

# Market Review

## 2014 H1

Electricity market insights  
First half 2014



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# Introduction



Given the positive response to the first edition, published in March this year, we decided to continue the publication of a market review in the same style. Of course in this second edition, as well as the general developments, we zoom in on other aspects of the market, aiming to contribute to further understanding of the functioning of the current electricity market.

The publication of the TenneT Market Review aims to facilitate the public debate by providing facts, analysis and insight. As Transmission System Operator in two countries, TenneT is a neutral market facilitator and therefore in a unique position to monitor and interpret developments in the electricity market.

The review covers the last six months, but for most of the analyses we will cover an 18-month period for comparison reasons. For the general price developments we discuss the Central West European region (CWE), with a focus on price differences between the Netherlands and Germany. In order not to lose valuable information by taking average amounts, we include graphs presenting the spread between the market outcomes. In addition, we add examples to illustrate general patterns, where relevant.

In addition to the day-ahead market, we devote more attention to the analysis of the Intraday market. A well-functioning Intraday market is vital for the integration of intermittent sources that are prone to forecast errors like wind and solar energy.

An analysis of the balancing regimes in the Netherlands and Germany completes this review. To market parties, the risk of supplying to customers with unpredictable demand, the risk of covering sales using intermittent generation, and the value of reliable and adjustable production are ultimately determined by the balancing regime. This is why we analysed the imbalance prices and volumes to compare the results for the Dutch and the German regimes in a more fundamental way. This allows us to share insights in how the design influences the behaviour of market parties.

As in the first edition, TenneT has collaborated closely with Bert den Ouden of Berenschot and Albert Moser of IAEW and their teams, to contribute independent views and complement the insights and analysis. We hope you enjoy reading this second TenneT Market Review.



# General market trends

In the first half of 2014, we have seen decreasing wholesale prices but also decreasing price differences for the CWE countries. Below we describe the general price movements in these markets and the factors driving these developments.

## 2.1. General Price Movements in the first half of 2014

Here we focus on the markets of the region commonly referred to as Central Western-Europe, or CWE. This consists of the combined market area of Germany, Austria and Luxemburg, the French market area and the market areas of Belgium and the Netherlands.

In the first half of 2014, we see two main trends in the wholesale market, see figure 2.1:

- Wholesale prices of all countries have decreased
- Price differences between countries have also decreased

Half-yearly average of Day-ahead wholesale prices in CWE countries



Figure 2.1 Half-yearly average of Day-ahead wholesale prices in CWE countries.  
Source: Berenschot (data: APX; EPEX Spot)



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During the first half of 2014 the Dutch price decreased steadily and more than those of neighbouring countries, resulting in smaller price differences. Whereas the average price difference Netherlands-Germany was 14 €/MWh throughout 2013, this difference was reduced to 8 €/MWh as an average in the first half of 2014. That the price development in the last six months is not just a typical seasonal development can be seen by comparing it to the same period last year.

Figure 2.2 shows this development in more detail by plotting the monthly averages.

As can be observed from figure 2.2, the price decrease was gradual for the Dutch and French prices. After a decrease in the first quarter of the year, the German price remained stable, allowing the French and Dutch prices to reduce the price gap gradually. It is to be noted that converging prices between France and Germany in the summer months is a known seasonal pattern. The Belgian price was virtually equal to the French price in the first quarter of the year but converged strongly with the Dutch price in the second quarter.

Monthly average of Day-ahead wholesale prices in CWE countries

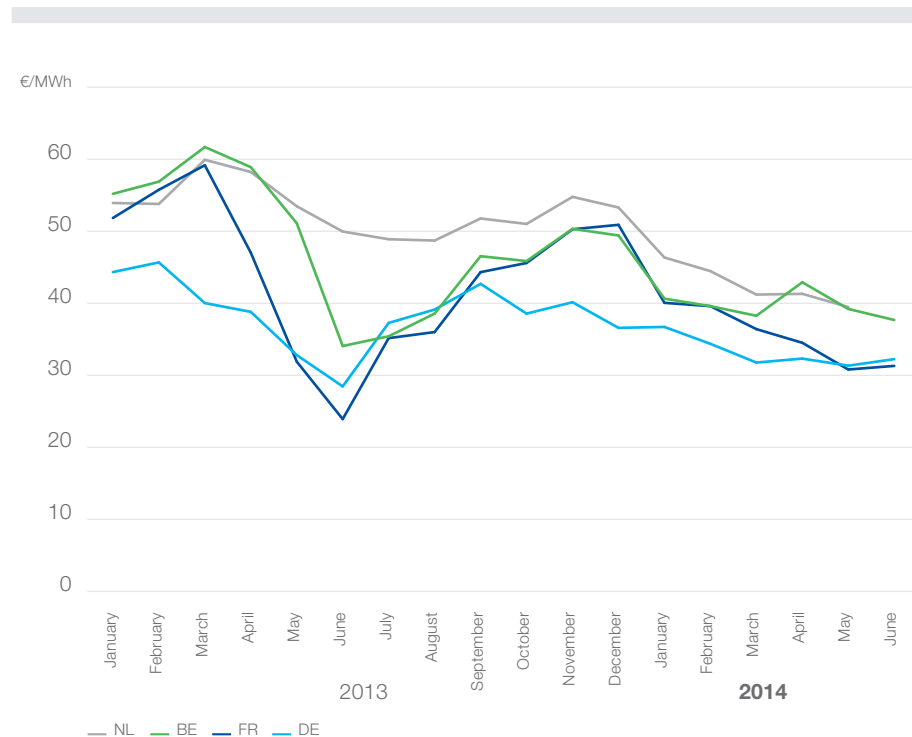


Figure 2.2 Monthly average of Day-ahead wholesale prices in CWE countries, January 2013 - June 2014. Source: Berenschot (data: APX; EPEX Spot)





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## 2.2 Distribution of price differences in the first half of 2014

Before looking at the factors driving these price movements, we take a deeper look into their distribution. The price differences shown in the previous graphs are averages. The hourly price differences that they are based on vary greatly.

### Hourly price differences between CWE countries (in €/MWh)

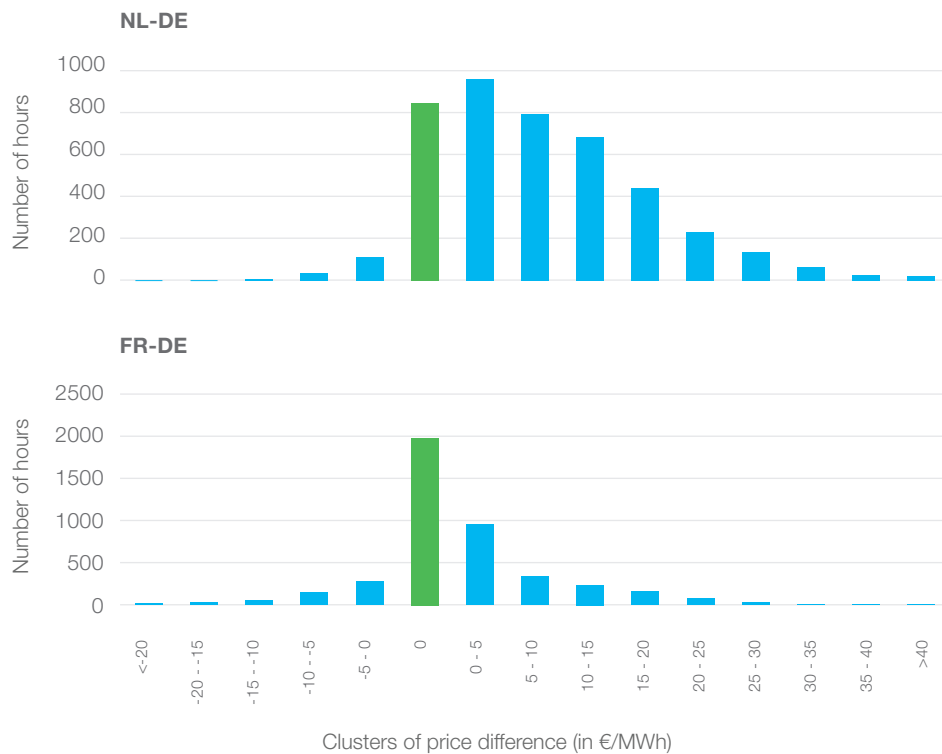


Figure 2.3 shows their distribution in the first half of 2014 for the Central Western European countries (“CWE countries”). Zero price difference is shown as a separate cluster, revealing the number of hours of absolute price convergence between two countries.

