: Nord Pool Spot and Syspower

*Figure 3.19 Breakdown of total trade volumes by trade type (2008)*




Source: Pöyry Management Consulting analysis

# 4 SUMMARY OF KEY DIFFERENCES BETWEEEN NORWAY AND THE NETHERLANDS

We will here summarise the key differences between the different markets in Norway and the Netherlands, and in particular those related to incentives to trade intraday.

With respect to the day-ahead markets in the two countries, the biggest difference with exception of size is that the day-ahead market in Norway is also used for congestion management through price areas. In general also, the Netherlands is based more on bilateral trade, and the trading costs are higher in APX Power NL than in Nord Pool Spot.

With respect to the intraday market, or trading intraday in general, there is a larger initial incentive in the Netherlands due to higher imbalance charges. Changes to the imbalance pricing in Norway has however increased the incentives to trade into balance intraday for production. Norway is also part of a larger and more liquid intraday market giving a likely better opportunity to trade into balance intraday. Also historically, the trading system and opportunity to trade 24 hours in Elbas may also have been a factor making it easier to trade intraday in Norway than in the Netherlands. In the Netherlands, the APX Power intraday market has only been open in two trading sessions.

Both countries require reporting of each intraday trade, but stricter rules apply to this in the Netherlands, as consistency (internally and externally) is necessary for modifications to be approved (also required for initial approval). This implies some risk for traders in the Dutch market, which is not the case in Norway.[25]

Also, in both countries intraday trading is possible up to two hours before real-time (exchange-based and bilateral). This affects the access of both countries to the rest of the Elbas trading area, where trade can be undertaken up to one hour before real-time. This already creates some distortion in the Norwegian/Elbas market place, as a not insignificant volume is traded in this time period between the two gate closures.

With respect to the balancing markets and imbalance pricing, there are also important differences. In the Netherland, passive contribution to balancing is incentivised and allowed, and close to real-time information is published by the TSO TenneT to support this. There is an economic incentive to be in imbalance in the opposite direction of the system in Norway with regards to the trade and consumption balance, but it is however not allowed. In neither of the countries is it allowed to be in imbalance on purpose at day-ahead or intraday stage.

The possibility to contribute passively to balancing in the Netherlands provides a market place for those who don't participate actively in the balancing market – and also an alternative to the intraday market for these players.

Another difference between the balancing markets is that in the Norwegian market the imbalance price is related to the day-ahead price, which is not the case in the Netherlands. Finally, secondary reserve is the main product for balancing in the Netherlands while in Norway it is tertiary reserve.

These differences should not be a cause for distortion to a common intraday market.

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[25] The requirement for external consistency for E-programmes is to be removed, effectively taking away this risk.

# 5 MARKET COUPLING

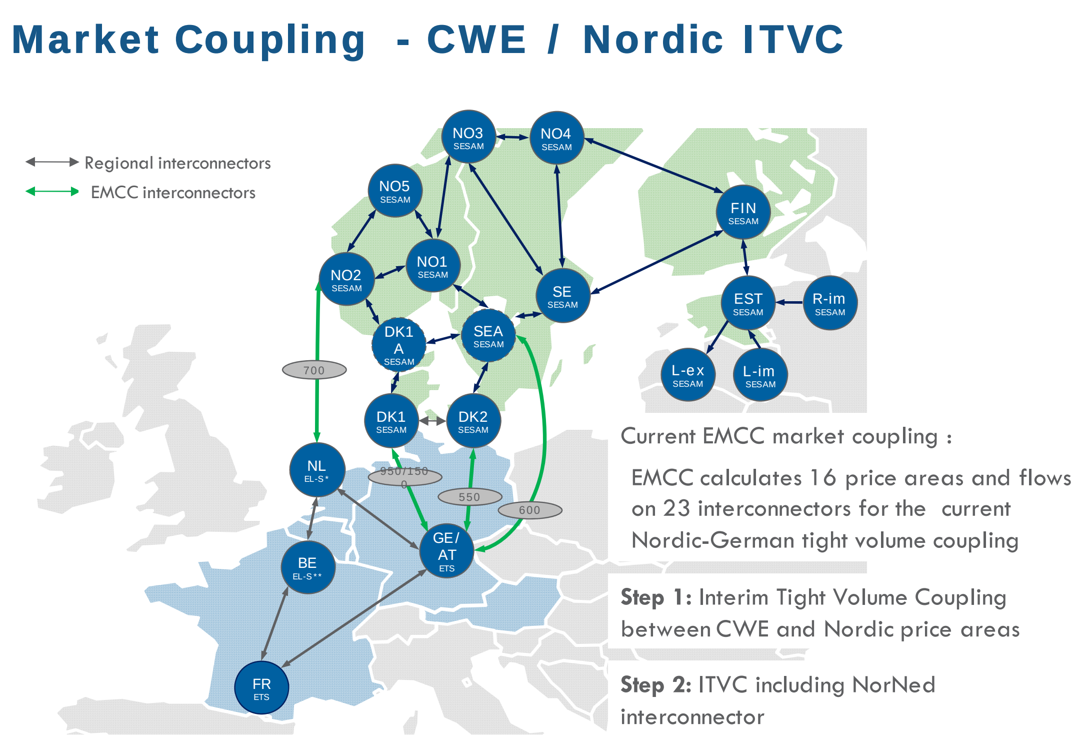
### *5.1.1 Market coupling in the Nordics*

There has been several market coupling solutions for Nord Pool Spot since the establishment of the common Nordic power market:

- The first solution for a market coupling included the establishment of a bidding area (KONTEK) that represented parts of Germany. This was launched in May 2005 and was used until 2009;
- In November 2009 a tight volume coupling between the Nordic countries and Germany was launched (Nordic ITVC – Interconnected Tight Volume Coupling) replacing the KONTEK area. This market coupling was organised by EMCC – the European Market Coupling Company, owned by the respective power exchanges and TSOs;
- In May 2010, a market coupling was introduced on the Baltic cable (ESTLINK);
- In November 2010, the EMCC was extended to cover the link from both Sweden and Germany in one calculation.
- In December 2010, the Swedpol link was included allowing for trading against Poland.
- In January 2011, the capacity of the NorNed cable between Norway and the Netherlands was added to the common ITVC calculation of EMCC.

The figure below illustrates the current solution where both steps now are implemented.

*Figure 5.1 Overview of the CWE / Nordic ITVC market coupling*




Source: EMCC

### 5.1.2 Market coupling in the Netherlands

In the Netherlands there have been three main market coupling solutions

- In 2006, the Netherlands was coupled with France and Belgium in the so-called trilateral coupling - TLC.
- In November 2010 the Central Western European Market Coupling (CWE) was launched, replacing the Trilateral Market Coupling. The CWE region is also linked to the EMCC coupling of Germany and Denmark through an Interim Tight Volume Coupling.
- On 12 January 2011, NorNed was connected to the CWE Market Coupling through the EMCC/ITVC coupling.

# 6 ANALYSIS OF THE EFFECTS OF INTRADAY TRADE ON NORNED

## 6.1 INTRODUCTION

In this section we will analyse the effects of introducing intraday trade on NorNed. The analysis of effects will be based on a study of how the incentives for existing and potential participants in the intraday markets on both sides of the interconnector will change.

A main part of the analysis is based on a what-if analysis of a selection of cases, where we study what would have been the optimal market solution day-ahead if the information received during intraday/real-time time frame had been known at the day-ahead stage. This will show the theoretical incentive for intraday trading based on the resource prices in both market areas. We will compare this to the actual imbalance prices to check for consistency in the methodology. In addition, we will look at what is necessary to change the optimal direction of flow from the actual day-ahead market solution in the case of congestion.

In theory, there will be an incentive to trade intraday on the interconnector in the case that a price difference is introduced between the two markets at the intraday stage if there is available capacity on the interconnector, or that the optimal direction of flow changes at the intraday stage compared to the day-ahead stage in the case of congestion. In the case of no congestion, there is initially no price difference. A change in the optimal direction of flows means that the low-price market changes to become the high-price market in the intraday situation due to the changes in demand and supply.

The market coupling at intraday timeframe should in general increase the intraday trading potential for market participants on both sides of the interconnector, as the market coupling opens for possible matching of bids and offers across the interconnector. The potential will be subject to the likelihood of available capacity on the interconnector after the day-ahead auctions and the possibility of a change in optimal direction of flows in case of congestion.

The what-if analyses give an indication of the incentives for trade based on the optimal total market solution to meet the aggregated demand and supply from both day-ahead and intraday/real-time time stages for the market areas. To understand better the actual trading, it is necessary to also look at the dynamics of the trade and how the prices will be set, as intraday trade is based on continuous trading with pay-as bid. We will therefore also comment on that.

Finally, we will comment on the interdependencies of the intraday markets with the balancing markets and the day-ahead markets. As the intraday market offers the market participants an alternative to the balancing market and imbalances charges in case of imbalances, the market places become interconnected. This is also potentially so for the day-ahead market.

We will also comment on the possibilities for strategic behaviour or incentives to arbitrage between the different markets.

## 6.2 INCENTIVES TO TRADE INTRADAY

Intraday trade can in general be said to be incentivised by two factors: a change in the market views of market participants and thereby an incentive to change their market position, or by expected imbalances after the day-ahead time frame. The driver behind both these is the introduction of new information, which implies that the market solution at day-ahead time frame is no longer the optimal. The strongest driving factor can be seen as imbalances, where parties either are in imbalance or may offer to buy or sell power to parties in imbalance.

The intraday market provides the participants with an opportunity to trade themselves into balance before the balancing market comes into operation. Better prices may exist in the intraday market compared to the balancing market, as the time frame to actual delivery is longer during intraday. This is due to technology and flexibility, and amount of potential participants in the intraday market in comparison to the balancing market. The expected imbalance prices will therefore theoretically set an upper and lower bound for the prices in the intraday market.

The incentives for intraday trade between two market areas can fundamentally be seen as the same as within a market, but driven by price differences. Different technologies, resource mixes and access to alternatives to electricity affect the supply and demand curves of the markets, and prices will then fundamentally be a reflection of costs and availability of resources. Intraday trade between two market areas enables the participants to use cheaper supply resources on the other side of the interconnector (producers or consumers), or sell to parties with higher willingness to pay (producers or consumers), if available. Congestion on the interconnector after day-ahead and/or at intraday stage may limit access to the cheaper supply resources or parties with the highest willingness to pay.

If there is congestion, it is initially only physically possible to send power in the opposite direction of the day-ahead flow. After a trade in opposite direction, capacity will be freed up in the original direction as well. If the flow changes intraday, congestion may also arise in the opposite direction of the day-ahead stage, depending on the demand for transmission and available capacity.[26]

### 6.2.1 Intraday trade in case of no congestion

In case of no congestion, it is physically possible to trade if there is an economical incentive to do so. In the optimal market solution, the market area with the cheapest resources should supply the additional demand or shortfall of supply, while the market area with the most expensive resources should buy the freed power from lower demand or surplus of supply. In the case that a price difference is introduced between the two market areas at intraday stage, there will be an incentive to trade intraday using the available capacity.

### 6.2.2 Intraday trade in case of congestion

In the case of congestion, it is initially only physically possible to send power in the opposite direction of the day-ahead flow. In market terms, this means that the high price market area from day-ahead would sell power to the low price market area from day-ahead during intraday stage, or opposite, that the low price market area at day-ahead stage would buy power from the high price market area at day-ahead stage during intraday stage. There will only be an economic incentive to do so if the high price market area change to become the low price market area during intraday, or vice versa.

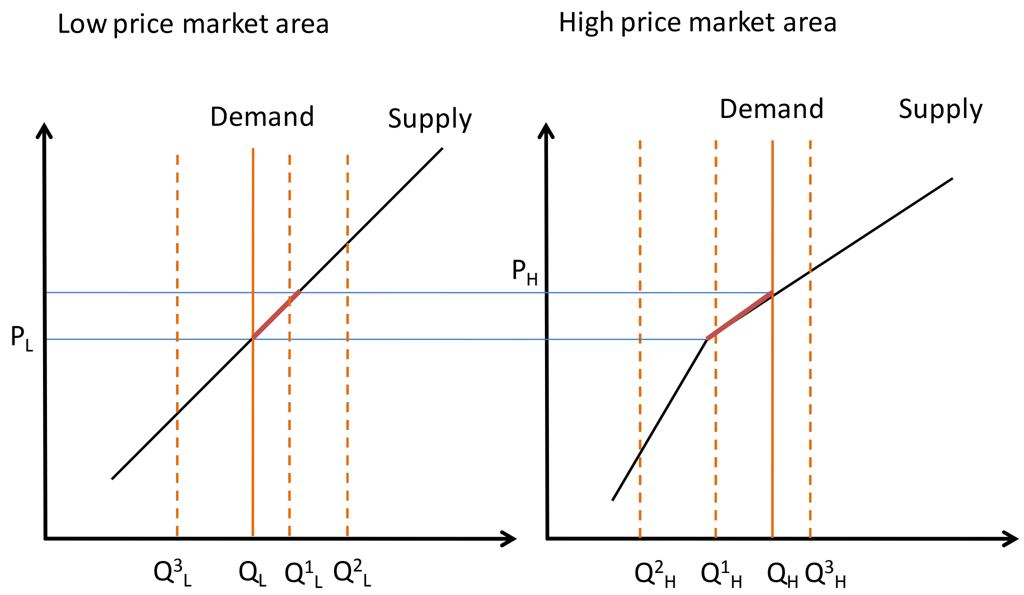
We will now go through the fundamental situation of incentives and possibilities for intraday trade in case of congestion through a theoretical analysis. Assume a situation with a low price market area and a high price market area after the day-ahead market has

[26] The available capacity on DC-interconnectors will intraday, as day-ahead, be restricted by ramping rules. The ramping rules state that the maximum change of flow on the interconnector between two hours cannot be more than 600 MW.

closed, as represented in Figure 6.1. In this situation, the power is flowing from the low price market area to the high price market area and there is no available capacity.

Let us now go through various situations with changes in demand and supply after day-ahead stage. For simplicity, we will assume that all changes will be represented through the demand curve and that the supply curve remain unchanged (the same results could have been shown changing the supply curve instead or both curves). Also for simplicity, we assume that demand is price inelastic (vertical demand curve).

*Figure 6.1*




### *Change in the low price market area*

Assume first only a change in the low price market area, with an increase in demand intraday changing the total demand day-ahead and intraday to $Q^1_L$. In this situation, as shown in the figure, there will be cheaper supply resources available in the low price market area to meet this additional demand. In this situation, the low price market area continues to stay the low price market area during intraday and there will be no incentive for intraday trade. Assume then, a further increase in the demand intraday in the low price market area to $Q^2_L$. As can be seen in the figure, in this situation there will become cheaper supply resources available in the original high price market area. The first part of the demand change will be supplied at a lower marginal cost in the original low price market area, but after passing the point where the price is equal in both areas, then the original high price market area will supply the additional power at a lower marginal cost.[27] In this situation there will be an incentive to trade intraday. Finally, assume a change in the low price market area with reduced demand intraday to $Q^3_L$. In this situation, as can be seen in the figure, there are supply resources in the low price market area with a higher willingness to pay to buy back power than in the high price market area.[28] Also, as the interconnector between the two countries is already congested in the direction from the low price market area to the high price market area, it is neither possible for the low price

[27] As the supply curves are sloping upwards with price (neither vertical nor horizontal), this is somewhat a simplification.

[28] The marginal cost of a producer also represents the producer's highest willingness to pay to buy power. As the marginal cost is the cost the producers incurs producing power, they would be willing to pay up to this cost to buy power, as they would then be indifferent between producing it by themselves or buying it from someone else.

market area to sell the additional power to the high price market area, whether economical or not.

*Change in the high price market area*

Assume then only a change in the high price market area, with a decrease in demand intraday changing the total demand day-ahead and intraday to $Q^1_H$. In this situation, as shown in the figure, there are supply resources with a higher willingness to pay to buy back power in the original high price market area than in the low price market area. In this situation, the high price market area continues to stay the high price market area during intraday and there will be no incentive for intraday trade. Assume then, a further decrease in the demand intraday in the high price market area to $Q^2_H$. As can be seen in the figure, in this situation there will be supply resources with a higher willingness to pay to buy back power in the low price market area than in the high price market area. The first part of the demand change will be bought back by resources in the original high price market area, but after passing the point where the price is equal in both countries, then the original low price market area will buy back power from the original high price market area. In this situation there will be an incentive to trade intraday. Finally, assume a change in the high price market area with increased demand intraday to $Q^3_H$. In this situation, as can be seen in the figure, there are supply resources with a lower marginal cost in the low price market area. However, as the interconnector between the two countries is already congested in the direction from the low price market area to the high price market area, it is not possible for the high price country to buy power from the low price country to meet the additional demand.

*Change in both market areas*

Assume then a change in both the high price and low price market area during intraday. This can occur as an increase or decrease in demand in both areas, or as an increase in one area and a decrease in the other area. In total this counts four possibilities for the two market areas. Assume an increase in demand in the original low price market area and a decrease in demand in the original high price market area represented by $Q^1_L$ and $Q^1_H$. In this case, the joint changes in demand in both market areas would give an incentive for intraday trade. Assume then a decrease in demand in the low price market area and an increase in demand in the high price market area, represented by $Q^3_L$ and $Q^3_H$. This would just enhance the price difference between the two market areas from day-ahead and there would be no incentive to trade. Assume then an increase in demand in both the low and high price market area, represented by $Q^2_L$ and $Q^3_H$. As above, if the price in the low price country would reach the level of the high price market area, there would be an incentive for intraday trade. The only difference is that the necessary size of the demand change would increase. Finally, assume a decrease in demand in both market areas, represented by $Q^3_L$ and $Q^2_H$. The same would then be true as in the case of increased demand in both areas.

The above fundamental analysis shows how both the direction of changes in demand intraday, size of the changes and the actual shape of the supply curves (price elasticity) are very important for the incentives and possibilities to trade (the first also true in case of no initial congestion).

Table 6.1 shows an overview of the possible combinations of changes to demand and supply intraday and whether there is a physical possibility of intraday trade in the case of congestion. If there will be economic incentives for trade as well, will then further depend on the resource pricing (the shapes of the demand and supply curves) and volumes.

*Table 6.1 Overview of combinations with changes in demand and supply intraday and possibility for intraday trade in case of congestion*

| | | High price country | | |
|---|---|---|---|---|
| | | Increased demand (decreased supply) | Decreased demand (increased supply) | In balance |
| Low price country | Increased demand (decreased supply) | Yes | Yes | Yes |
| | Decreased demand (increased supply) | No | Yes | No |
| | In balance | No | Yes | No |

## 6.3 WHAT IF ANALYSIS

### *6.3.1 Methodology and use of data*

In this section we will study how the incentives for intraday trade will change through introducing intraday trade on NorNed, based on a what-if analysis of a selection of cases. We analyse what would have been the situation day-ahead, if the information received during intraday/real-time time frame had been known at day-ahead stage. This will show the theoretical incentive for intraday trading based on resource pricing. We will compare this to the actual imbalance prices within each market to check for consistency in the methodology. Finally, we will study what is necessary to change the optimal direction of flow from the day-ahead market situation.

The analysis is based on perfect foresight (changes to demand) and perfect information (on the shapes of the bid curves), and shows the theoretical optimal market solution to meet the aggregated demand and supply from both day-ahead and intraday/real-time time stages for the coupled market areas for a given hour.

The data used for the analysis is the actual demand and supply curves for the APX NL and Nord Pool Spot day-ahead markets for a given hour in each of the selected cases. The demand and supply curves for Nord Pool Spot are for the whole Nordic market, that is, the demand and supply curves used to calculate the system price.[29] The APX NL data is for the Netherlands.[30] To represent the change in the market situation from day-ahead, we use the net volumes of activated balancing power in the Nordics and in the Netherlands as a proxy for the imbalance volumes in each area.[31]

In the case of a net positive volume of active balancing power, that is, the given country or market area is short of power after day-ahead time frame, we simulate this as an outward shift in demand. In the case of a net negative volume of balancing power, that is, the given country or market area is long or with a surplus of power after day-ahead time frame, we

[29] The Nord Pool Spot bid curves are adjusted for exchanges with other market areas, represented as changes to volumes on either buy or sell side. The market areas is historically Germany and Estonia, and since 12th of January 2011 also the Netherlands. Block bids are represented as changes to volumes to either or both buy and sell side. That is, both are treated as price independent bids.

[30] The APX NL bid curves are also adjusted for exchanges with other countries. The latter is included as bids on either buy or sell side. Block bids are also included as bids on either or both buy and sell side.

[31] Due to technicalities, using activated balancing volumes as a proxy for imbalance volumes in the Netherlands may be more problematic, and it might be more correct to use net imbalance volumes, which are also published by TenneT (not the case of Statnett). However, in our cases, this choice of methodology does not affect any of the findings.

simulate this as an inward shift in demand. The shifts of the curves are approximated adding or subtracting the actual net balancing power volumes from each aggregated volume/price pair in the demand curve.[32]

We then estimate the new day-ahead prices due to changes in demand and the necessary volumes to make the original day-ahead prices equal in the two market areas separately, using the supply curves only.[33] This is because it is most likely that it will be supply resources which will respond to imbalances after day-ahead stage.[34]

These choices of methodology will affect the true optimal day-ahead solution in the alternative day-ahead situation depending on the price elasticity of demand and supply, and effects of potential changes to block bids and exchanges with other countries. It will also affect the estimated volumes needed to change the day-ahead prices in either of the market areas to the same level. However, at the level of precision of the methodology, we find these solutions acceptable.

### 6.3.2 Selection of cases

We have selected eight cases based on the typical flow patterns on the NorNed cable and corresponding price differences between Norway and the Netherlands. The reason for this is to show examples of different but typical market situations between the two countries. Due to data availability on the supply and demand curves for Nord Pool Spot, we have had to select the cases within the time period of July 2010 up to and including November 2010.

It is important to note that the cases only intend to give an understanding of the situations which they represent, and are not intended to be representative of all possible outturns as such.

*Typical patterns of flow and price differences*

Figure 6.2 and Figure 6.3 below show the flow pattern between Norway and the Netherlands for the time period of July 2008 up to and including November 2010, and July 2010 up to and including November 2010. The first time period largely corresponds to the time period the NorNed interconnector has been in operation. The flow data is based on the nominated capacity from the historical explicit auction on the interconnector.

As can be seen there is an obvious flow pattern between Norway and the Netherlands at peak and off-peak, even though some of this pattern has been less strong in off-peak hours during the latter time period. This is due to a higher price in the Nordics during this period due to a combination of cold weather and a low water level in the reservoirs.

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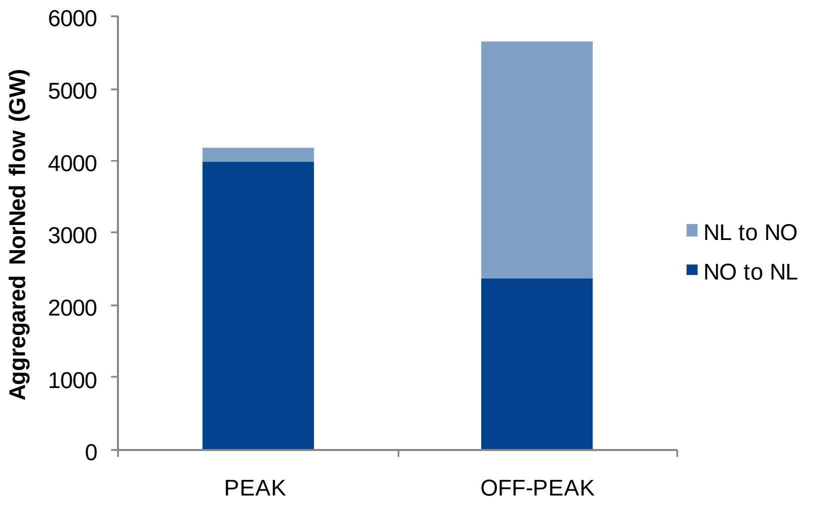
32 This is an approximation which is not completely correct because of demand elasticity, but non-significant in this analysis as the demand curves are not used in any of the calculations, as explained below.

33 In the Nord Pool Spot data this is done using linear interpolation. In the AXP NL data this is done reading directly from the supply curve, as the bid curves in APX are based on step bids (giving in all our cases an unambiguous price and volume).

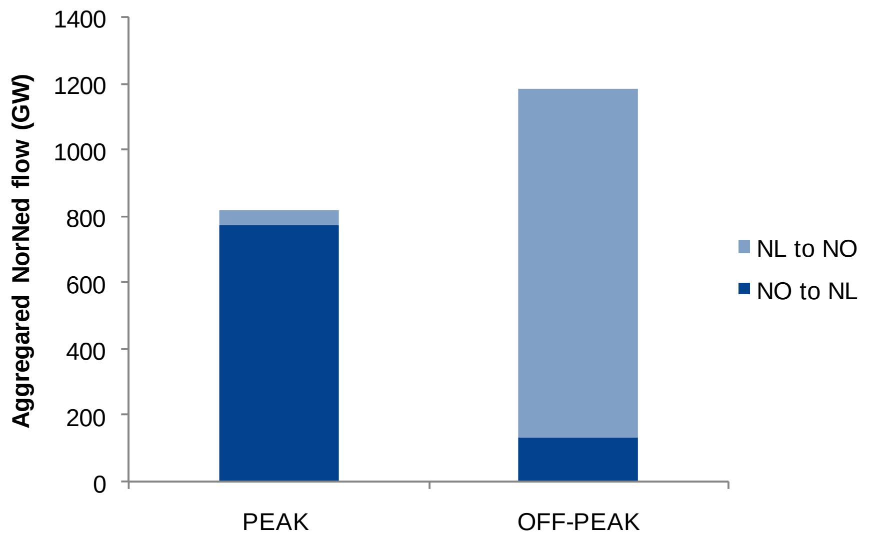
34 We basically assume that demand is inelastic when we consider the aggregated demand from day-ahead and balancing time frame, and find the necessary price to have the desired changes to supply (more or less supply).

*Figure 6.2 Flow on NorNed from July 2008 up to and including November 2010 based on nominated capacity*




Source: NorNed Auction and Pöyry Management Consulting

*Figure 6.3 Flow on NorNed from July 2010 up to and including November 2010 based on nominated capacity*



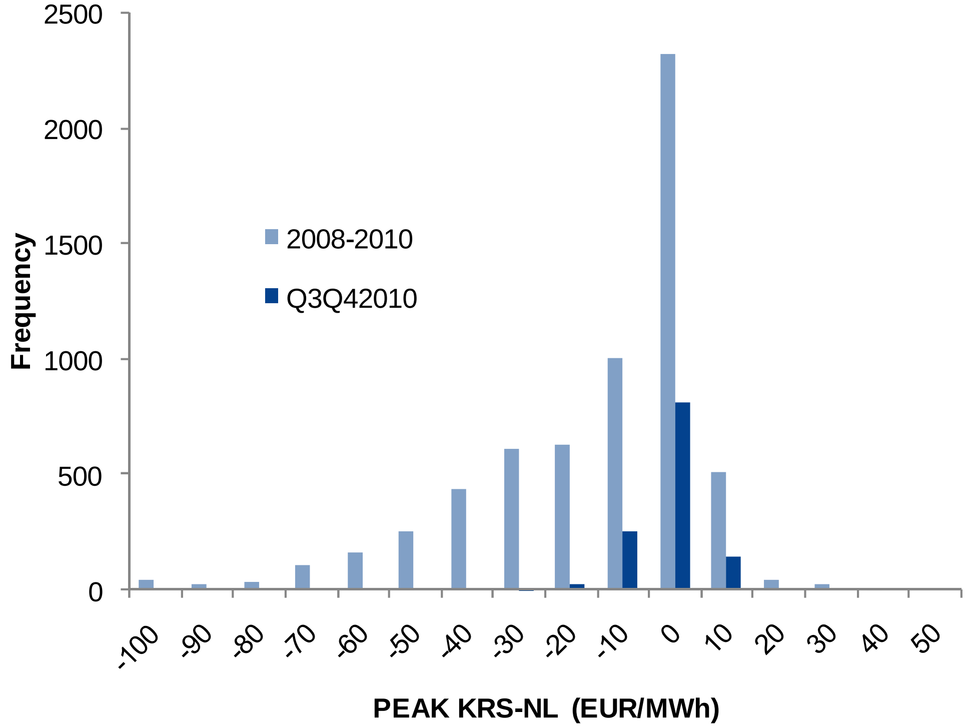

Source: NorNed Auction and Pöyry Management Consulting

This flow pattern illustrated above corresponds to the hourly price differences between the two market areas, as shown in Figure 6.4 and Figure 6.5. Hours where the NorNed interconnector has been out of operation have been excluded from the price data.[35] The price used to determine the price difference between Norway and the Netherlands is the price area where the NorNed cable is connected, which is currently NO2. However, as the price areas have changed during the period we have named the price area KRS for Kristiansand, which is the actual geographical area of connection.

[35] The definition used to define for which hours NorNed was out of operation, is that the available capacity given to the TSOs to the NorNed explicit auction, which was used for capacity allocation during the relevant time period, was zero.

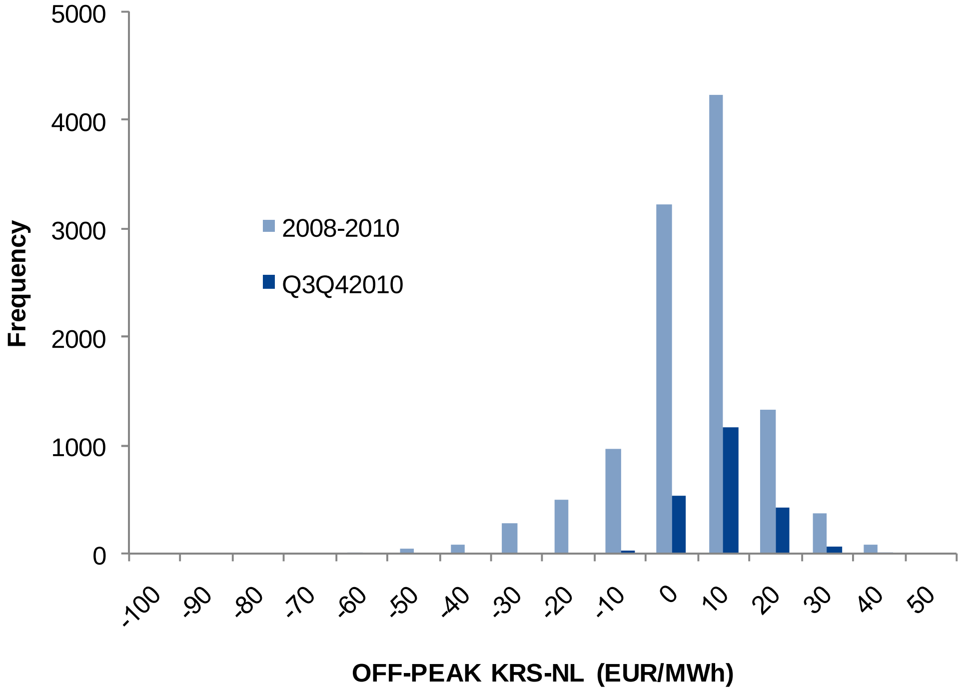
As can be seen, there is also some difference between the two time periods in this respect, due to the situation explained above. The very large price differences between Norway and the Netherlands, in the hours when Norwegian price is lower than in the Netherlands, are not represented in the latter time period.

*Figure 6.4 Price differences between Norway and the Netherlands in peak hours for both time periods.*




Source: Syspower, NorNed Auction and Pöyry Management Consulting

*Figure 6.5 Price differences between Norway and the Netherlands in off-peak hours for both time periods.*




Source: Syspower, NorNed Auction and Pöyry Management Consulting

In our data set, there is a price difference between Norway and the Netherlands in almost all the hours (only 33 hours have a price difference of zero, however more hours with a price difference close to zero). That is, based on the historical price differences only, there should be almost no situation with spare capacity on the interconnector. Due to the use of an explicit auction to allocate the capacity on the interconnector up to January 12th of 2011, this might however give a misleading picture of the economically correct situation, both historically and for the future price picture. It is not unlikely that some of the hours with very small price differences (accounting for losses) could have been hours with no price differences with the use of an implicit auction as now instead.

Due to the explicit auction method, there have also been historical situations with price differences according to APX NL and Kristiansand day-ahead prices and available capacity on the cable. Finally, there have also been historical cases of flows in the opposite direction of the price differences. In our analysis however, we chose to ignore this, and assume that a price difference indicate full flow on the cable in the right direction. Also, due to this, we choose to not analyse a case with zero price differences and concentrate on the situations with price differences. However, the actual hours with no price differences will also be situations with possible incentives to trade intraday.

There are basically four possible border line combinations of flow direction and size of price differences, and eight if taking into consideration whether it is a peak or off-peak hour. We have therefore chosen to select eight cases to give an example of each of these situations in the what-if analysis.