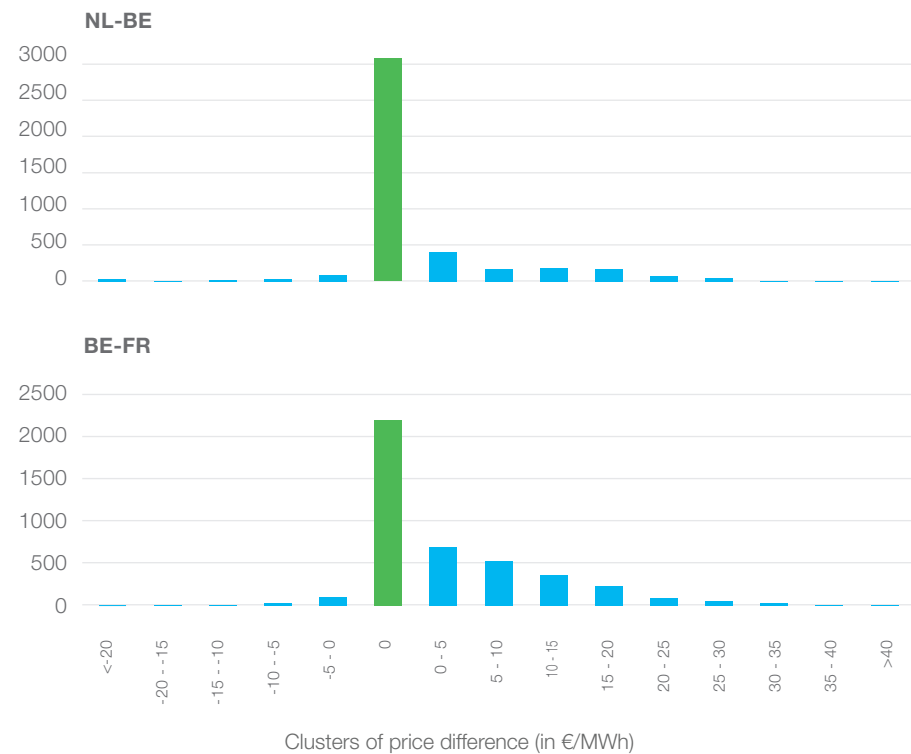


Figure 2.3 Hourly price difference between CWE countries in the first half 2014 divided over clusters of price difference. Source: TenneT

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From figure 2.3 it becomes apparent that between Belgium and the Netherlands, but also between France and Germany, there is a high number of hours with full price convergence. For Germany and the Netherlands this is much lower. However, if we look at the development of the percentage of hours with full

price convergence per month for these two countries, as shown in figure 2.4, we see that price convergence has been increasing over the last months, reaching 40% of full convergence in June. We will look into this development in more detail in chapter 3.

## Price convergence between Germany and the Netherlands

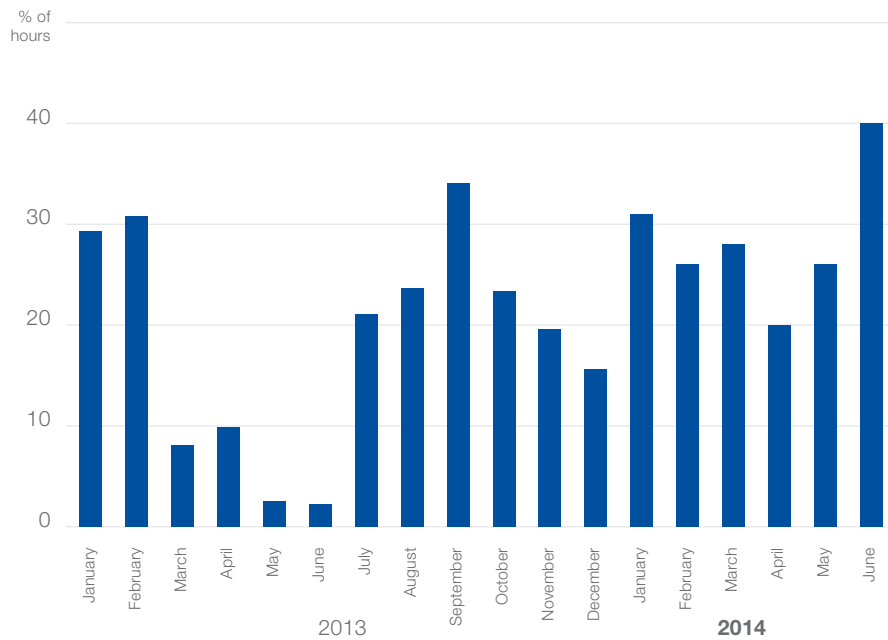


Figure 2.4 Share of hours with full price convergence between Germany and the Netherlands, January 2013 - June 2014. Source: Berenschot (data: APX)



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## 2.3 Development of price drivers

In the TenneT Market Review 2013 several important factors driving prices were identified, including:

- the prices for hard coal, natural gas and CO<sub>2</sub> certificates
- the generation assets
- the production from renewable sources
- weather-dependent price developments

Below we briefly discuss relevant developments of these drivers in the first six months of 2014 in relation to the development of price differences between the CWE countries.

### Development of Natural Gas Price (TTF Spot)

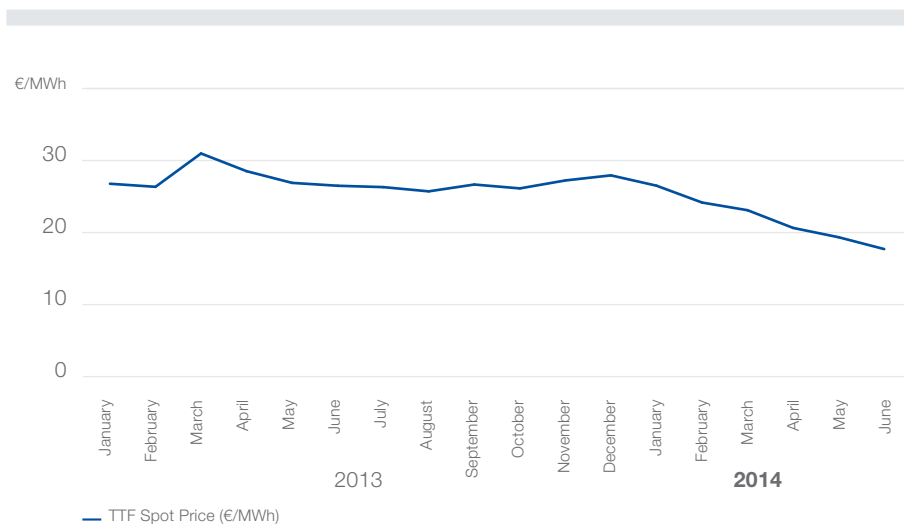


Figure 2.5 Dutch TTF natural gas spot prices, January 2013 - January 2014.  
Source: Berenschot (data: ICE-ENDEX; Spectron; EEX; Energate)

## 2.3.1 Prices for hard coal, natural gas and CO<sub>2</sub> certificates

Price differences between countries are a reflection of the relative competitiveness of their generation assets. To a large extent this is caused by the underlying relative prices of fuels. In the first six months of 2014 gas spot prices decreased substantially from February 2014 onwards, shown in figure 2.5.