*Table 6.2 Overview of combinations of price differences*

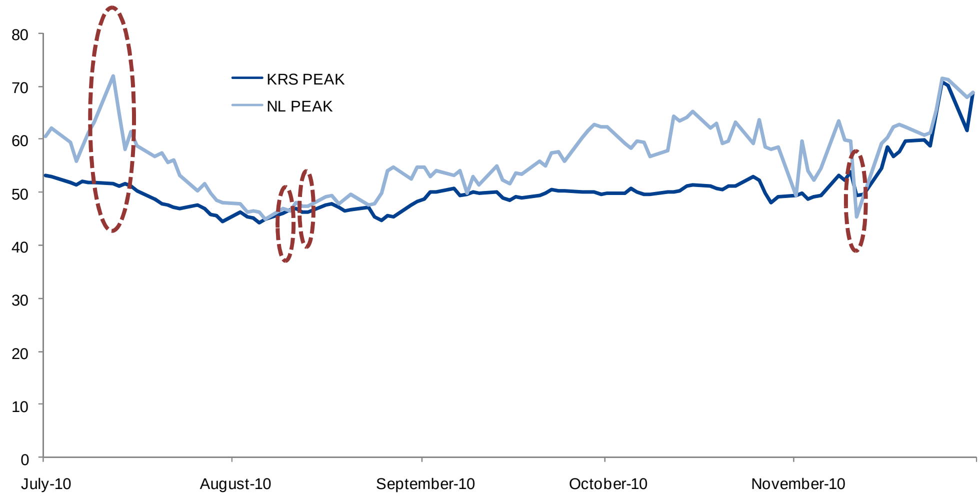
| | Large price difference | Small price difference |
|---|---|---|
| Peak / off-peak | Flow NO to NL | Flow NO to NL |
| Peak / off-peak | Flow NL to NO | Flow NL to NO |

### *Selection of hours to the cases*

Due to the large amount of data, we have chosen to illustrate the price differences during peak and off-peak, based on the daily average peak and off-peak price difference instead of hourly, in the time period July 2010 up to and including November 2010. Based initially on these graphs, we have selected the cases for the eight different situations. As the graphs are daily averages, it has been necessary to be careful in selecting the dates, to find hours which truly represent the situation we would like to analyse (the averages might be misleading). In selecting the cases, we have also taken care to find hours where the price difference between the price area where the interconnector is connected, currently NO2, and the system price, is small.

Figure 6.6 and Figure 6.7 below show the daily average peak and off-peak prices in Norway and the Netherlands for the time period of July 2010 up to and including November 2010, and the dates which we have chosen are indicated with red circles. [36]

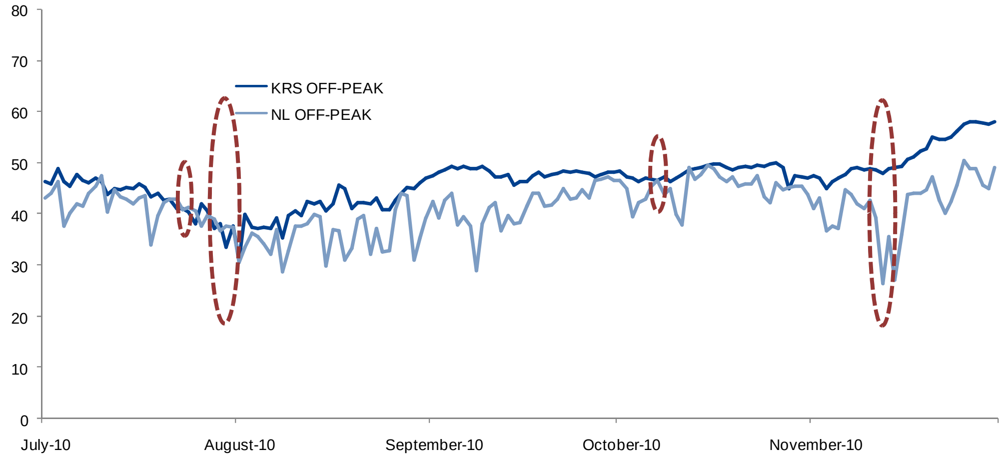
*Figure 6.6 Daily average peak prices in the Netherlands and NO2/Kristiansand*




Source: Syspower and Pöyry Management Consulting

[36] These graphs include all data for the period, also data when the NorNed cable was out of operation, for reason of completeness. The NorNed cable was only out of operation for revision during a few days in September during this time period. The exact outage period was 06.09.2010 from 06:00 am up to and including 10.09.2010 17:00 pm.

*Figure 6.7 Daily average off-peak prices in the Netherlands and NO2/Kristiansand*




Source: Syspower and Pöyry Management Consulting

The eight selected cases are shown more specifically in the table below.

*Figure 6.8 Eight selected cases*

| | | Large price difference | Small price difference |
|---|---|---|---|
| Peak | Flow NO to NL | 12.07.2010<br>Case 1 | 19.08.2010<br>Case 2 |
| | Flow NL to NO | 11.11.2010<br>Case 3 | 10.08.2010<br>Case 4 |
| Off-peak | Flow NO to NL | 30.07.2010<br>Case 5 | 21.07.2010<br>Case 6 |
| | Flow NL to NO | 14.11.2010<br>Case 7 | 07.10.2010<br>Case 8 |

Further, all peak hours are set to 10:00 am and all off-peak hours are set to 05:00 am in order to be consistent.

### *6.3.3 Case analysis general structure*

In each of the cases, we will go through the theoretical incentive to trade intraday with the actual imbalance volumes and the new estimated day-ahead prices/adjusted market clearing prices.[37] We will also show this visually in a figure of the two day-ahead markets, where the shifts in demand due to the actual imbalance volumes are shown as the red demand curves. The original bid curves are centred around zero based on the actual day-ahead volume, and the supply curve of both countries drawn in both market areas, both to increase comparability.

We also compare the theoretical incentive with the actual imbalances prices in the given hour as a check of the methodology. We include the imbalance price of NO2/Kristiansand

[37] We will use the term **adjusted market clearing price** through-out the case analysis. This is to avoid any potential misunderstanding of the methodology, explained more thoroughly in 6.3.1, as there will be discrepancies from the true new day-ahead market price.

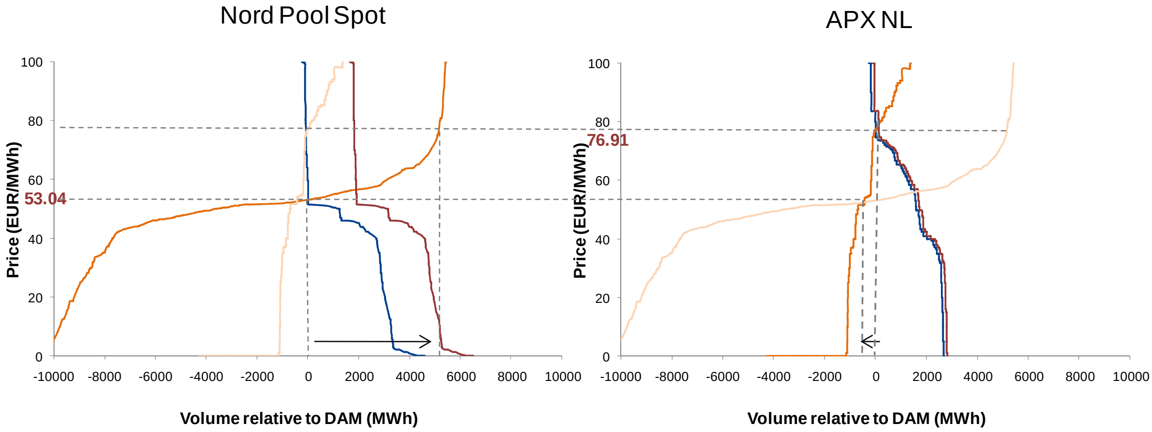
and the average Norwegian and Nordic imbalance prices. In the case of the Netherlands, which uses balancing intervals of 15 min, we use the hourly average.

We will also show the estimated volumes needed to make prices equal in each of the two countries separately (a change in one of the market areas only), and comment on the likelihood of trade if that was to be the case. The direction of change and volumes are also indicated in the figures mentioned above. We also provide a more detailed figure of the supply curves of Nord Pool Spot and APX NL after the points where prices are equal in the two markets, to increase the comparability. The volume axis of these figures are set to a 1000 MW, as this volume area should be the most relevant (ramping rules restrict the maximum change of power on the interconnector to 600 MW between two hours).

### *6.3.4 Case 1*

Figure 6.9 shows the bidding curves at 10:00 am on July 12th 2010 in the two day-ahead markets.

*Figure 6.9 Bidding curves in Nord Pool Spot and APX at 10:00 am, July 12th 2010*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

In this particular hour there is a need for up-regulation in both market areas. There is no theoretical incentive for intraday trade in the actual situation in the only possible direction.

*Table 6.3 Day-ahead, adjusted market clearing and imbalance prices in €/MWh*

| | Kristiansand/NO2 | Norway | Nordics | Netherlands |
|---|---|---|---|---|
| Original day-ahead price | 52.18 | | 53.04 | 76.91 |
| Adjusted market clearing price | - | - | 56.48 | 79.4 |
| Imbalance price consumption | 61.35 | 61.78 | 107.37 | - |
| Take from / Feed into system | - | - | - | 81.29/81.29 |
| Main direction or regulating state | Up | Up | Up | Up |

Source: APX-ENDEX, Nord Pool Spot, TenneT and Pöyry Management Consulting

As can be seen in Table 6.3, the adjusted market clearing price in Nord Pool Spot is lower than both the original day-ahead price and adjusted market clearing price in APX NL. The imbalance prices in the Nordics also fall below both the original day-ahead price and adjusted market clearing price of APX NL, which corresponds to the theoretical result.[38] Also, the imbalances prices in the Netherlands were above the APX NL day-ahead and adjusted market clearing price. This is also in line with the theoretical result.

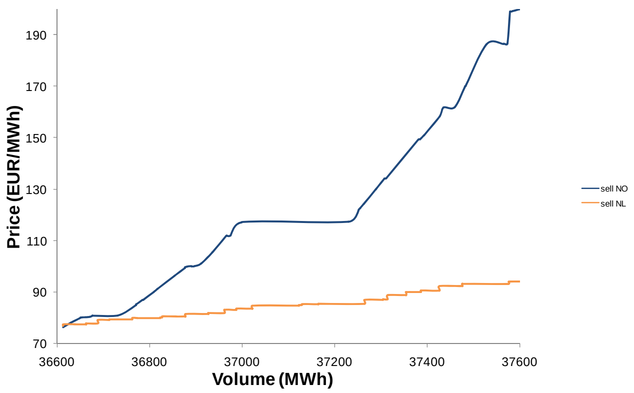
*Table 6.4 Actual day-ahead and balancing volumes versus estimated volumes needed to possibly change flow direction (in MWh)*

| | Day-ahead | Actual change | | | Minimum change | | |
|---|---|---|---|---|---|---|---|
| | Volume | Volume | % of day-ahead | Incentive | Volume | % of day-ahead | Incentive |
| Nordics/KRS | 32007.4 | 1910/117 | 6% | No | 5155 | 16% | Yes |
| Netherlands | 4282.9 | 132.4 | 3% | No | -424 | -10% | Yes |

Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

The necessary increase in demand in Nord Pool Spot and the necessary decrease in demand in APX NL to achieve equal prices in the two market areas separately are found in Table 6.4. In the case of the Nordics, as seen in Figure 6.10, there would afterwards be cheaper supply resources available in the Netherlands. It would therefore be a theoretical incentive for trade if the volumes increased above this point. In the case of the Netherlands, as seen in Figure 6.11, there would afterwards be supply resources with a higher willingness to pay to buy back power in the Nordics than in the Netherlands. It would therefore be a theoretical incentive for trade if the volumes decreased below this point.

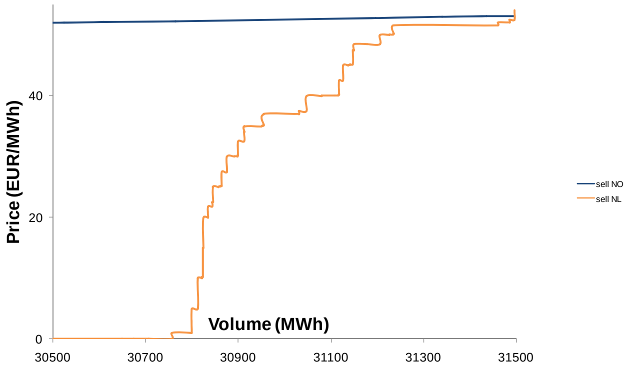
*Figure 6.10 Supply curves after point when Nord Pool Spot price is equal to APX NL*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

[38] The average imbalance price for all the Nordic countries is far above the APX day-ahead price, but this is most likely due to internal congestion in the Nordic balancing market affecting prices, and of less importance.

*Figure 6.11 Supply curves after point when APX NL is equal to Nord Pool Spot*

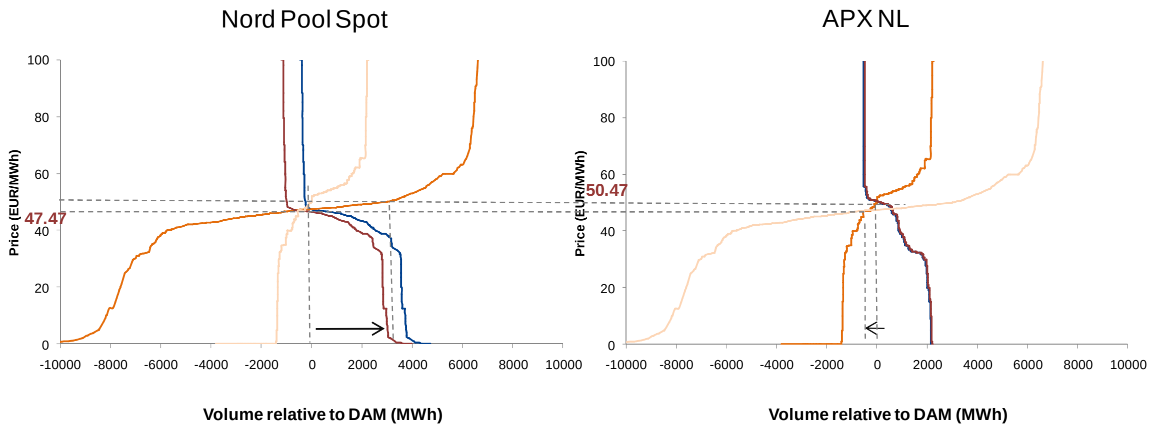



Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

### 6.3.5 Case 2

Figure 6.12 shows the bidding curves at 10:00 am on August 19th 2010 in the two day-ahead markets.

*Figure 6.12 Bidding curves in Nord Pool Spot and APX at 10:00 am, August 19th 2010*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

In this particular hour there is a need for down-regulation in the Nordics and up-regulation in the Netherlands. In the actual situation, there is no theoretical incentive for intraday trade, as there are no imbalances in the right direction.

*Table 6.5 Day-ahead, adjusted market clearing and imbalance prices in €/MW*

| | Kristiansand/ NO2 | Norway | Nordics | Netherlands |
|---|---|---|---|---|
| Original day-ahead price | 47.44 | | 47.47 | 50.47 |
| Adjusted market clearing price | - | - | 46.97 | 52 |
| Imbalance price consumption | 39.17 | 39.99 | 42.03 | - |
| Take from / Feed into system | - | - | - | 44.8/44.8 |
| Main direction or regulating state | Down | Down | Down and none | Up and down |

Source: APX-ENDEX, Nord Pool Spot, TenneT and Pöyry Management Consulting

The actual situation is just an enhancement of the price difference from the original day-ahead stage, as can also be seen from the day-ahead and adjusted market clearing prices in Table 6.5. The imbalance prices in the Nordics are also below the Nordic day-ahead price as would be expected. The Dutch imbalance prices however are below the APX NL day-ahead and adjusted market clearing price, which would not be expected as there is mostly up-regulation during this hour. This can neither be explained by the use of the average of the 15 min intervals.