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This substantial decrease of the spot gas price is due to several factors. One of these is the mild early 2014 winter period. Normally, the seasonal gas storage reservoirs in Europe are emptied during the winter months to cover large consumption for heating purposes. This year, due to mild temperatures in early 2014, more gas was left in storages than normally at the end of the winter. This reduces demand for refilling the storage in summer.

The reduction in the gas price, combined with relatively stable prices for hard coal and CO<sub>2</sub> certificates, improved the competitiveness of gas over coal by reducing the gap in marginal generation costs, as shown in figure 2.6. The remaining difference in marginal generation costs shows that gas cannot compete with coal as a baseload supplier, but the number of hours in which it can recover a part of its fixed costs has increased slightly.

Marginal Generation Costs of Electricity: Gas vs. Coal

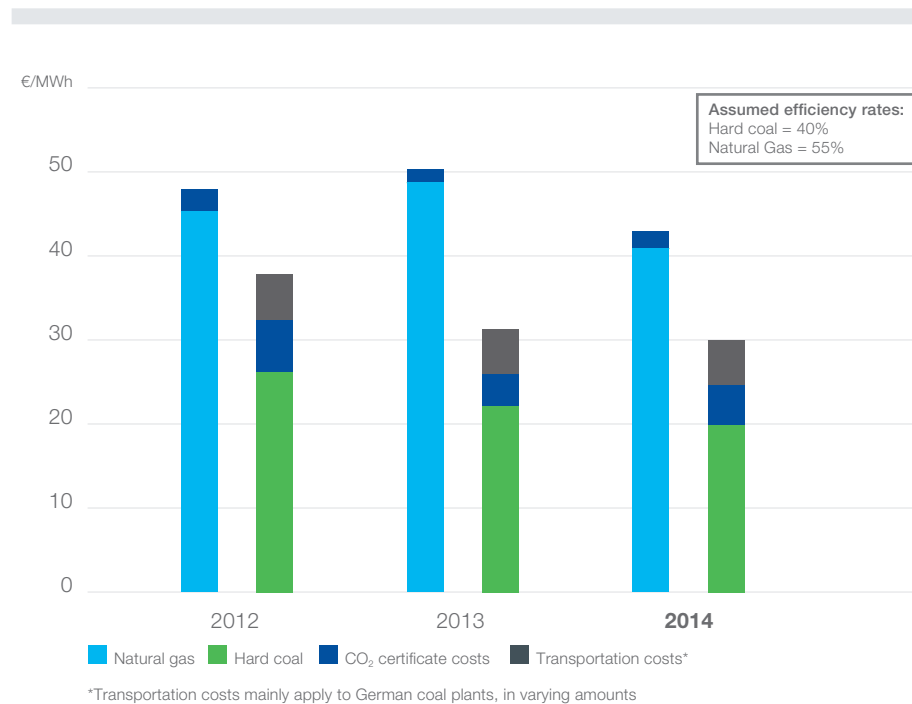


Figure 2.6 Marginal generation costs of electricity for hard coal and natural gas power plants. Source: Berenschot/IAEW (data: ICE-ENDEX; APX; Energate)





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After January, in the Netherlands this development partly translated into lower electricity prices and partly into a slightly recovering clean spark spread<sup>1</sup> [figure 2.7]. Although the latter brings some relief for those who invested in gas-fired generation, it is clear that these spreads do not present sustainable margins, as evidenced by the mothballing of some high-efficiency gas-fired power plants (see 2.3.2). Additionally, compared to the Dutch gas-fired generation, the German plants have the clear disadvantage of the lowering effect of renewable energy on wholesale prices during the midday hours.

**Clean spark spread development: marginal gas-fired generation costs versus wholesale electricity baseload prices**

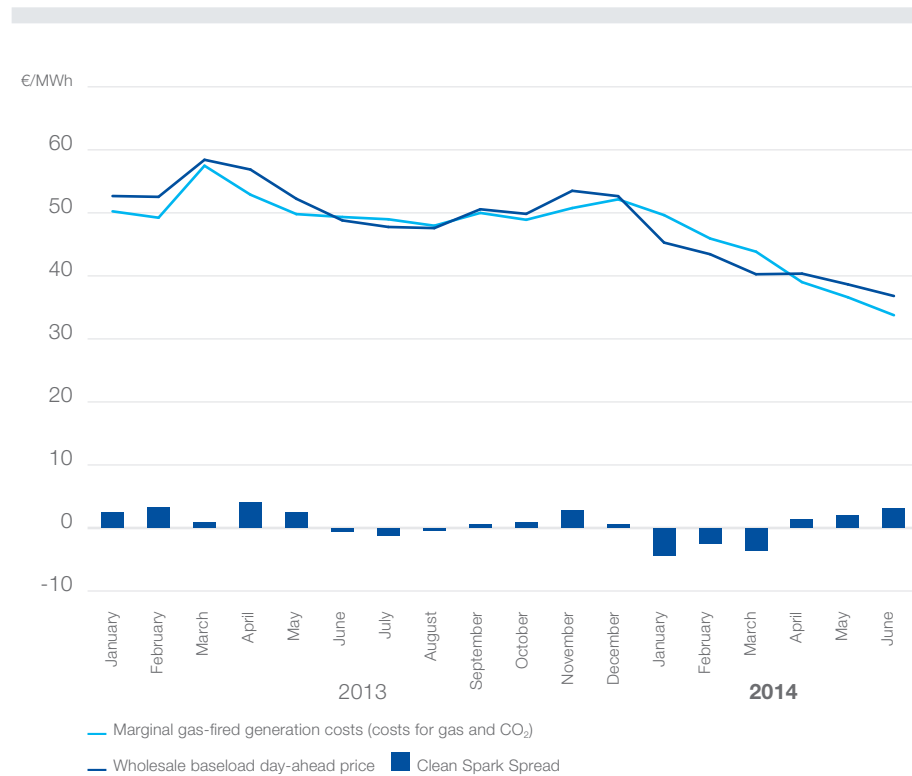


Figure 2.7 Clean spark spread development in the Netherlands: marginal gas-fired generation costs and the monthly average of the Day-ahead wholesale prices. Source: Berenschot (data: APX; ICE-ENDEX; Energate) Emission factor: 56,5 kg/GJ. Assumed efficiency: 55%

<sup>1</sup> The clean spark spread is defined as the electricity price minus the cost for fuel and CO<sub>2</sub> emission allowances. It is an indicator of the ability of generation units to recover costs above the marginal costs.



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It should be noted that the low gas spot price may be only temporary, as the mild past winter was one of the main causes. The prices for future delivery have shown some decrease [figure 2.8] though considerably less than those for spot delivery. This indicates that market parties expect gas spot prices to pick up again in 2015.