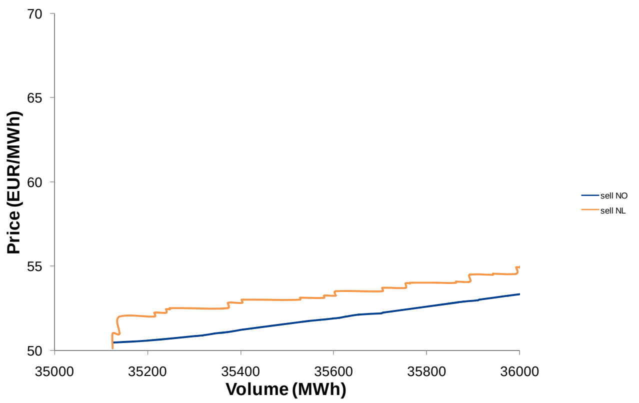
*Table 6.6 Actual day-ahead and balancing volumes versus estimated volumes needed to possibly change flow direction (in MWh)*

| | Day-ahead | Actual change | | | Minimum change | | |
|---|---|---|---|---|---|---|---|
| | Volume | Volume | % of day-ahead | Incentive | Volume | % of day-ahead | Incentive |
| Nordics/KRS | 32622.4 | -742/-94 | -2% | No | 3215 | 10% | Some |
| Netherlands | 3813.4 | 37 | 1% | No | -256 | -7% | Yes |

Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

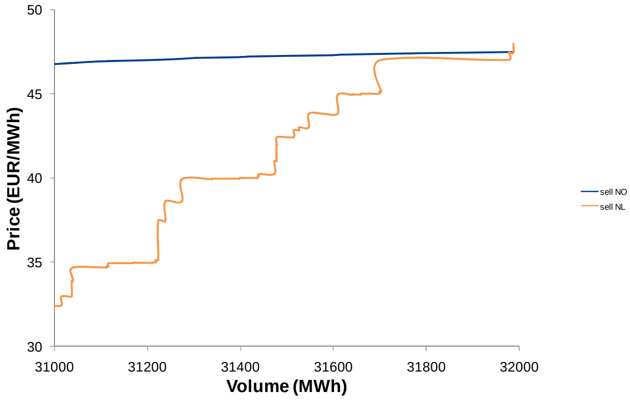
The necessary increase in demand in Nord Pool Spot and the necessary decrease in demand in APX to achieve equal prices in the two market areas separately are seen in Table 6.6 below. In the case of the Nordics, as seen in Figure 6.13, there would afterwards still be quite cheaper supply resources available in the Nordics. It would therefore only be some theoretical incentive for trade if the volumes increased above this point. In the case of the Netherlands, as seen in Figure 6.14, there would afterwards be resources with a higher willingness to pay to buy back power in the Nordics than in the Netherlands. It would therefore be a theoretical incentive for trade if the volumes decreased below this point.

*Figure 6.13 Supply curves after point when Nord Pool Spot price is equal to APX NL*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

*Figure 6.14 Supply curves after point when APX NL is equal to Nord Pool Spot*

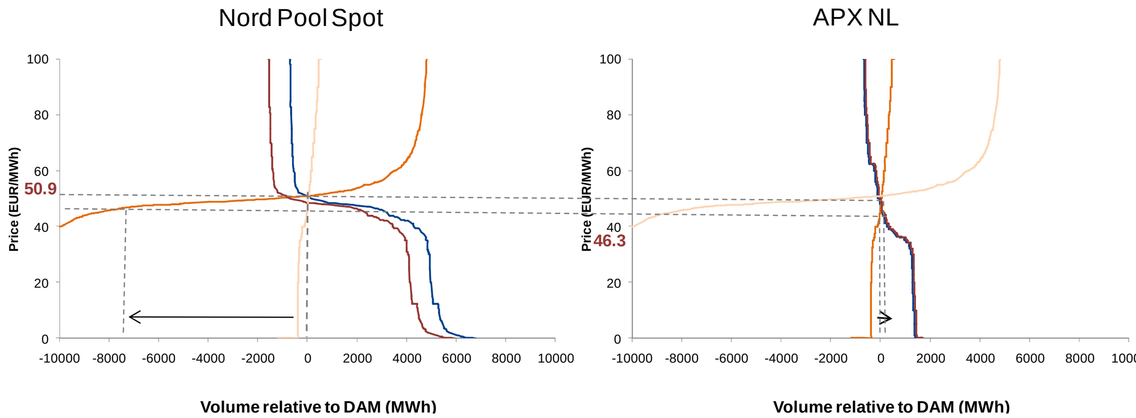



Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

### 6.3.6 Case 3

Figure 6.15 below shows the bidding curves at 10:00 am on November 11th 2010 in the two day-ahead markets.

*Figure 6.15 Bidding curves in Nord Pool Spot and APX at 10 am, November 11th 2010*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

In this particular hour there is a need for down-regulation in the Nordics and up-regulation in the Netherlands. The imbalances are in the right directions, but in the actual situation, there is no theoretical incentive for intraday trade. It is however just at the limit, and the reason there is no theoretical incentive is that the supply curve of Nord Pool Spot is very flat in the relevant section.

*Table 6.7 Day-ahead, adjusted market clearing and imbalance prices in €/MWh*

| | Kristiansand/ NO2 | Norway | Nordics | Netherlands |
|---|---|---|---|---|
| Original day-ahead price | 49.71 | | 50.9 | 46.3 |
| Adjusted market clearing price | - | - | 50.40 | 50.23 |
| Imbalance price consumption | 43.97 | 43.97 | 43.97 | - |
| Take from / Feed into system | - | - | - | 52.92/52.92 |
| Main direction or regulating state | Down | Down | Down | Up and down |

Source: APX-ENDEX, Nord Pool Spot, TenneT and Pöyry Management Consulting

As can be seen in Table 6.7, the adjusted market clearing price in Nord Pool Spot stays higher than the adjusted market clearing price in APX NL. The imbalance prices in the Nordics however fall below the original day-ahead price of APX. Also, the imbalance prices in the Netherlands are above both the Nordic day-ahead and adjusted market clearing price. This indicates that there could have been an incentive to trade in practice this hour, which due to simplifications in the methodology, is not captured.

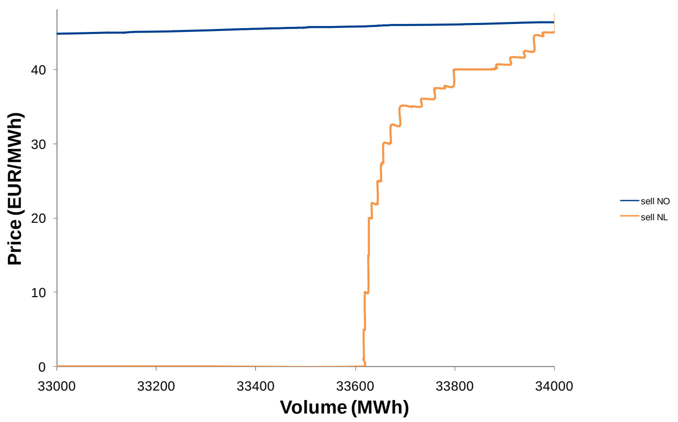
*Table 6.8 Actual day-ahead and balancing volumes versus estimated volumes needed to possibly change flow direction (in MWh)*

| | Day-ahead | Actual change | | | Minimum change | | |
|---|---|---|---|---|---|---|---|
| | Volume | Volume | % of day-ahead | Incentive | Volume | % of day-ahead | Incentive |
| Nordics/KRS | 42223.7 | -850/-61 | -2% | No | -7629 | -18% | No |
| Netherlands | 3294.5 | 61 | 2% | No | 62 | 2% | Yes |

Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

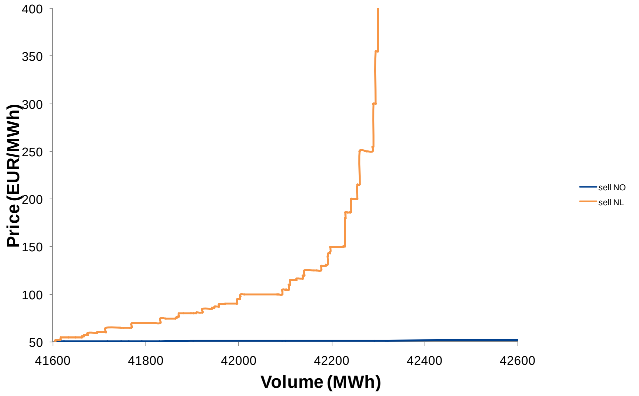
The necessary decrease in demand in Nord Pool Spot and the necessary increase in demand in APX NL to achieve equal prices in the two market areas separately are found in Table 6.8. In the case of the Nordics, as seen in Figure 6.16, there would afterwards be supply resources with a higher willingness to pay to buy back power available in the Nordics. It would therefore not be a theoretical incentive for trade if the volumes decreased below this point. In the case of the Netherlands, as seen in Figure 6.17, there would afterwards be resources with a lower marginal cost in the Nordics than in the Netherlands. It would therefore be a theoretical incentive for trade if the volumes increased above this point.

*Figure 6.16 Supply curves after point when Nord Pool Spot price is equal to APX NL*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

*Figure 6.17 Supply curves after point when APX NL is equal to Nord Pool Spot*

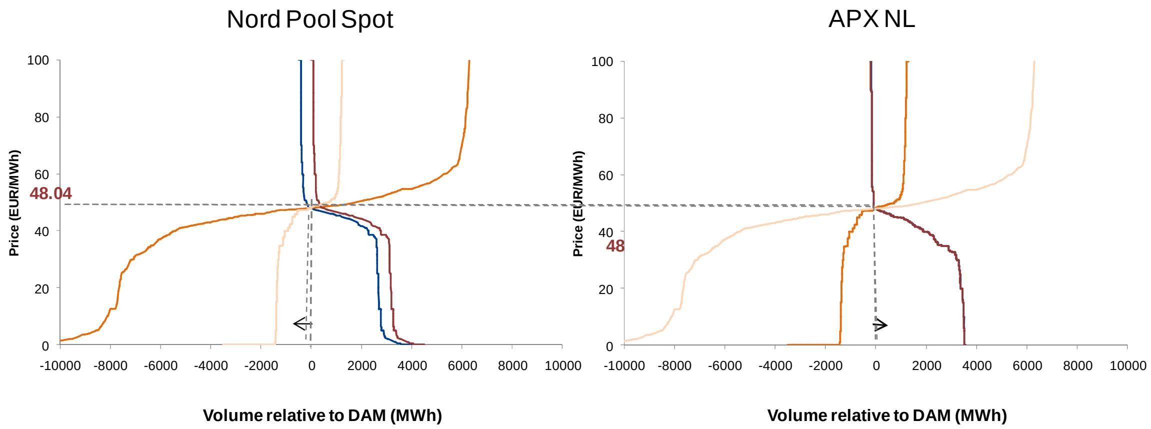



Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

### 6.3.7 Case 4

Figure 6.18 below shows the bidding curves at 10:00 am on August 10th 2010 in the two day-ahead markets.

*Figure 6.18 Bidding curves in Nord Pool Spot and APX at 10:00 am, August 10th 2010*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

In this particular hour there is a need for up-regulation in the Nordics and down-regulation in the Netherlands. In the actual situation, there is no theoretical incentive for intraday trade, as there are no imbalances in the right direction.

*Table 6.9 Day-ahead, adjusted market clearing and imbalance prices in €/MWh*

| | Kristiansand/ NO2 | Norway | Nordics | Netherlands |
|---|---|---|---|---|
| Original day-ahead price | 48.04 | | 48.04 | 48 |
| Adjusted market clearing price | - | - | 48.50 | 48 |
| Imbalance price consumption | 50 | 50 | 50 | - |
| Take from / Feed into system | - | - | - | 41.96/37.98 |
| Main direction or regulating state | Up | Up | Up | Up, down and neither |

Source: APX-ENDEX, Nord Pool Spot, TenneT and Pöyry Management Consulting

The actual situation is again just an enhancement of the price difference from the original day-ahead stage, as can also be seen from the day-ahead and adjusted market clearing prices in Table 6.9. The imbalance prices in the Nordics are above the level of the original day-ahead price in Nord Pool Spot, and the imbalance prices in the Netherlands fall below the original day-ahead price in APX NL, which is as expected.

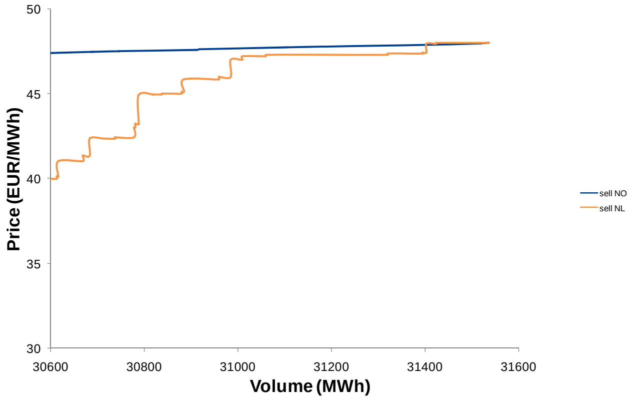
*Table 6.10 Actual day-ahead and balancing volumes versus estimated volumes needed to possibly change flow direction (in MWh)*

| | Day-ahead | Actual change | | | Minimum change | | |
|---|---|---|---|---|---|---|---|
| | Volume | Volume | % of day-ahead | Incentive | Volume | % of day-ahead | Incentive |
| Nordics/KRS | 32391 | 498/50 | 2% | No | -34 | -0.1% | Some |
| Netherlands | 3528.6 | -6 | 0% | No | 0 up | 0.0% | Yes |

Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

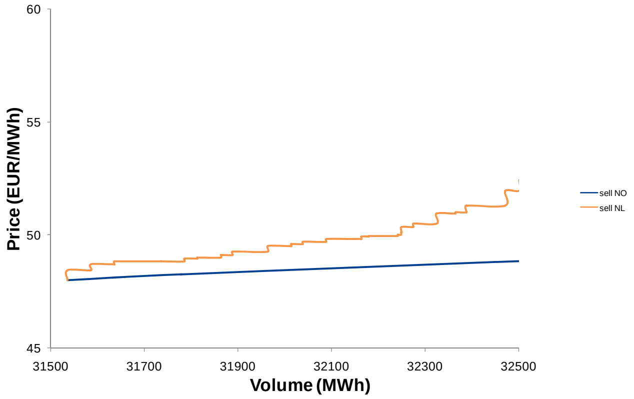
The necessary decrease in demand in Nord Pool Spot and the necessary increase in demand in APX NL to achieve equal prices in the two market areas separately are seen in Table 6.10. In the case of the Nordics, as seen in Figure 6.19, there would afterwards mostly be supply resources with a higher willingness to pay to buy back power in the Nordics. It would therefore not be a large theoretical incentive for trade if the volumes decreased below this point. In the case of the Netherlands, as seen in Figure 6.20, there would afterwards be resources with a lower marginal cost in the Nordics than in the Netherlands. It would therefore be a theoretical incentive for trade if the volumes increased above this point.

*Figure 6.19 Supply curves after point when Nord Pool Spot price is equal to APX NL*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

*Figure 6.20 Supply curves after point when APX NL is equal to Nord Pool Spot*

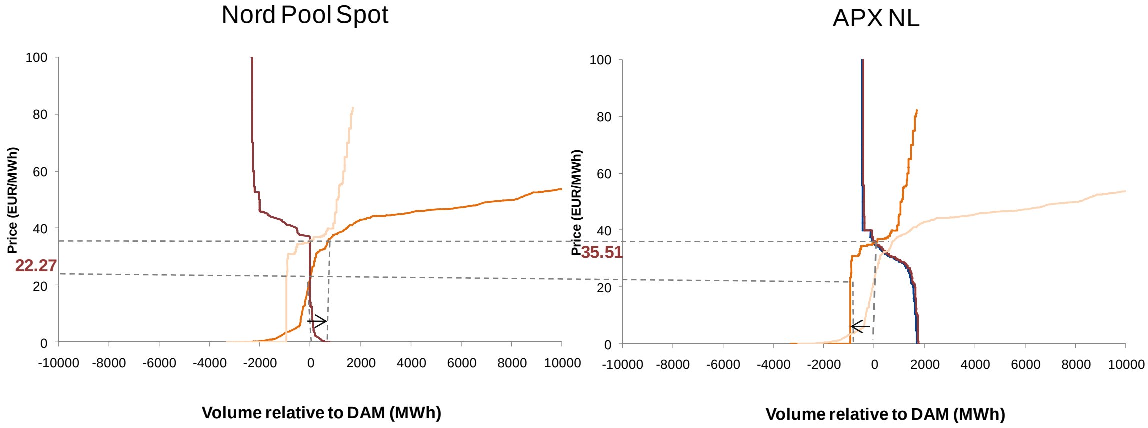



Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

### 6.3.8 Case 5

Figure 6.21 below shows the bidding curves at 05:00 am on July 30th 2010 in the two day-ahead markets.

*Figure 6.21 Bidding curves in Nord Pool Spot and APX at 05:00 am, July 30th 2010*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

In this particular hour there is only a need for up-regulation in the Netherlands. In the actual situation, there is no theoretical incentive for intraday trade, as the imbalance is in the wrong direction.