### Development of natural gas baseload futures

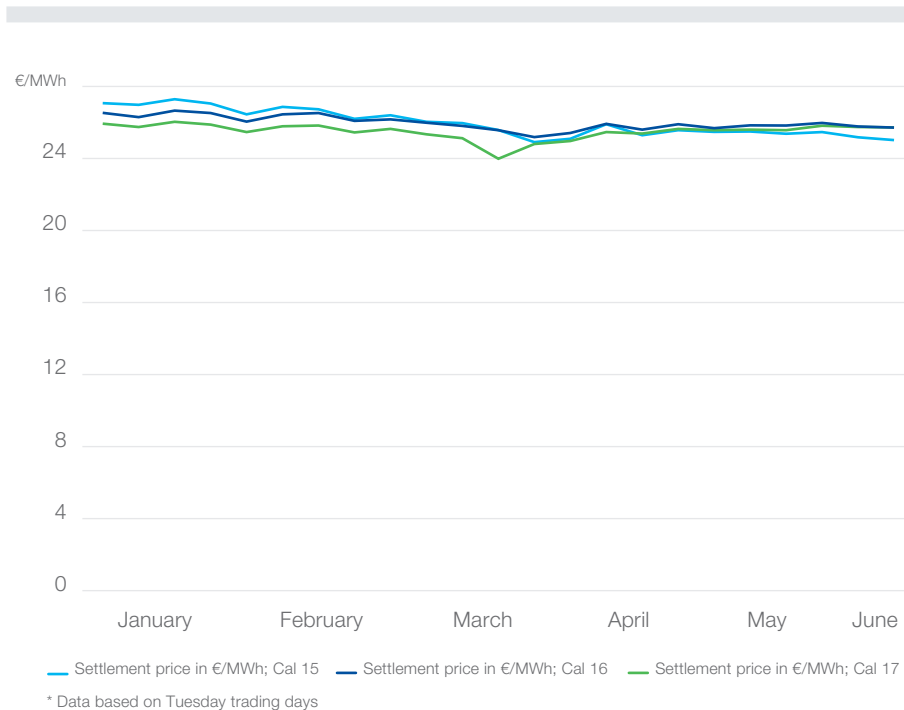


Figure 2.8 Dutch TTF natural gas baseload futures prices. Delivery years 2015, 2016 and 2017.  
Source: Berenschot (data: ICE-ENDEX)

This development of the gas price has to be seen as the major development driving the reduction of the Dutch power price. Since the role of gas-fired generation is larger in the Netherlands, it also explains the reduction of the price difference between the Netherlands and Germany.

### 2.3.2 Generation assets

The following developments were witnessed with respect to the generation assets.

#### Nuclear outage Belgium

In Belgium the outage of the nuclear reactors Doel 3 and Tihange 2 closed in the first week of April. This triggered the rising price in Belgium in that month. The Belgian price, which was almost identical to the French price in the first quarter, increased following the outage to become highly convergent with the Dutch price in the second quarter.



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## Mothballing and closure

In 2013 and the first half of 2014, a substantial amount of conventional generation capacity was mothballed or closed in both Germany and the Netherlands. An overview is given in table 2.1. Besides older plants, the numbers also include new, highly efficient power plants. Decisions for closure of further plants adding up to a substantial amount have been made public by several energy companies.

	Germany <sup>1</sup>		Netherlands	
	1-4-2013	1-7-2014	1-1-2013	1-7-2014
Natural gas		3223		5567
Hard coal		992		240
Oil		424		-
Multi fuels		152		-
Lignite		60		-
<b>Total</b>		<b>4851</b>		<b>5807</b>

Table 2.1 Mothballing and closure of conventional generation capacity. Source: BNetzA, TenneT

In the Netherlands, 3284 MW of the indicated number concerned mothballing. Furthermore, three new coal-fired plants came on stream end 2013 and beginning 2014 and are in the process of starting up full commercial operation. Almost all previously announced investment projects for the Netherlands have been either cancelled or been put on hold.

The reduction of conventional generation capacity is to be understood as a result of current and expected prices rather than their cause. It will, however, be an important factor determining prices in the future.

Mothballing and closure can be seen as a reduction of the overcapacity that resulted from lower than expected growth in electricity demand, but even more from the rapid growth of subsidized renewable generation capacity and the ambitious investment strategies of energy companies, formulated when profits were high. Although this development can be seen as a normal market response in a competitive environment, it can cause serious concerns. Closure of conventional generation assets in specific locations can give rise to transportation bottlenecks or voltage control issues. These issues can be resolved by adapting the grid and are to be seen as temporary. Due to the high pace of the development, resulting from its dynamic energy policy, in Germany intermediate measures had to be implemented to address the issues, making closure of plants subject to review.

<sup>1</sup> Generation Capacity [MW] that switched operational state from "Operation" to "Shut Down", "Reserve plant for TSO" or alike.

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### 2.3.3 Production from renewable energy sources

In Germany particularly, the feed-in of intermittent energy sources is a significant driving factor for price developments. Besides the ongoing trend of increasing capacity of renewable generation units in the German market area, another effect could be observed during this reporting period. At the end of 2013 and

especially in the first quarter of 2014, a high above-average feed-in of wind power units could be observed [figure 2.9], contributing additionally to the price decrease in the German market due to the merit order effect. In April and May of 2014, the high solar radiation (average 110-115% of the year 2013) led to higher feed-in of photovoltaic units as well.

### German Monthly Average Renewables Feed-in Capacity

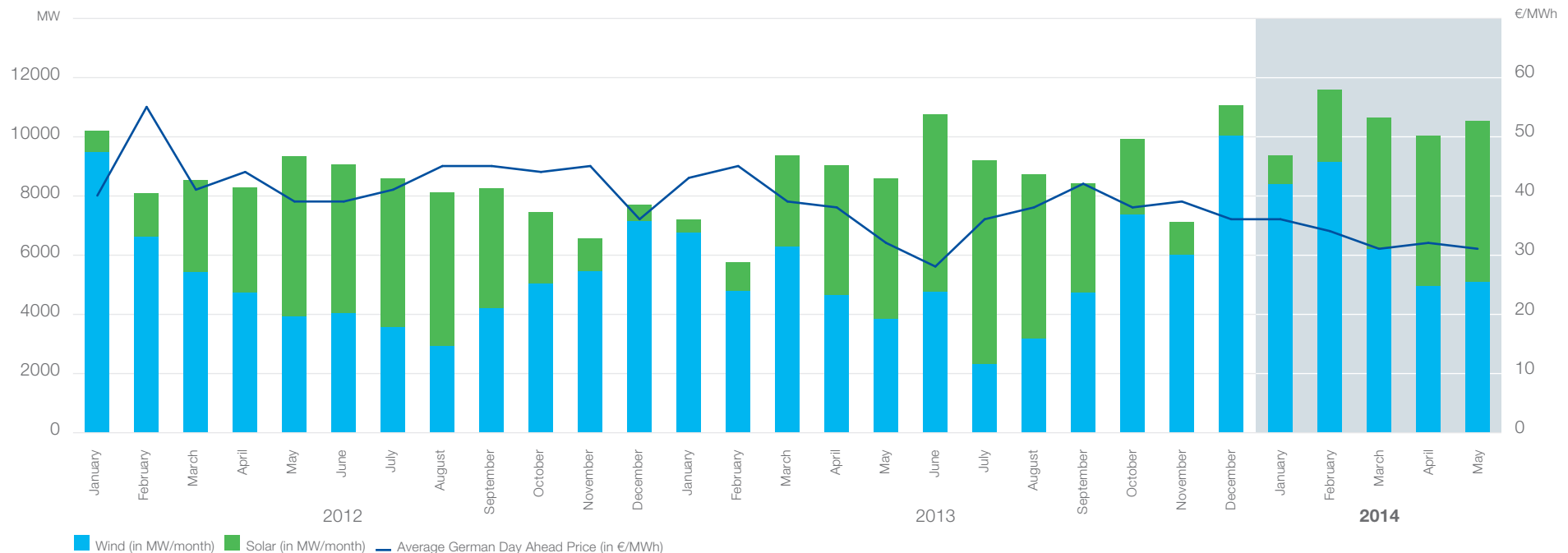


Figure 2.9 Development of monthly average feed-in capacity of wind and solar energy in Germany, January 2012 – May 2014. Source IAEW (data: EPEX spot; German TSOs)