*Table 6.11 Day-ahead, adjusted market clearing and imbalance prices in €/MWh*

| | Kristiansand/ NO2 | Norway | Nordics | Netherlands |
|---|---|---|---|---|
| Original day-ahead price | 22.27 | | 22.41 | 35.51 |
| Adjusted market clearing price | - | - | - | 35.8 |
| Imbalance price consumption | 22.41 | 22.41 | 22.33 | - |
| Take from / Feed into system | - | - | - | 51.87/51.87 |
| Main direction or regulating state | None | None | None | Up |

Source: APX-ENDEX, Nord Pool Spot, TenneT and Pöyry Management Consulting

As can be seen in Table 6.11, the adjusted market clearing price in APX NL is higher than the original day-ahead price APX NL and day-ahead price in Nord Pool Spot. The imbalance prices in the Netherlands are also above the adjusted market clearing price in the Netherlands.[39]

*Table 6.12 Actual day-ahead and balancing volumes versus estimated volumes needed to possibly change flow direction (in MWh)*

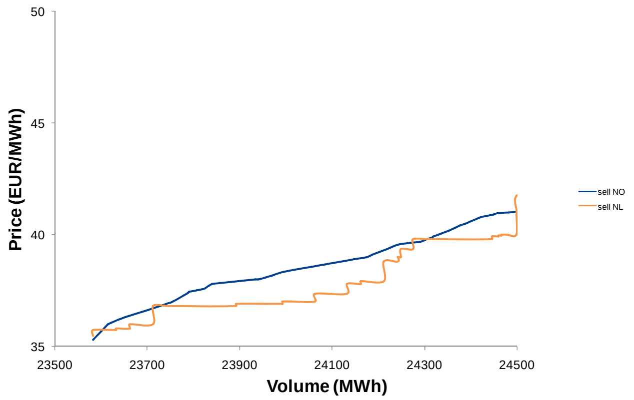
| | Day-ahead | Actual change | | | Minimum change | | |
|---|---|---|---|---|---|---|---|
| | Volume | Volume | % of day-ahead | Incentive | Volume | % of day-ahead | Incentive |
| Nordics/KRS | 23696.2 | 0/0 | - | No | 714 | 3% | Yes |
| Netherlands | 3321.6 | 68 | 2% | No | -953 | -29% | Yes |

Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

The necessary increase in demand in Nord Pool Spot and the necessary decrease in demand in APX NL to achieve equal prices in the two market areas separately are seen in Table 6.12. In the case of the Nordics, as seen in Figure 6.22, there would afterwards be cheaper supply resources available in the Netherlands. It would therefore be a theoretical incentive for trade if the volumes increased above this point. In the case of the Netherlands, as seen in Figure 6.23, there would afterwards be resources with a higher willingness to pay to buy back power in the Nordics than in the Netherlands. It would therefore be a theoretical incentive for trade if the volumes decreased below this point.

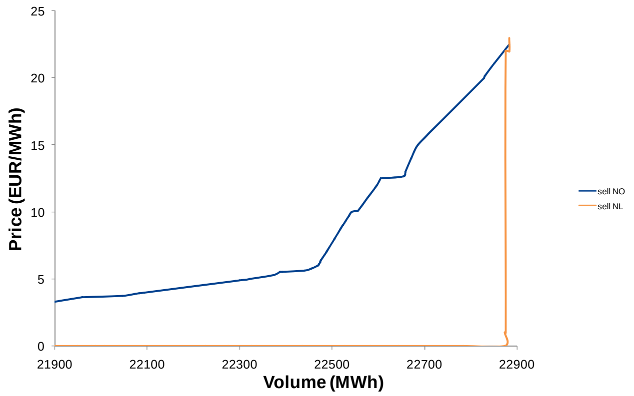
39 The reason the imbalances prices in the Nordics deviate from the day-ahead price is due to rounding errors caused by the exchange rates used to calculate the imbalance prices in Euros. The exchange rates are taken from data from Nord Pool Spot.

*Figure 6.22 Supply curves after point when Nord Pool Spot price is equal to APX NL*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

*Figure 6.23 Supply curves after point when APX NL is equal to Nord Pool Spot*

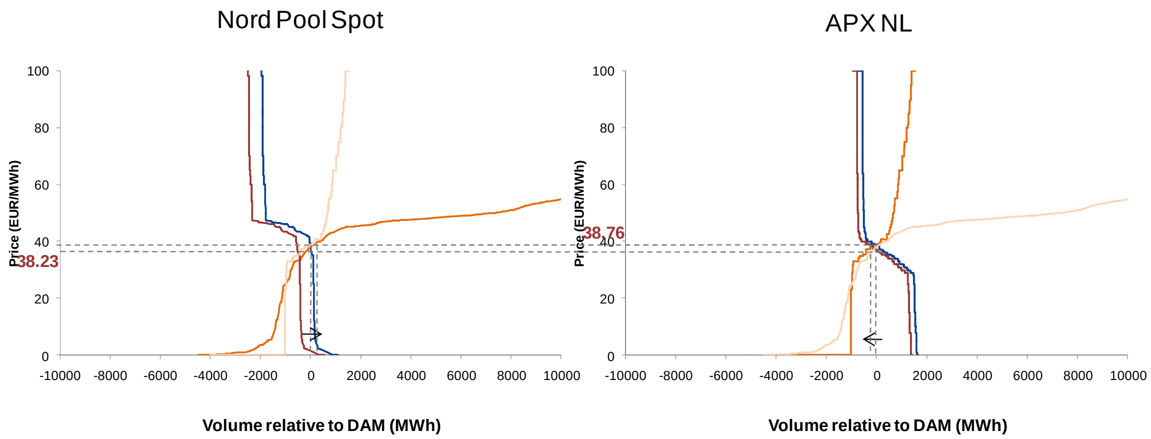



Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

### 6.3.9 Case 6

Figure 6.24 below shows the bidding curves at 05:00 am on July 21th 2010 in the two day-ahead markets.

*Figure 6.24 Bidding curves in Nord Pool Spot and APX at 05:00 am, July 21th 2010*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

In this particular hour there is a need for down-regulation in both the Nordics and in the Netherlands. In the actual situation, there is no theoretical incentive for intraday trade, because of the simultaneous reduction in demand in the Nordics and the shape of supply curves.

*Table 6.13 Day-ahead, adjusted market clearing and imbalance prices in €/MWh*

| | Kristiansand/ NO2 | Norway | Nordics | Netherlands |
|---|---|---|---|---|
| Original day-ahead price | 38.23 | | 38.23 | 38.76 |
| Adjusted market clearing price | - | - | 33.16 | 37.89 |
| Imbalance price consumption | 24.57 | 24.57 | 24.57 | - |
| Take from / Feed into system | - | - | - | 20.04/20.04 |
| Main direction or regulating state | Down | Down | Down | Down |

Source: APX-ENDEX, Nord Pool Spot, TenneT and Pöyry Management Consulting

As can be seen in Table 6.13, the adjusted market clearing price in APX stays higher than the adjusted market clearing price in Nord Pool Spot. The Nordic imbalances prices are lower than the adjusted market clearing price in Nord Pool Spot. However, the imbalance prices in the Netherlands are lower than any of the prices in the Nordics, which would not be expected.

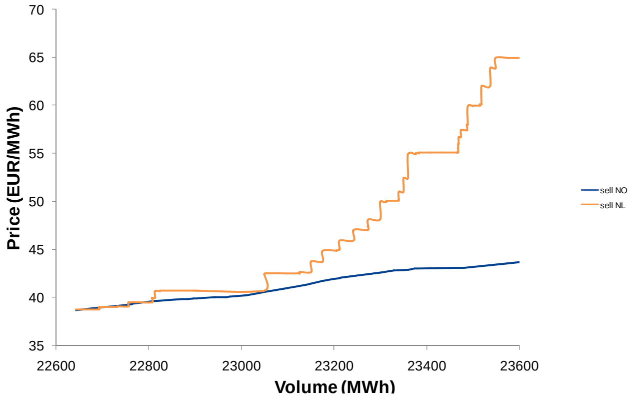
*Table 6.14 Actual day-ahead and balancing volumes versus estimated volumes needed to possibly change flow direction (in MWh)*

| | Day-ahead | Actual change | | | Minimum change | | |
|---|---|---|---|---|---|---|---|
| | Volume | Volume | % of day-ahead | Incentive | Volume | % of day-ahead | Incentive |
| Nordics/KRS | 23197.4 | -539/-33 | -2% | No | 96 | 0.4% | Yes |
| Netherlands | 4019.7 | -232 | -6% | No | -84 | -2% | Some |

Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

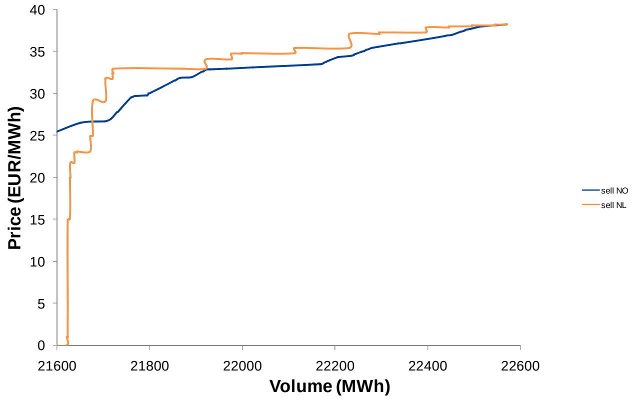
The necessary increase in demand in Nord Pool Spot and the necessary decrease in demand in APX NL to achieve equal prices in the two market areas separately are found in Table 6.14. In the case of the Nordics, as seen in Figure 6.25, there would afterwards be quite equally priced supply resources available in both market areas first, before the supply resources are cheaper in the Nordics. It would therefore be a theoretical incentive for trade if the volumes increased above this point. In the case of the Netherlands, as seen in Figure 6.26, there would mostly be supply resources with a higher willingness to pay to buy back power in the Netherlands than in the Nordics. It would be some theoretical incentive for trade if the volumes decreased below this point.

*Figure 6.25 Supply curves after point when Nord Pool Spot price is equal to APX NL*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

*Figure 6.26 Supply curves after point when APX NL is equal to Nord Pool Spot*

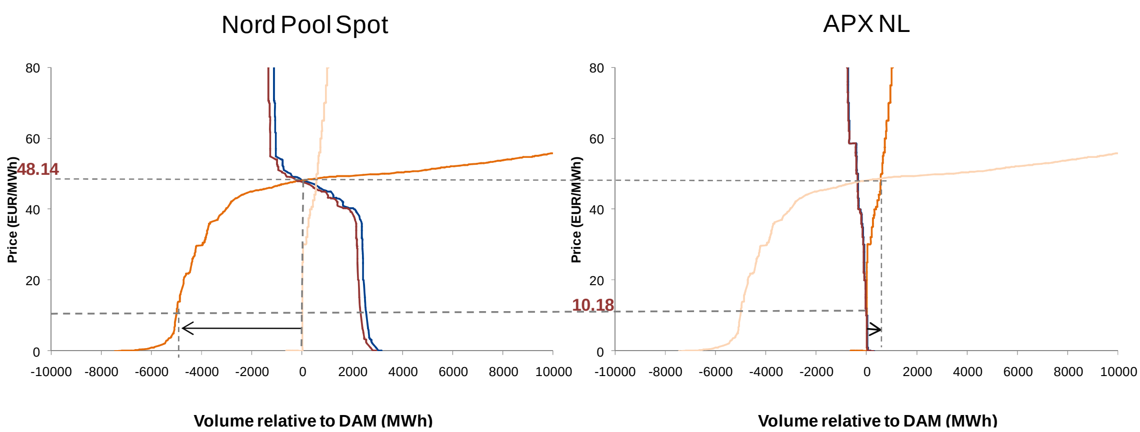



Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

### *6.3.10 Case 7*

Figure 6.27 below shows the bidding curves at 05:00 am on November 14th 2010 in the two day-ahead markets.

*Figure 6.27 Bidding curves in Nord Pool Spot and APX at 05:00 am, November 14th 2010*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

In this particular hour there is a need for down-regulation in both the Nordics and the Netherlands. In the actual situation, there is no theoretical incentive for intraday trade in the only right direction.

*Table 6.15 Day-ahead, adjusted market clearing and imbalance prices in €/MWh*

| | Kristiansand/ NO2 | Norway | Nordics | Netherlands |
|---|---|---|---|---|
| Original day-ahead price | 48 | | 48.14 | 10.18 |
| Adjusted market clearing price | - | - | 47.90 | 0.01 |
| Imbalance price consumption | 42.86 | 42.86 | 42.97 | - |
| Take from / Feed into system | - | - | - | 21.21/21.21 |
| Main direction or regulating state | Down | Down | Down | Down |

Source: APX-ENDEX, Nord Pool Spot, TenneT and Pöyry Management Consulting

As can be seen in Table 6.15, the adjusted market clearing price in Nord Pool Spot stays higher than the adjusted market clearing price in APX NL. The imbalance prices in the Nordics are lower than the adjusted market clearing price in Nord Pool Spot, and higher than the imbalance prices in the Netherlands, which is as expected. However that the imbalance price in the Netherlands is higher than the APX day-ahead price, is not expected.

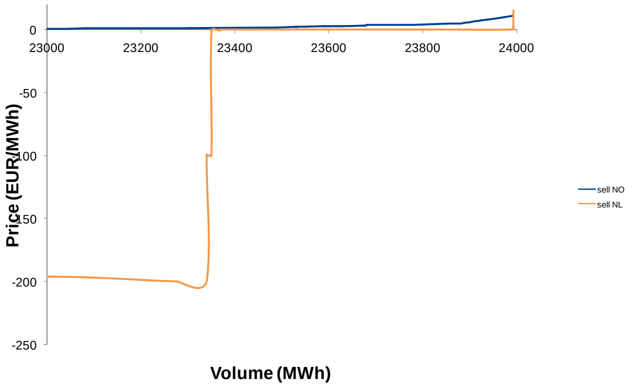
*Table 6.16 Actual day-ahead and balancing volumes versus estimated volumes needed to possibly change flow direction (in MWh)*

| | Day-ahead | Actual change | | | Minimum change | | |
|---|---|---|---|---|---|---|---|
| | Volume | Volume | % of day-ahead | Incentive | Volume | % of day-ahead | Incentive |
| Nordics/KRS | 29342 | -218/-54 | -1% | No | -5024 | -17% | Some |
| Netherlands | 3549.4 | -21 | -1% | No | 567 | 16% | Yes |

Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

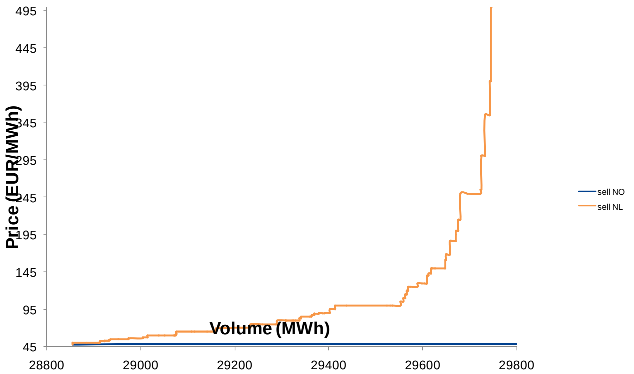
The necessary decrease in demand in Nord Pool Spot and the necessary increase in demand in APX NL to achieve equal prices in the two market areas separately are seen in Table 6.16. In the case of the Nordics, as seen in Figure 6.28, there would afterwards to some degree mostly be supply resources with a higher willingness to pay to buy back power in the Nordics. It would therefore not be a very large theoretical incentive for trade if the volumes decreased below this point. In the case of the Netherlands, as seen in Figure 6.29, there would afterwards be resources with a lower marginal cost in the Nordics than in the Netherlands. It would therefore be a theoretical incentive for trade if the volumes increased above this point.

*Figure 6.28 Supply curves after point when Nord Pool Spot price is equal to APX NL*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

*Figure 6.29 Supply curves after point when APX NL is equal to Nord Pool Spot*

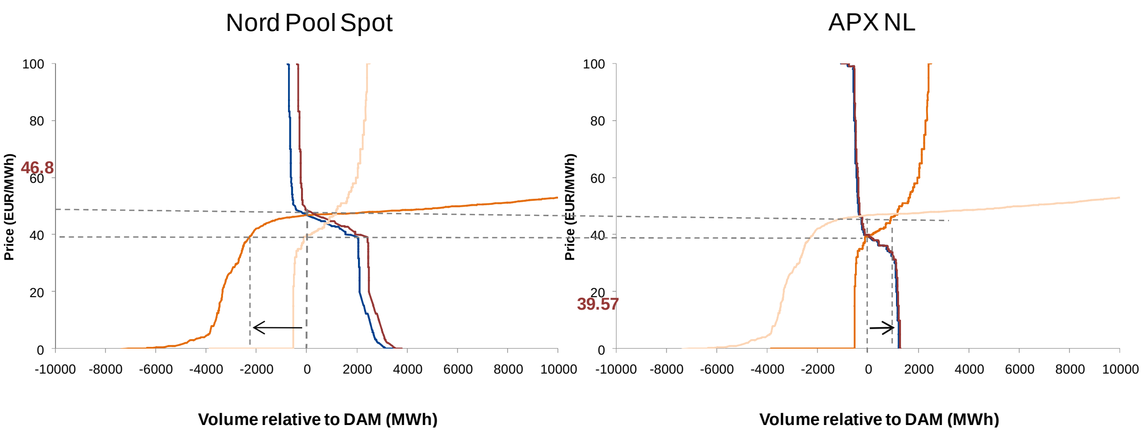



Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

### 6.3.11 Case 8

Figure 6.30 below shows the bidding curves at 05:00 am on October 7th 2010 in the two day-ahead markets.