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### 2.3.4 Weather-dependent price developments

Besides the indirect effect via the gas price, the mild winter also has had a direct price effect. As temperatures in January and February were higher this year than last year, the demand from electric heating has been lower. This effect is mainly felt in France, which has a high proportion of electric heating. This caused price differences between Germany and France to be lower in this year's winter period than last year's.

### 2.3.5 Other

The 700 MW NorNed cable from Norway to the Netherlands was fully available during the whole first half of 2014. Between October 28 and December 19, 2013, NorNed was unavailable due to storm damage to a converter station. NorNed imports from Norway to the Netherlands resumed after the problem was solved, explaining part of the Dutch price decrease early 2014 compared to the last two months of 2013.

### 2.4 Resulting cross-border flows

All these developments above, in combination with market coupling, resulted in nominations on the interconnectors between countries [figure 2.10]. The following figure shows the utilization rate of the interconnectors. Typically, between the countries with a structural price difference, the utilization rate is high in one direction and low in the other (Germany - Netherlands). Countries with a high price convergence would show more moderate utilization rates in both directions (Belgium - Netherlands).

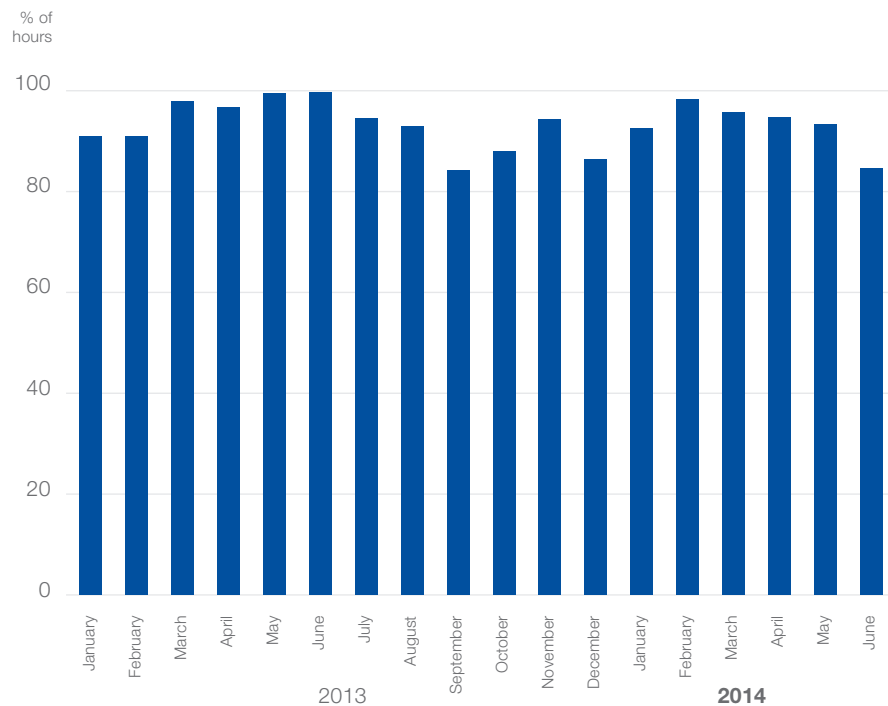


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### Utilization rate of interconnector DE > NL



### Utilization rate of interconnector NL > DE

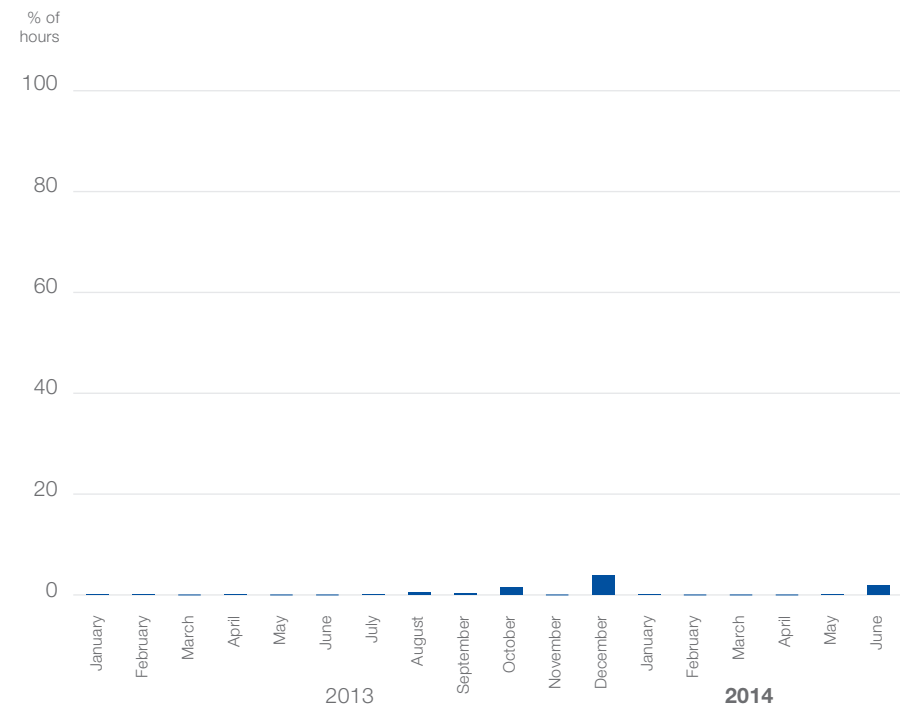


Figure 2.10 Monthly average of hourly interconnector utilization; January 2013 – June 2014 (as percentage of available capacity) Germany-Netherlands. Source: Berenschot (data: TenneT)

The interconnector flows mirror the price developments described above. The utilization rate from Germany to the Netherlands is decreasing slightly in line with the higher number of hours with full price convergence and even

some hours of flow from the Netherlands to Germany in June. Still, overall, the interconnector utilization is very high in the direction from Germany to the Netherlands.



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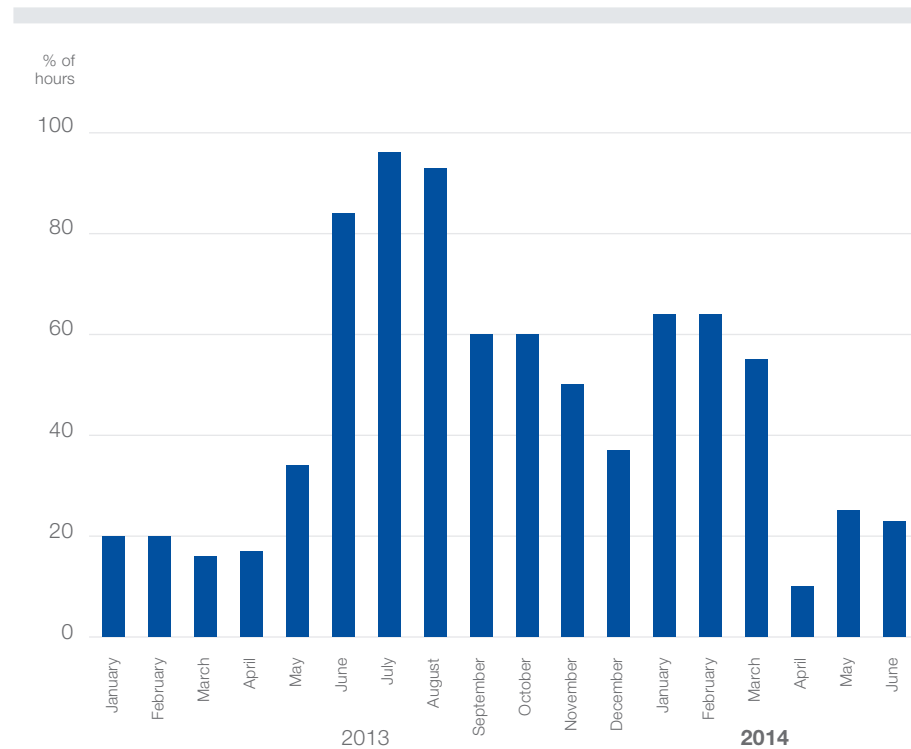
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The high level of full price convergence between the Netherlands and Belgium is realized with a much more varying import and export pattern. At times, price convergence is realized with flow from the Netherlands to Belgium, at other times with flows in the opposite direction.

## Utilization rate of interconnector BE > NL



## Utilization rate of interconnector NL > BE

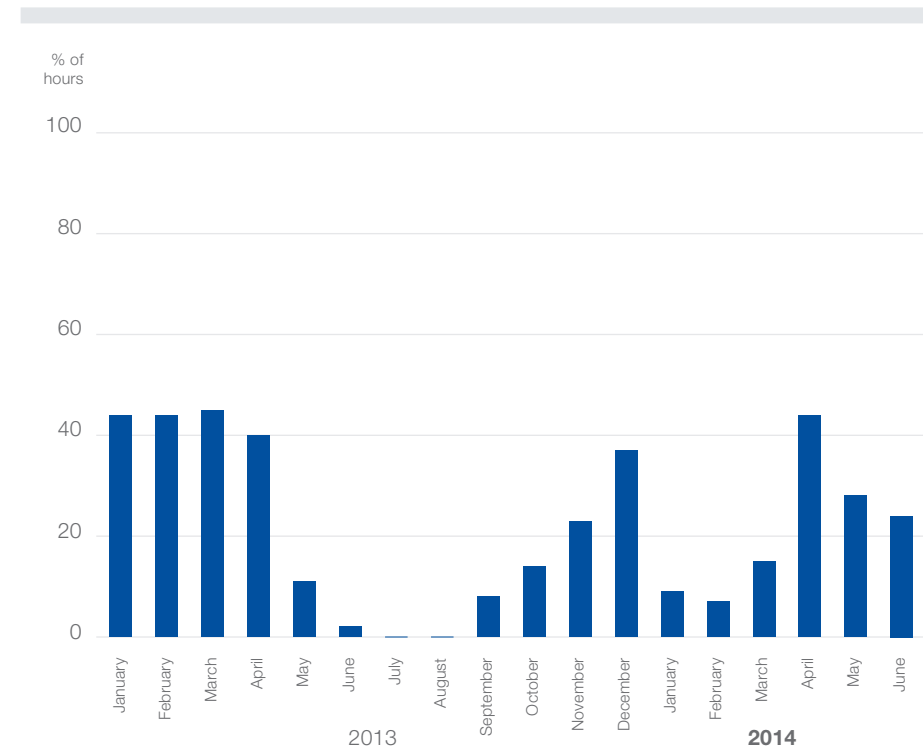


Figure 2.11 Monthly average of hourly interconnector utilization; January 2013 – June 2014 (as percentage of available capacity) Belgium-Netherlands. Source: Berenschot (data: TenneT)

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Figures 2.12 and 2.13 show the resulting commercial import and export flows of the Netherlands and Germany.

Figure 2.12 clearly shows that Germany is a net exporter to its surrounding countries. With Austria, which is part of the same market area, Germany has the largest exchange, with Germany being the net exporter. The second largest export volume is directed to the Netherlands. The exchanges with France and Poland show a seasonal pattern, exporting more in winter, importing more in summer.