*Figure 6.30 Bidding curves in Nord Pool Spot and APX at 05:00 am, October 7th 2010*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

In this particular hour there is a need for up-regulation in both the Nordics and the Netherlands. In the actual situation, there is no theoretical incentive for intraday trade in the only right direction.

*Table 6.17 Day-ahead, adjusted market clearing and imbalance prices in €/MWh*

| | Kristiansand/ NO2 | Norway | Nordics | Netherlands |
|---|---|---|---|---|
| Original day-ahead price | 46.8 | | 46.8 | 39.57 |
| Adjusted market clearing price | - | - | 47.00 | 39.85 |
| Imbalance price consumption | 50 | 50 | 50 | - |
| Take from / Feed into system | - | - | - | 45.07/40.68 |
| Main direction or regulating state | Up | Up | Up | Up and neither |

Source: APX-ENDEX, Nord Pool Spot, TenneT and Pöyry Management Consulting

As can be seen in Table 6.17, the adjusted market clearing price in Nord Pool Spot is still higher than the adjusted market clearing price in APX NL. Also, the imbalance price for the Nordics is higher than the imbalance price in the Netherlands, which is as expected.

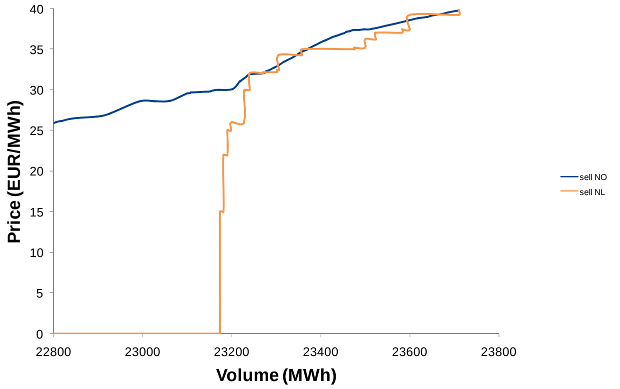
*Table 6.18 Actual day-ahead and balancing volumes versus estimated volumes needed to possibly change flow direction (in MWh)*

| | Day-ahead | Actual change | | | Minimum change | | |
|---|---|---|---|---|---|---|---|
| | Volume | Volume | % of day-ahead | Incentive | Volume | % of day-ahead | Incentive |
| Nordics/KRS | 26529.8 | 380/0 | 1% | No | -2233 | -8% | Some |
| Netherlands | 3872.1 | 41 | 1% | No | 1063 | 27% | Yes |

Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

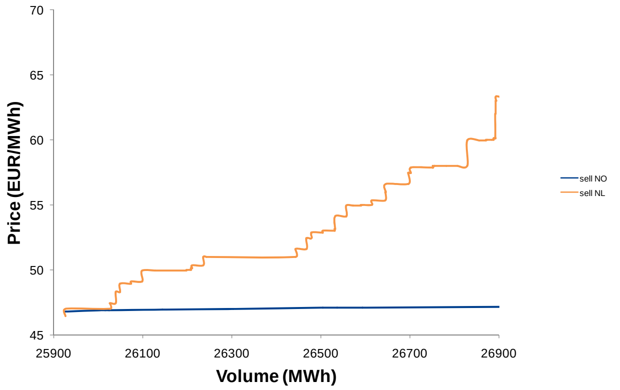
The necessary decrease in demand in Nord Pool Spot and the necessary increase in demand in APX NL to achieve equal prices in the two market areas separately are found in Table 6.18. In the case of the Nordics, as seen in Figure 6.31, there would afterwards to some degree be supply resources with similar willingness to pay to buy back power in both market areas, all though higher volumes in the Nordics. It would therefore not be a large theoretical incentive for trade, but more unclear, if the volumes decreased below this point. In the case of the Netherlands, as seen in Figure 6.32, there would afterwards be supply resources with a lower marginal cost in the Nordics than in the Netherlands. It would therefore be a theoretical incentive for trade if the volumes increased above this point.

*Figure 6.31 Supply curves after point when Nord Pool Spot price is equal to APX NL*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

*Figure 6.32 Supply curves after point when APX NL is equal to Nord Pool Spot*




Source: APX-ENDEX, Nord Pool Spot and Pöyry Management Consulting

### 6.3.12 Summary of what-if case analyses

We will here summarise some of the findings in the what-if case analyses. It is here very important to note, that as the cases are not meant to be representative as such, it is necessary to be very careful about drawing any strong conclusions from the case analysis. The below is therefore more a summary of indications given by the cases than conclusions, which may then be more or less correct in comparison to what may have been found in a fully representative analysis.

In none of the cases, the actual change in demand in the two market areas changed the direction of the optimal flow on the interconnector. In other words, there was no theoretical incentive for trade with the actual balancing volumes in any of the cases. In case 3 however, there was almost a situation with a theoretical incentive for trade. With larger volumes or different combinations of imbalances, there would in general in all but one of the cases be at least some incentive to trade.

As could be seen, the shapes of the supply curves are naturally very important for incentives to trade. In the cases, after passing the point where prices are equal in the two market areas, down-regulation is almost always cheaper (higher willingness to pay to buy back power) in the Nordics. For up-regulation, it is a little more ambiguous, even though the Nordics is cheaper in five of the cases.

The actual imbalance prices for the Nordics were always as expected except in case 3, while the imbalance prices in the Netherlands were not as expected in four of the cases. One of these cases were case 3, where, as already commented on, this might be due to actual incentives to trade in the case (applies to both the Nordic and Dutch imbalance prices). In two of the cases, the Dutch imbalances prices were not as expected in comparison to the APX day-ahead prices, and in the last situation, the imbalance prices were lower than expected. The latter could be due to resource availability, which could also explain case 3.

If there would be large deviations in the supply curve intraday from the day-ahead stage, this could possibly have a significant influence on the adjusted market clearing prices. We have however not made any analysis of this (except the possibilities mentioned above). Also, the supply curve at the balancing stage is more likely to deviate from the supply curve at the day-ahead stage than at intraday stage, so it is not necessarily possible to draw any strong conclusions from such a comparison neither. Internal congestion in the Nordics could also affect the availability of supply resources in the Nord Pool Spot curves.

An overview of the average absolute actual and necessary volumes to obtain equal prices in %, separated by whether peak or off-peak hour, direction of flow and market area, can be found in Table 6.19. The numbers in the table indicate that there may be a need for a lower minimum volume to change the optimal direction of flow in the less typical flow directions. That is, flows at peak hours from the Netherlands to the Nordics and flows at off-peak hours from the Nordics to the Netherlands. This indication is dependent on for which market area the minimum volume applies to (see the numbers highlighted with grey colour).[40]

[40] In the actual cases behind the average numbers highlighted in grey, there would thereafter always be at least some incentive for trade.

*Table 6.19 Average absolute actual and necessary volumes to obtain equal prices in %, separated by peak/off-peak, flow direction and market area*

| | | | Actual change % of day-ahead | Minimum change % of day-ahead |
|---|---|---|---|---|
| Peak | NO to NL | Nordics | 4% | 13% |
| | | Netherlands | 2% | 8% |
| Peak | NL to NO | Nordics | 2% | 9% |
| | | Netherlands | 1% | 1% |
| Off-peak | NO to NL | Nordics | 2% | 2% |
| | | Netherlands | 4% | 15% |
| Off-peak | NL to NO | Nordics | 1% | 13% |
| | | Netherlands | 1% | 22% |

An overview of the average absolute actual and necessary volumes to obtain equal prices in %, separated by whether there is a large or small price difference and peak or off-peak hour/ in total, can be found in Table 6.20. The figures in the table indicate that there may be a need for a lower minimum volume to change optimal direction of flow in the cases with a small price difference.

*Table 6.20 Average absolute actual and necessary volumes to obtain equal prices in %, separated by large or small price difference, peak/off-peak and market area*

| | | Large price difference | | Small price difference | |
|---|---|---|---|---|---|
| | | Actual change % of day-ahead | Minimum change % of day-ahead | Actual change % of day-ahead | Minimum change % of day-ahead |
| Peak | Nordics | 6% | 17% | 2% | 5% |
| | Netherlands | 3% | 6% | 1% | 3% |
| Off-peak | Nordics | 1% | 10% | 2% | 4% |
| | Netherlands | 1% | 22% | 3% | 15% |
| Total | Nordics | 3% | 14% | 2% | 5% |
| | Netherlands | 2% | 14% | 2% | 9% |

Even if the case analysis may give, or seem to give, some indications of potential, it is important to remember that this is not a study of the potential for intraday trade on NorNed. The analysis is as stated before not representative, and to study the potential it would be necessary to analyse a much larger amount of cases, and also make an analysis of future imbalance needs (renewables would be very important here) and potential changes to the resource mixes and costs of each market area. It is also important to remember trade potential in hours without congestion, which may be more relevant than indicated by the historical data as mentioned before, due to the historical use of an explicit auction. The most important part, or lesson learnt, from the what-if case analyses, is more how it gives an intuition for the fundamental resource pricing in the two market areas, and how this drives the fundamental incentives for trade.

## 6.4 EFFECT OF DYNAMICS

The above analysis of incentives for intraday trade on NorNed has been based on the estimated optimal market solution to meet the aggregated demand and supply from both day-ahead and intraday/real-time time stages for the coupled market areas for a given hour. It has been based on perfect foresight and perfect information, and the new market equilibrium has been solved in one step.

The actual intraday trading is however continuous and based on pay-as-bid. It is neither based on perfect foresight with regards to changes in demand, that is, demand changes are uncertain.[41] With regards to perfect information, the actors in the market have access to the same bid curves as we have used in the analysis above, which are published the same day as the day-ahead auction in both day-ahead markets.[42] Information about the costs and supply curves of both markets is then likely somewhat known (hydro systems providing some more uncertainty here, as the water values depend on expectations).

Literature on pay-as-bid auctions, indicate that in the case of perfect information on demand and supply, all actors will bid the marginal cost of the marginal supplier. This way, all the producers would receive the same price as in an auction based on the marginal price (uniform price auction). This is so in a completely competitive market. A monopolist would with perfect information, also bid in the same way as in a uniform price auction. In the case of imperfect information on demand, that is, uncertainty with respect to demand changes, the average prices and outputs will decrease in the case of a completely competitive market. In particular, the low-cost producers will lose more under a pay-as-bid regime than in a uniform price auction due to a higher opportunity cost in terms of foregone profits. The higher opportunity cost will make them bid more aggressively. In the case of the monopolist, the situation is not necessarily so. A pay-as-bid auction also makes the risk for collusion smaller. All the above results are found given the assumption of risk-neutral producers.

Even if the findings referred to above are for auctions, and not continuous trading, we find it likely that some of the same effects will exist. The continuous trading may however likely allow for more testing of different bids, as bids can be withdrawn and changed if they have not been matched. But this also implies a risk. The dynamics of trade also apply to how information is given continuously to the market through the continuous bidding process.

## 6.5 INTERDEPENDENCIES BETWEEN THE DIFFERENT TIME FRAMES

As the intraday market offers the market participants an alternative to the balancing market and imbalances charges in case of imbalances, the two market places become interconnected. This is also potentially so for the day-ahead market (we will return to this below).

The intraday market will fundamentally represent a market place for some of the imbalance volumes, which in the case of no intraday market, would have been handled in the balancing market. The existence of intraday market gives a market participant a choice to actively try to trade into balance in the intraday market, or passively wait for the balancing market and face the imbalance payment based on this.

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[41] Some patterns may however exist in the imbalance volumes, as we will return to in the next sub-chapter

[42] In Nord Pool Spot, both data and a graphical representation is published free of charge. In the case of APX Power NL, only a graphical representation is published free of charge, while the data is available for a charge only.

A theoretic fundamental interdependency between the intraday and balancing market is that the expected imbalance prices set a theoretical upper and lower bound on the intraday prices. Prices in the intraday market would however be expected to be somewhat better than in the balancing market, due to flexibility and amount of participants which may trade. If the expected prices would not have been better, there would have been no incentive to trade intraday, but instead leave the handling of imbalances to the TSO.

While day-ahead and intraday markets between market areas either are coupled or in the process of being coupled, balancing markets are normally national. A market coupling at intraday stage will however in practice, at least in part, couple the balancing of the two market areas together, even though the actual balancing market stays national. This is due to the fact that the intraday market coupling will shift some of the imbalance volumes between the market areas. A market coupling at intraday stage will therefore affect the total “balancing volumes” to be handled in a given market area, and thereby the demand for balancing resources/flexible resources, in a given market area. This will then affect prices in the national balancing markets, as the total “balancing” may become cheaper or more expensive.

Market coupling at intraday stage is less likely to affect the need for balancing reserves (volume) in the market areas. The need for balancing reserves is more likely to be defined based on the volumes in the day-ahead market, as intraday trade would only represent a reduction in day-ahead flows on the interconnector or a full utilization of the interconnector capacity, which would already have been offered to the day-ahead market. A larger demand for reserves for balancing could possibly affect the day-ahead market negatively in situations with scarcity of generation capacity. As the reserved balancing volumes are naturally kept out of the day-ahead market, a larger demand for generation reserves could then increase scarcity in such situations. The opposite would be true for a lower demand for generation reserves for balancing.

Different prices in the different time frames may also give market players incentives to arbitrage between the different markets by allocating volumes across the markets or be in imbalance in the expected right direction in order to maximize profits. This may be in violation with market rules and would be monitored by the market surveillance functions.[43] If expecting higher prices in the intraday or balancing market, suppliers could have incentives to withhold volumes from the day-ahead market and instead supply in intraday (assuming same cost of supply). As the intraday market and balancing markets represent small volumes in comparison to day-ahead, this is likely to imply a significant volume risk. The other possibility is to be in imbalance in the expected right direction. Statistical arbitrage opportunities may support such strategies.[44]

[43] It is not allowed to be in imbalance on purpose at day-ahead or intraday stage in neither Norway nor the Netherlands.

[44] An article investigating the German balancing markets (Möller et al 2011), have found that market participants exploit statistical arbitrage opportunities between the balancing energy markets and the day-ahead market in Germany. This is due to patterns in the deployment of balancing power and is incentivized by the imbalance pricing system (economic incentive to be in imbalance in the right direction even though not allowed). The article also shows how this strategic behaviour contributes to an effective functioning of the electricity market, as it leads to cheaper balancing.

These incentives are however already present in today's intraday markets/balancing markets, and a market coupling intraday would most likely reduce this possibility as the liquidity and number of participants will increase in the total, coupled market. [45]

In the case of market power, this would more likely be an issue in the day-ahead market as the volumes are larger and profitability higher. There will not be specific market power issues due to the introduction of an intraday market that is not already identified in the day-ahead market. In general, it is more likely that a market coupling will reduce market power as it increases competition.

[45] Congestion rent on the NorNed interconnector is based on the day-ahead price differences. If day-ahead prices were to be affected due to such arbitrage, this would in case also affect congestion rent. We have not analysed this specifically, but as stated, we find that a market coupling intraday would most likely decrease the possibility of arbitrage. Neither have we analysed whether market coupling at intraday stage will be more beneficial to one of the parties. However, and somewhat obviously, it will under certain market and system conditions largely benefit one of the parties, and under other conditions largely benefit the other. Defining and understanding what these conditions are, and how this may play out on average, would require significant further analysis.

# REFERENCES

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In addition we have collected information mainly from the following web sites:

www.statnett.no

See in particular the following subpages (not all information available in English):

http://www.statnett.no/no/Kraftsystemet/Markedsinformasjon/

(http://www.statnett.no/en/The-power-system/The-power-situation/)

http://www.statnett.no/no/Kraftsystemet/Balanseavregning/

(http://www.statnett.no/en/The-power-system/Balanseavregning/)

www.tennet.org

See in particular the following subpages:

http://www.tennet.org/english/transmission_system_services/system_services/index.aspx

http://www.tennet.org/english/operational_management/system_data_preparation/offering_regulating_reserve_capacity/index.aspx

www.nve.no

www.nordpoolspot.com

www.apxendex.com

We have also received information directly from Nord Pool Spot, APX Power NL and Statnett.