### Commercial import and export flows Germany

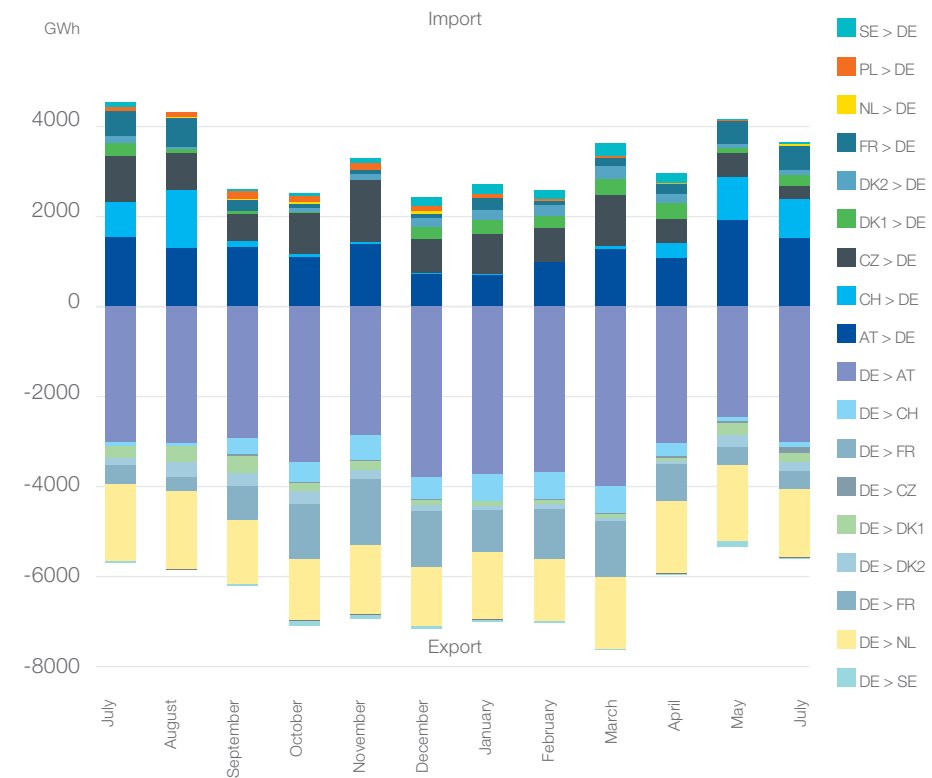


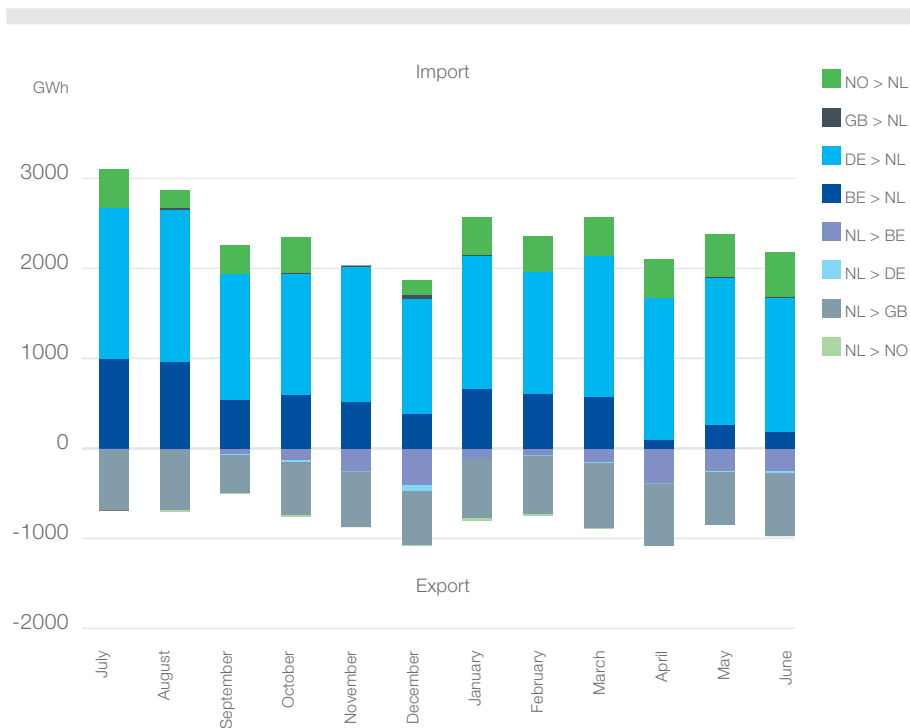
Figure 2.12 Day-ahead cross-border commercial schedules for Germany; July 2013 - June 2014. Source: Berenschot/IAEW (data: ENTSO-E; TenneT)



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## Commercial import and export flows for the Netherlands



The Netherlands, on the other hand, is a net importer, with the exchange with Belgium going in both directions. The flow on BritNed is directed towards the UK, contrary to flows from Norway and Germany, which are predominantly directed towards the Netherlands.

Figure 2.13 Day-ahead cross-border commercial schedules for the Netherlands; July 2013 - June 2014. Source: Berenschot/IAEW (data: ENTSO-E; TenneT)



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Day-ahead market coupling places electricity producers throughout Europe in competition with each other and ensures the efficient use of the interconnection capacity that is made available by TSOs for each hour. Here we use the results to analyse when and why prices between Germany and the Netherlands differ or converge by looking at the fuel mix in various situations.

### 3.1 Price convergence

In figure 2.3 of the previous chapter we showed the distribution of the price difference to point out that this difference has a large variation. The price difference in every hour is determined by a large number of factors, nevertheless some patterns are interesting to point out. Figure 3.1 shows the price convergence and the price difference for all hours of the week, both averaged for all 27 weeks of the first half of 2014.

The graph shows a clear daily pattern of two 'cycles' per day for the weekdays. The price difference is smallest early in the morning between 06:00 and 07:00 and late in the evening between 22:00 and 0:00. In a lot of these hours, known to be ramping hours (volume-up in the morning, volume-down in the evening), there is even price convergence. In contrast, the price difference is largest around noon and in the night hours.

On weekend days the pattern is much less pronounced, with a much higher price difference and very low price convergence.



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### Weekly patterns for full price convergence and price difference for the Netherlands and Germany

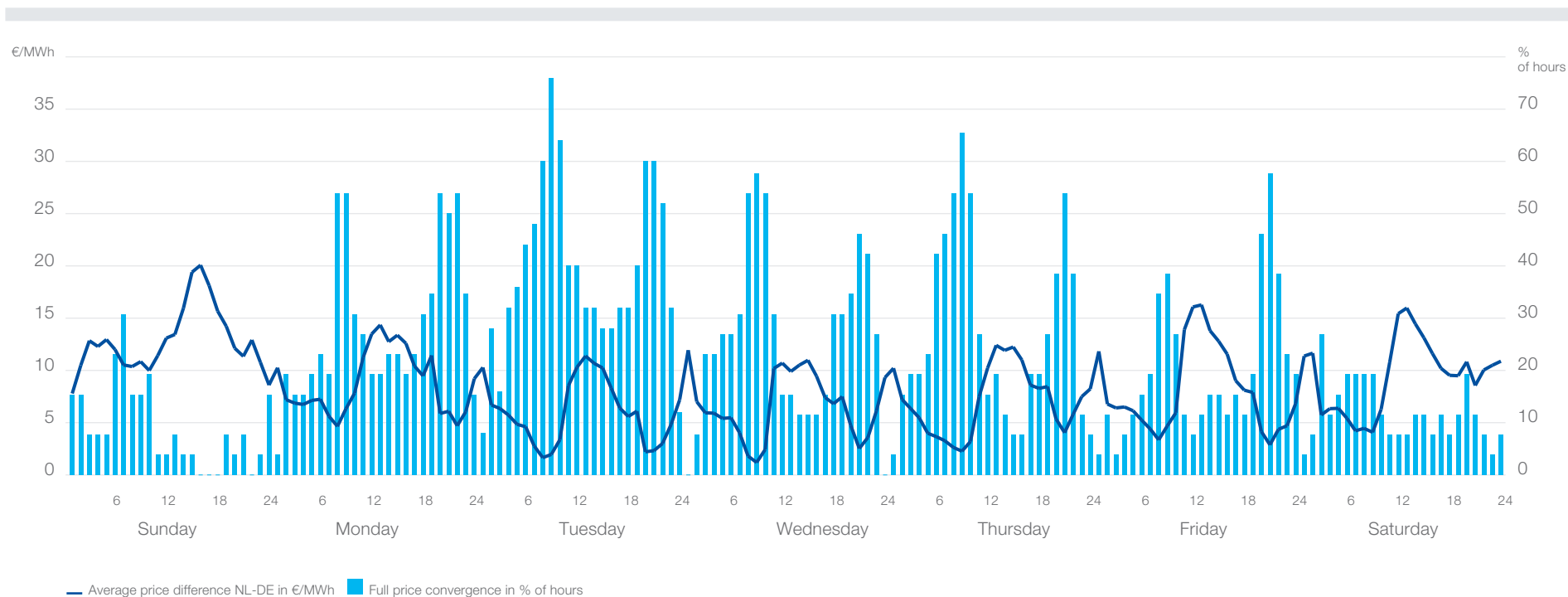


Figure 3.1 Average price difference between Germany and the Netherlands and full price convergence between Germany and the Netherlands for each hour of the week for the first 27 weeks of 2014. Source: TenneT, APX, EPEX



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### 3.2 Typical daily patterns

#### Marginal generation costs

Marginal generation costs play a crucial role for price setting in the Day-ahead market due to the marginal price setting design. Thereby, marginal costs of the most expensive generator (“the marginal unit”) sets the market clearing price at every hour, which is valid for all buyers and sellers.

As a result, a market development only has an effect on the electricity price when it changes the price of the marginal unit.

Roughly speaking this can take effect in two ways: firstly, by changing which unit is the marginal unit or, secondly, by changing the marginal price of the price setting unit. An example of the first way can be an hour with a lot of wind energy shifting the supply curve outwards: the merit order effect. An example of the second way can be the reduction of the marginal price of a gas-fired power plant in an hour where the gas-fired power plant is the marginal unit (shifting the supply curve downwards). Below we discuss various situations that occurred in the last twelve months to get a better feeling for the differences between the Dutch and German electricity markets.