# APPENDIX 1: MEMBERSHIP LIST NORD POOL SPOT

## *ELSPOT*

| Country | Participant | Direct participant | Clearing customer | Represen-tative |
|---|---|---|---|---|
| Norway | AGA AS | | x | |
| Norway | Agder Energi Produksjon AS | x | | |
| Norway | Akershus Energi Vannkraft AS | x | | |
| Norway | Alpiq Norway AS | x | | x |
| Norway | A/S Eidefoss | | x | |
| Norway | Avinor AS | | x | |
| Norway | Markedskraft ASA | x | | |
| Norway | Bane Energi | | x | |
| Norway | Bergen Energi AS | x | | x |
| Norway | BKK Produksjon AS | x | | |
| Norway | Boliden Odda AS | | x | |
| Norway | Coop Norge SA | | x | |
| Norway | Dalane Energi IKS | | x | |
| Norway | EB Handel AS | x | | |
| Norway | EB Kraftproduksjon | | x | |
| Norway | E-CO Vannkraft AS | x | | |
| Norway | EGL Nordic AS | x | | |
| Norway | Eidsdal Kraft AS | x | | |
| Norway | Eidsiva Marked AS | x | | |
| Norway | Eidsiva Vannkraft AS | x | | |
| Norway | Eiendomsspar Energi AS | | x | |
| Norway | Elkem ASA Energi Handel | x | | |
| Norway | Elkraft AS | x | | |
| Norway | Eramet Titanium & Iron AS | | x | |
| Norway | Fellesdata AS | | x | |
| Norway | Fesil AS | | x | |
| Norway | Fjord Energi AS | | x | |
| Norway | Flesberg Elektrisitetsverk AS | | x | |
| Norway | Fortum Markets AS | | x | |
| Norway | GDF SUEZ E&P NORGE AS | | x | |
| Norway | Gudbrandsdal Energi AS | | x | |
| Norway | Hafslund Strøm AS | x | | |
| Norway | Haugesund Kommune | | x | |
| Norway | Helgelandskraft AS | x | | |
| Norway | Heidelbergcement Norway AS | | x | |
| Norway | Helse Sør-Øst RHF | | x | |
| Norway | Hemsedal Energi KF | | x | |
| Norway | Hjelmeland Kommune | | x | |
| Norway | Hålogaland Kraft AS | x | | |
| Norway | Ishavskraft AS | x | | |
| Norway | ISS Facility Services | | x | |
| Norway | Istad Kraft AS | x | | |
| Norway | Jotun Kraft AS | | x | |
| Norway | Klæbu Kommune | | x | |

| Country | Participant | Direct participant | Clearing customer | Represen-tative |
|---|---|---|---|---|
| Norway | Kongsberg Energi Eiendom AS | | x | |
| Norway | Kongsvinger Kommune | | x | |
| Norway | Konsesjonskraftfondet for Aust-Agder IKS | | x | |
| Norway | Kraftinor AS | | x | |
| Norway | Lantmännen Unibake Norge AS | | x | |
| Norway | Lier Everk KB | | x | |
| Norway | Lindex AS | | x | |
| Norway | Lofotkraft Produksjon AS | | x | |
| Norway | LOS AS | | x | |
| Norway | Lunds Energi Norge AS | x | | |
| Norway | Luster Energiverk AS | | x | |
| Norway | Lyse Handel AS | | x | |
| Norway | Lyse Produksjon AS | x | | |
| Norway | Lærdal Energi AS | | x | |
| Norway | Max Kraft AS | x | | |
| Norway | Malvik Everk KF | | x | |
| Norway | Markedskraft ASA | x | | x |
| Norway | Mesta Konsern AS | | x | |
| Norway | Midt Kraft Buskerud AS | | x | |
| Norway | Midt-Telemark Energi AS | | x | |
| Norway | Mo Industripark AS | | x | |
| Norway | Møre og Romsdal Fylkeskommune | | x | |
| Norway | Nammo Raufoss AS | | x | |
| Norway | Nesset kraft AS | | x | |
| Norway | Nordkraft Produksjon AS | x | | |
| Norway | Nordmøre Energiverk AS | x | | |
| Norway | Nordvest Kraft AS | | x | |
| Norway | NORD-ØSTERDAL KRAFTLAG SA | | x | |
| Norway | NTE Energi AS | x | | |
| Norway | NTE Marked AS | | x | |
| Norway | Norsk Hydro Produksjon AS | x | | |
| Norway | Norske Skogindustrier AS | x | | |
| Norway | Norway Pelagic As | | x | |
| Norway | Odda Energi AS | x | | |
| Norway | Oppegård Kommune | | x | |
| Norway | Oppland Energi AS | | x | |
| Norway | Oslo Lufthavn AS | | x | |
| Norway | Pasvik Kraft A/S | | x | |
| Norway | PowerTrade AS | | x | |
| Norway | Presidium AS | | x | |
| Norway | Rauma Energi Kraft AS | | x | |
| Norway | Reitan Servicehandel AS | | x | |
| Norway | Ringeriks-Kraft Produksjon AS | | x | |
| Norway | Ringsaker Kommune | | x | |
| Norway | Rogaland Fylkeskommune | | x | |
| Norway | Røros Elektrisitetsverk A/S | | x | |
| Norway | Scandem Norge | | x | |
| Norway | Schibsted ASA | | x | |
| Norway | Selbu Energiverk AS | | x | |
| Norway | SFE Produksjon AS | x | | |

| Country | Participant | Direct participant | Clearing customer | Represen-tative |
|---|---|---|---|---|
| Norway | Shell Energy | | x | |
| Norway | Skagerak Kraft AS | x | | |
| Norway | Skandiakraft AS | | x | |
| Norway | Skedsmo Kommune | | x | |
| Norway | SKL Produksjon AS | x | | |
| Norway | SKS Kraftsalg AS | | x | |
| Norway | SKS Produksjon AS | x | | |
| Norway | Sognekraft AS | x | | |
| Norway | Sparebank 1 Gruppen AS | | x | |
| Norway | Stange Energi AS | | x | |
| Norway | Statens Vegvesen-Vegdirektoratet | | x | |
| Norway | Statkraft Energi AS | x | | |
| Norway | Statnett SF | x | | |
| Norway | Statoil ASA | x | | |
| Norway | Stranda Energiverk AS | | x | |
| Norway | Stryn Energi AS | | x | |
| Norway | Studentsamskipnaden i Oslo | | x | |
| Norway | Sunndal Energi KF | | x | |
| Norway | Sunnfjord Energi AS | x | | |
| Norway | Svorka Energi AS | | x | |
| Norway | Tafjord Kraftproduksjon AS | x | | |
| Norway | Telenor AS | | x | |
| Norway | Telinet Energi AS | | x | |
| Norway | Time Kommune | | x | |
| Norway | Tinfos AS | | x | |
| Norway | Troms Kraft Marked AS | x | | |
| Norway | TrønderEnergi Kraft AS | x | | |
| Norway | Tussa Energi AS | x | | |
| Norway | Ustekveikja Energi AS | | x | |
| Norway | Uste Nes AS | | x | |
| Norway | Varner Retail AS | | x | |
| Norway | Wacker Chemicals Norway AS | | x | |
| Norway | Østfold Energi AS | x | | |
| Norway | Øystre Slidre Kommune | | x | |
| Sweden | 3G Infrastructure Services AB | | x | |
| Sweden | AB Fortum Värme samägt med Stockholms stad | | x | |
| Sweden | AGA Gas Aktiebolag | | x | |
| Sweden | Akademiska Hus | | x | |
| Sweden | Alfa Laval Corporate AB | | x | |
| Sweden | Aktiebolaget Strömstadsbyggen | | x | |
| Sweden | AMF Pension | | x | |
| Sweden | Arctic Paper Håfreströms Aktiebolag | | x | |
| Sweden | Arctic Paper Munkedals Aktiebolag | | x | |
| Sweden | Arise Windpower AS | | x | |
| Sweden | Armada Fastigheter | | x | |
| Sweden | Atria Supply AB | | x | |
| Sweden | Bergen Energi AB | x | | x |
| Sweden | Bixia AB | x | | |
| Sweden | Dala Kraft AB | x | | |

| Country | Participant | Direct participant | Clearing customer | Represen-tative |
|---|---|---|---|---|
| Sweden | EDB Business Partners AB | | x | |
| Sweden | EGL Sverige AB | | x | |
| Sweden | Elitkraft Sverige AB | | x | |
| Sweden | Erasteel Kloster Aktiebolag | | x | |
| Sweden | Eskilstuna Energi & Miljö AB | | x | |
| Sweden | Fastighetsaktiebolaget Förvaltaren | | x | |
| Sweden | Fortum Generation AB | | x | |
| Sweden | Fortum Markets AB | | x | |
| Sweden | Fyrfasen Kraftenergi AB | | x | |
| Sweden | Gamla Byn Aktiebolag | | x | |
| Sweden | Gällivare Kommun | | x | |
| Sweden | GodEl AB | | x | |
| Sweden | Graflunds Byggnads Aktiebolag | | x | |
| Sweden | Göta Energi AB | | x | |
| Sweden | Göteborg Energi Din El AB | x | | |
| Sweden | Götene Kommun | | x | |
| Sweden | Halmstads Kommun | | x | |
| Sweden | Heidelberg Cement Sweden AB | | x | |
| Sweden | Huge Fastigheter AB | | x | |
| Sweden | Härryda Kommun | | x | |
| Sweden | Hyresbostäder i Norrköping Aktiebolag | | x | |
| Sweden | Jernhusen AB | | x | |
| Sweden | Jämtkraft AB | x | | |
| Sweden | Kirunabostäder AB | | x | |
| Sweden | Kommunalförbundet Inköp Gävleborg | | x | |
| Sweden | Konsum Värmland Ekonomiska Förening | | x | |
| Sweden | Korsnäs Rockhammar AB | | x | |
| Sweden | Kraft og Kultur i Sverige AB | | x | |
| Sweden | Kungälvs Kommun | | x | |
| Sweden | Landstinget i Värmland | | x | |
| Sweden | Lerums kommun | | x | |
| Sweden | Lidköpings Kommun | | x | |
| Sweden | Lindex AB | | x | |
| Sweden | Mariestads Kommun | | x | |
| Sweden | Markedskraft Sverige, filial till Markedskraft AS | | x | |
| Sweden | Mälarenergi AB | x | | |
| Sweden | McDiensten Ökonomiska Förening | | x | |
| Sweden | Metsä Tissue AB | | x | |
| Sweden | Metso Svenska AB | | x | |
| Sweden | Mjölby Kommun | | x | |
| Sweden | Modity Energy Trading AB | x | | |
| Sweden | Motala Kommun | | x | |
| Sweden | Mölndal Energi AB | | x | |
| Sweden | Nya Arvika Gjuteri AB | | x | |
| Sweden | Nynas AB (Publ) | | x | |
| Sweden | Ovako Bar AB | | x | |
| Sweden | Ragn-Sells Aktiebolag | | x | |
| Sweden | Rezidor SAS Hospitality Sweden AB | | x | |
| Sweden | Rodamco Sverige AB | | x | |

| Country | Participant | Direct participant | Clearing customer | Represen-tative |
|---|---|---|---|---|
| Sweden | Rottneros Rockhammar AB | | x | |
| Sweden | Scaent AB | x | | |
| Sweden | SCA Graphic Sundsvall AB | | x | |
| Sweden | Scan AB | | x | |
| Sweden | Scandem AB | x | | x |
| Sweden | Scandem Market AB | | x | |
| Sweden | Skellefteå Kraft AB | x | | |
| Sweden | Skövde Kommun | | x | |
| Sweden | Stena Fastigheter AB | | x | |
| Sweden | Stena Metall Aktiebolag | | x | |
| Sweden | Storuman Energi AB | | x | |
| Sweden | Sundsvall Kommun | | x | |
| Sweden | Svenska Handelsbanken AB | | x | |
| Sweden | Svenska Lantmännen Ekonomisk Förening | | x | |
| Sweden | Svenska McDonalds AB | | x | |
| Sweden | SVK | x | | |
| Sweden | SVK Gasturbiner AB | x | | |
| Sweden | Swebus AB | | x | |
| Sweden | Swedavia AB | | x | |
| Sweden | Swedbank AB | | x | |
| Sweden | SwePol Link AB | x | | |
| Sweden | Tekniska Verken Linköping AB | x | | |
| Sweden | Telinet Energi AB | | x | |
| Sweden | Telge Energi AB | | x | |
| Sweden | Telge Kraft AB | | x | |
| Sweden | Telge Krafthandel AB | x | | x |
| Sweden | TomtbergaHuge Fastigheter AB | | x | |
| Sweden | Trafikverket | | x | |
| Sweden | Tyresö Kommun | | x | |
| Sweden | Umeå Energi Elhandel AB | | x | |
| Sweden | Uppsala Kommun | | x | |
| Sweden | Vallviks Bruk AB | | x | |
| Sweden | Vattenfall AB Försäljning Norden | | x | |
| Sweden | Vattenfall AB Produktionsledning | x | | |
| Sweden | Vida AB | | x | |
| Sweden | V&S Vin & Sprit AB | | x | |
| Sweden | Wallenstam NaturEnergi AB | x | | |
| Sweden | Yello Strom AB | | x | |
| Sweden | Zinkgruvan Mining AB | | x | |
| Sweden | Örebro Kommun | | x | |
| Sweden | Örebro Läns Landsting | | x | |
| Sweden | Örebrobostäder | | x | |
| Sweden | Övik Energi AB | | x | |
| Sweden | Älvsbyn Kommun | | x | |
| Sweden | Åkers Sweden AB | | x | |
| Denmark | AGA A/S | | x | |
| Denmark | Danske Commodities AS | x | | |
| Denmark | DONG Energy El & Gas A/S | x | | |
| Denmark | DONG Energy Generation A/S | x | | |

| Country | Participant | Direct participant | Clearing customer | Represen-tative |
|---|---|---|---|---|
| Denmark | DONG Energy Power A/S | x | | |
| Denmark | DONG Naturgas A/S | x | | |
| Denmark | Energi Danmark AS | x | | |
| Denmark | Energimidt Handel A/S | | x | |
| Denmark | Energinet.dk | x | | |
| Denmark | Energi Fyn Handel A/S (Energi Fyn Forsyningspligt AS) | | x | |
| Denmark | EnergyDirect | | x | |
| Denmark | Grøn Synergi A/S | | x | |
| Denmark | Markedskraft Danmark, Filial af Markedskraft ASA, Norge | | x | |
| Denmark | NOE Energi A/S | | x | |
| Denmark | Nordjysk Elhandel A/S | x | | |
| Denmark | OK A.M.B.A | | x | |
| Denmark | Scanenergi AS | x | | |
| Denmark | Vattenfall Danmark A/S | | x | |
| Finland | Altia Oyj | | x | |
| Finland | Atria Tekniikka Oy | | x | |
| Finland | Atria Yhtymä Oyj | | x | |
| Finland | Chevys Voiman Ostajat Oy | x | | |
| Finland | Energiakolmio Oy | x | | |
| Finland | Energiameklarit Oy | x | | |
| Finland | E.ON Kainuu Oy | | x | |
| Finland | Fingrid Oyj | x | | |
| Finland | Fortum Markets Oy | | x | |
| Finland | Fortum Power and Heat Oy | x | | |
| Finland | Graninge Kainuu Oy | | x | |
| Finland | Helsingin Energia | x | | |
| Finland | Kemijärven Kaukolämpö Oy | | x | |
| Finland | Kuopion Energia Oy | x | | |
| Finland | Lapuan Energia Oy | | x | |
| Finland | Keuruun Lämpövoima Oy | | x | |
| Finland | Kotkan Energia Oy | | x | |
| Finland | Kymppivoima Hankinta Oy | x | | |
| Finland | Lahti Energia Oy | x | | |
| Finland | Lappeenrannan Energia Oy | x | | |
| Finland | Lidl Suomi Ky | | x | |
| Finland | Lindex Oy | | x | |
| Finland | Metso Oy | | x | |
| Finland | M-Real Oy | x | | |
| Finland | Nokian Renkaat Oyj | | x | |
| Finland | Norilsk Nickel Harjavalta Oy | | x | |
| Finland | Ovako Bar Oy | | x | |
| Finland | Oy AGA Ab | | x | |
| Finland | PVO-Pool Oy | x | | |
| Finland | RAO Nordic Oy | x | | |
| Finland | Scandem Oy | | x | |
| Finland | Senaatti-kiinteistöt | | x | |
| Finland | Stora Enso Oyj | x | | |
| Finland | S-Voima OY | x | | |

| Country | Participant | Direct participant | Clearing customer | Represen-tative |
|---|---|---|---|---|
| Finland | Tampereen Energiantuotanto OY | x | | |
| Finland | Tampereen Sähkönmyynti Oy | | x | |
| Finland | Tervakovski Oy | | x | |
| Finland | Turku Energia Oy | x | | |
| Finland | UPM Kymmene Oy Energia | x | | |
| Finland | Vantaan Energia Oy | x | | |
| Finland | Vattenfall Sähkönmyynti Oy | | x | |
| Finland | Vattenfall Sähköntuotanto Oy | | x | |
| Estonia, Lithuania, Latvia | AS Latvenergo (LV) | x | | |
| Estonia, Lithuania, Latvia | AS Nordic Energy Link (EE) | | x | |
| Estonia, Lithuania, Latvia | Elering OÜ (EE) | x | | |
| Estonia, Lithuania, Latvia | Eesti Energia AS (EE) | x | | |
| Estonia, Lithuania, Latvia | Eesti Energia Kaevandused AS (EE) | | x | |
| Estonia, Lithuania, Latvia | Eesti Energia Narva Elektrijaamad AS(EE) | | x | |
| Estonia, Lithuania, Latvia | Eesti Pank (EE) | x | | |
| Estonia, Lithuania, Latvia | Enefit SIA (LV) | | x | |
| Estonia, Lithuania, Latvia | Enefit UAB (LT) | | x | |
| Estonia, Lithuania, Latvia | Latvenergo Kaubandus (EE) | | x | |
| Estonia, Lithuania, Latvia | Lietuvos Energija AB (LT) | x | | |
| Estonia, Lithuania, Latvia | Nordic Power Management OÜ (EE) | x | | |
| Estonia, Lithuania, Latvia | OÜ Baltic Energy Services (EE) | x | | |
| Estonia, Lithuania, Latvia | UAB "EFT Lithuania" | x | | |
| Estonia, Lithuania, Latvia | UAB "Energijos kodas" | x | | |
| Other European | Alpiq Suisse Ltd (CH) | x | | |
| Other European | Alpiq Ltd (CH) | x | | |
| Other European | Barclays Bank Plc (GB) | x | | |
| Other European | Deutsche Bank AG London (UK) | x | | |
| Other European | EDF Trading Ltd (GB) | x | | |
| Other European | Electrabel SA (B) | x | | |
| Other European | Elektrizitäts-Gesellschaft Laufenb (CH) | x | | |
| Other European | ENECO Energy Trade B.V. (NL) | x | | |
| Other European | ENEL Trade SpA (I) | x | | |
| Other European | E.ON Energy Trading SE (D) | x | | |
| Other European | European Market Coupling Company GmbH(D) | x | | |
| Other European | IMC Energy Trading BV (NL) | x | | |
| Other European | J.Aron & Company (USA) | x | | |

| Country | Participant | Direct participant | Clearing customer | Represen-tative |
|---|---|---|---|---|
| Other European | Gazprom Marketing & Trading Limited (GB) | x | | |
| Other European | Global Energy Division, Gunvor International B.V. (CH) | x | | |
| Other European | Markedskraft Deutschland GmbH (D) | | x | |
| Other European | Merrill Lynch Commodities (Europe) Limited (GB) | x | | |
| Other European | Morgan Stanley Capital Group Inc. (USA) | x | | |
| Other European | Nidera Handelskompanie B.V (NL) | | x | |
| Other European | RWE Supply and Trading GmbH (D) | x | | |
| Other European | RWE Supply and Trading Switzerland S.A. (CH) | x | | |
| Other European | Scaent Europower Ltd. (IE) | x | | |
| Other European | The Royal Bank of Scotland plc (GB) | x | | |
| Other European | Shell Energy Europe Limited (GB) | x | | |
| Other European | Stadtwerke Flensburg (D) | x | | |
| Other European | Statkraft Markets GmbH (D) | x | | |
| Other European | Total Gas and Power Ltd (GB) | x | | |
| Other European | Trianel GmbH (D) | x | | |
| Other European | Vattenfall Energy Trading GmbH (D) | | x | |

## ELBAS

| Country | Participant | Direct Participant | Clearing Customer | Represen-tative |
|---|---|---|---|---|
| Denmark | Danske Commodities A/S | x | | |
| Denmark | DONG Energy Generation A/S | x | | |
| Denmark | DONG Energy Power A/S | x | | |
| Denmark | Energi Danmark A/S | x | | |
| Denmark | Nordjysk Elhandel A/S | x | | |
| Denmark | Vattenfall Danmark AS | | x | |
| Norway | Agder Energi Produksjon AS | x | | |
| Norway | Alpiq Norway AS | x | | |
| Norway | Bergen Energi AS | x | | x |
| Norway | BKK Produksjon As | x | | |
| Norway | EB-Handel AS | x | | |
| Norway | EB-Kraftproduksjon AS | | x | |
| Norway | E-CO Vannkraft AS | x | | |
| Norway | EGL Nordic AS | x | | |
| Norway | Hafslund Strøm AS | x | | |
| Norway | Kraftverkene i Orkla DA | | x | |
| Norway | Los AS | | x | |
| Norway | Lyse Produksjon AS | x | | |
| Norway | Markedskraft ASA | x | | x |
| Norway | Nordmøre Energiverk AS (NEAS) | x | | |
| Norway | NTE Energi AS | x | | |
| Norway | SFE Produksjon AS | x | | |
| Norway | Skagerak Kraft AS | x | | |
| Norway | SKS Produksjon AS | x | | |

| Country | Participant | Direct Participant | Clearing Customer | Represen-tative |
|---|---|---|---|---|
| Norway | Statkraft Energi AS | x | | |
| Norway | Tafjord Kraft Produksjon AS | x | | |
| Norway | Troms Kraft Marked AS | x | | |
| Norway | TrønderEnergi Kraft AS | x | | |
| Finland | Energiakolmio Oy | x | | x |
| Finland | Fingrid Oyj | x | | |
| Finland | Energiameklarit Oy | x | | |
| Finland | Fortum Power and Heat Oy (market maker) | x | | |
| Finland | Helsingin Energia | x | | |
| Finland | Kaakon Energia Oy | x | | |
| Finland | E.ON Kainuu Oy | x | | |
| Finland | Kuopion Energia | x | | |
| Finland | Kymppivoima Hankinta Oy | x | | |
| Finland | Lahti Energia | x | | |
| Finland | Lappeenrannan Energia Oy | x | | |
| Finland | M-real Oyj | x | | |
| Finland | PVO-Pool Oy | x | | |
| Finland | Ovako Bar Oy Ab | | x | |
| Finland | RAO Nordic Oy | x | | |
| Finland | Stora Enso Oyj | x | | |
| Finland | Tampereen Energiantuotanto OY | x | | |
| Finland | Turku Energia Oy | x | | |
| Finland | UPM Kymmene Oyj | x | | |
| Finland | Vantaan Energia Oy | x | | |
| Finland | Vattenfall Sähköntuotanto Oy | | x | |
| Sweden | AB Fortum Värme samägt med Stockholms Stad | | x | |
| Sweden | Bixia AB | x | | |
| Sweden | Dala Kraft AB | x | | |
| Sweden | Göteborg Energi DinEl AB | x | | |
| Sweden | EGL Sverige AB | | x | |
| Sweden | Fortum Generation AB | | x | |
| Sweden | Jämtkraft AB | x | | |
| Sweden | Kraftringen Energihandel AB | x | | |
| Sweden | Kraft og Kultur AB | | x | |
| Sweden | Mälarenergi AB | x | | |
| Sweden | Ovako Bar AB | | x | |
| Sweden | Skellefteå Kraft AB | x | | |
| Sweden | SwePol Link AB | x | | |
| Sweden | Tekniska Verken Linköping AB | x | | |
| Sweden | TelgeKraft AB | | x | |
| Sweden | Telge Krafthandel AB | x | | x |
| Sweden | Vattenfall AB Produktionsledning (market maker | x | | |
| Sweden | Wallenstam NaturEnergi AB | x | | |
| Germany | BECOMAC GmbH | | x | |
| Germany | Deutsche Bank AG London | x | | |
| Germany | European Market Coupling Company GmbH(D) | x | | |
| Germany | EnBW Trading GmbH | x | | |

| Country | Participant | Direct Participant | Clearing Customer | Represen-tative |
|---|---|---|---|---|
| Germany | envia Mitteldeutsche Energie AG | x | | |
| Germany | E.ON Energy Trading SE (market maker) | x | | |
| Germany | RWE Supply and Trading GmbH | x | | |
| Germany | RWE Supply & Trading Netherlands B.V | x | | |
| Germany | Stadtwerke Flensburg GmbH | x | | |
| Germany | Statkraft Markets GmbH | x | | |
| Germany | Trianel GmbH | x | | |
| Germany | Vattenfall Energy trading Gmbh | | x | |
| Estonia | Eesti Energia AS (EE) | x | | |
| Estonia | Latvenergo Kaubandus OU | | x | |
| Estonia | Nordic Power Management OÜ (EE) | x | | |
| Estonia | OÜ Baltic Energy Service (EE) | x | | |
| Other European | Alpiq Ltd (CH) | x | | |
| Other European | AS Latvenergo (LV) | x | | |
| Other European | BKW FMB Energie AG (CH) | x | | |
| Other European | Compagnie Nationale du Rhône (F) | x | | |
| Other European | Edf Trading Limited (GB) | x | | |
| Other European | EGL - Elektrizitäts-Gesellschaft Laufenburg A(CH) | x | | |
| Other European | Electrabel S.A (B) | x | | |
| Other European | ENEL Trade SpA (I) | x | | |
| Other European | Gazprom Marketing & Trading Limited (GB) | x | | |
| Other European | RWE Supply and Trading Switzerland S.A. | x | | |
| Other European | J. Aron & Company (USA) | x | | |
| Other European | Global Energy Division, Gunvor International B.V. (CH) | x | | |
| Other European | Merrill Lynch Commodities (Europe) Limited (GB) | x | | |
| Other European | Shell Energy Europe Limited (GB) | x | | |
| Other European | TIWAG-Tiroler Wasserkraft AG (A) | x | | |

# APPENDIX 2: OVERVIEW OF SUPPLY AND DEMAND CURVES

NOTE TO READER: BE AWARE OF DIFFERENT SCALES FOR VOLUME ON FIGURES FOR NORD POOL SPOT AND APX NL

## *PEAK HOURS*

*Figure A2.1 Supply and demand curves in Nord Pool Spot*

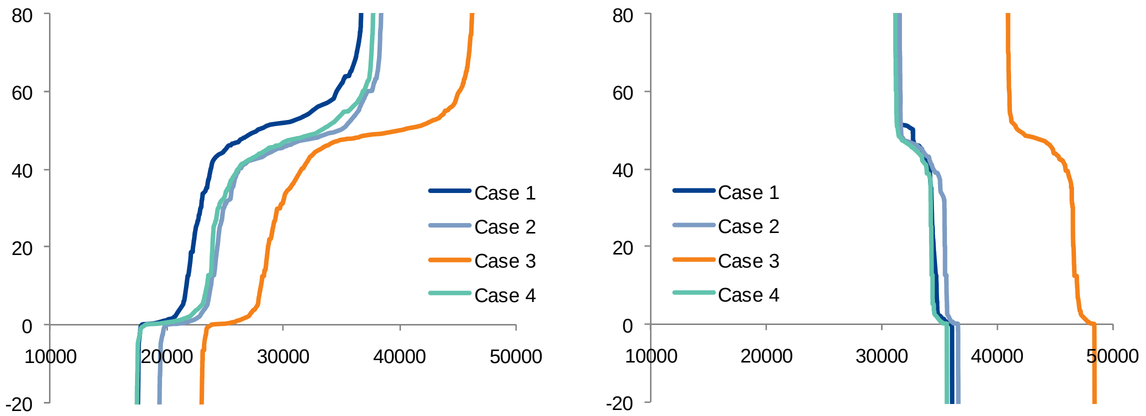
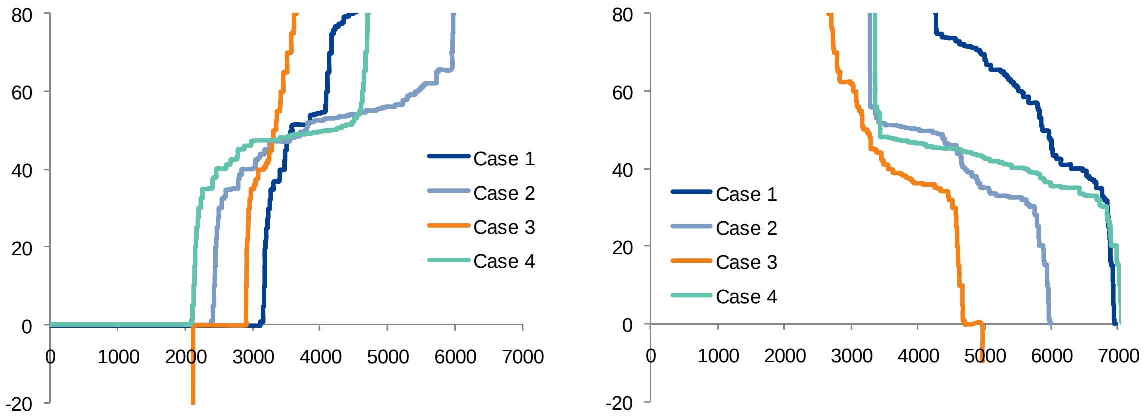



*Figure A2.2 Supply and demand curves in APX NL*



### *OFF-PEAK HOURS*

*Figure A2.3 Supply and demand curves in Nord Pool Spot*

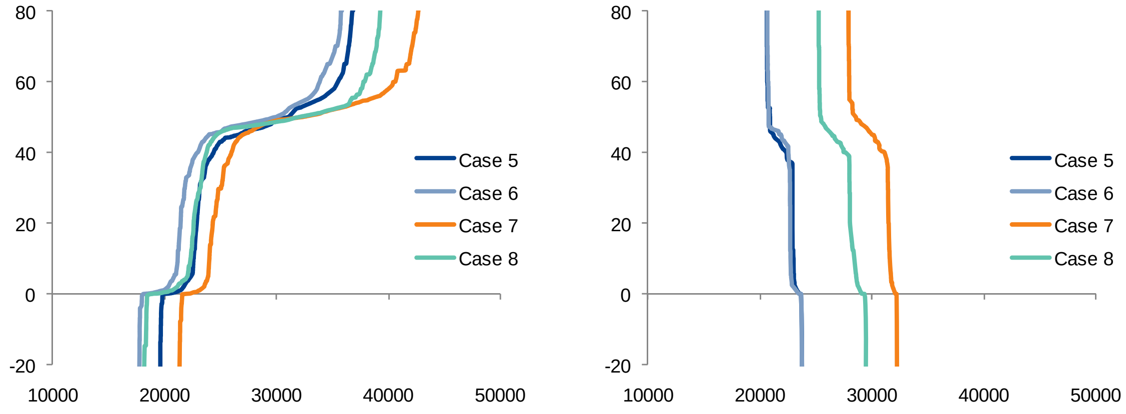
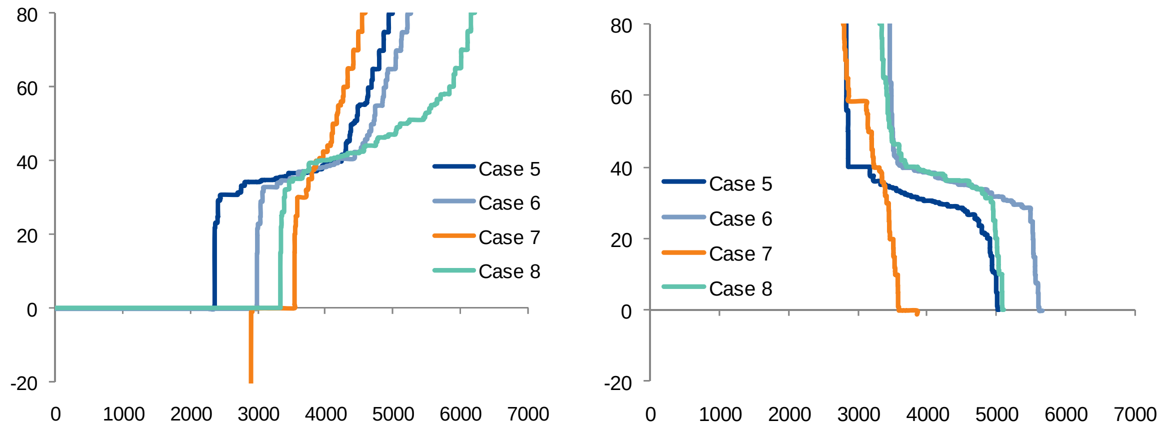



*Figure A2.4 Supply and demand curves in APX NL*



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