#### Normal summer day

Here we take a look at a situation on German short-term electricity markets and the scheduled production. Figure 3.2 shows the German hourly fuel mix of 18 July, 2013 as planned the day before.

German hourly fuel mix, 18 July 2013

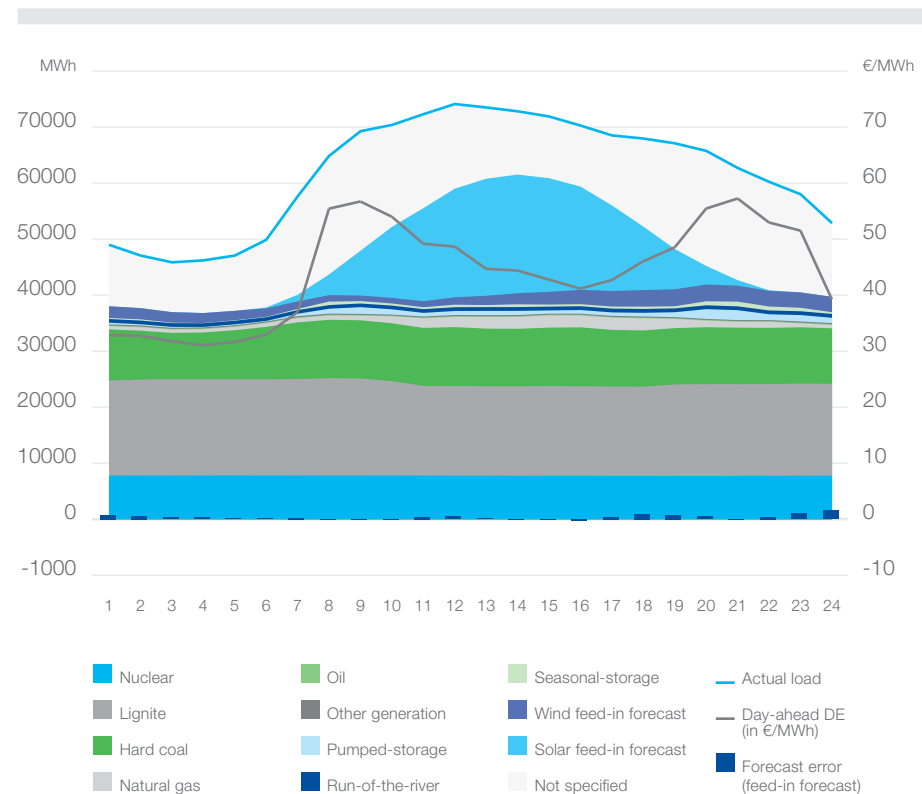


Figure 3.2 German Scheduled Hourly Fuel Mix, Forecast Error and Actual Total Load, 18 July 2013. Source: IAEW (data: EEX Transparency; EPEX Spot)



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On this summer working day, a Thursday, nuclear and lignite baseload plants show a constant generation pattern delivering baseload generation. More flexible hard coal and natural gas-fired units are throttled through the night following the load. Contrary to other countries, this task is not fulfilled by plants using natural gas as a primary energy source, even during the day, due to relatively high feed-in of renewable energy sources – mainly by solar panels. At noontime a significant solar generation of approximately 21 GWh/h peak generation can be observed. Due to the high solar feed-in, the price follows a bathtub curve during the day with price peaks in the morning and evening. Not specified areas are either other generation<sup>3</sup> or cross-border exchanges.

On the same day in the Netherlands, the hourly fuel mix<sup>4</sup> showed a completely different picture [figure 3.3]. Whereas in Germany solar energy delivers the major share of peak demand during the day hours with conventional production running at a flat profile, in the Netherlands this role is taken on by natural gas-fired power production, where solar energy is part of the category 'other' but is only a minor part even of this category. Furthermore, the Dutch price does not mirror the strong price dip during the midday hours shown for Germany caused by the feed-in of solar generation at marginal costs that are close to 0 €/MWh.

Dutch hourly fuel mix, 18 July 2013

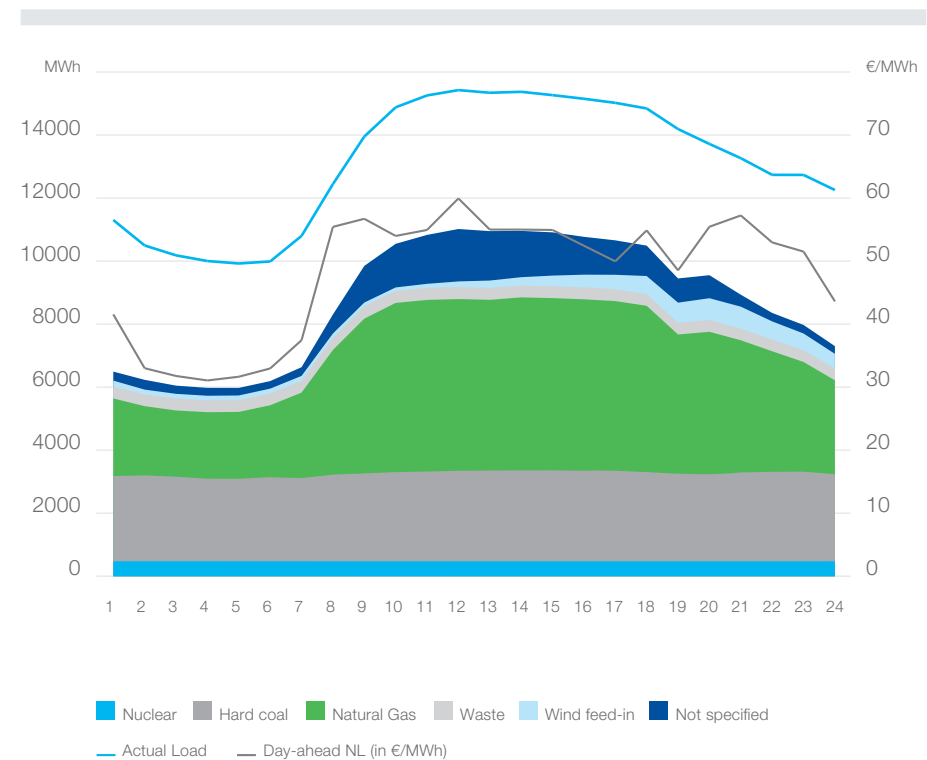


Figure 3.3 Dutch Actual Hourly Fuel Mix and Actual Total Load, 18 July 2013.  
Source: Berenschot. (data: APX; TenneT; ENTSOE-E)

<sup>3</sup> Other generation can cover coal and natural gas as well, as not all of the German generation units report their scheduled generation.

<sup>4</sup> Note that due to difference in data availability for Germany, the scheduled production is shown, for the Netherlands this is the realized production.

<sup>5</sup> The category 'not specified' consists mainly of natural gas, but also includes renewables like solar energy.

<sup>6</sup> The category 'wind' has been calculated by extrapolating hourly measurements of about 37% of the total wind energy production using monthly production data.



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### Normal winter day

Similarly, the figures below show the development on 29 January [figure 3.4] as an example of a winter working day. The contribution of wind and solar on this day can be seen as representative for this time of year although contribution can vary considerably. Clearly, the contribution of solar is smaller than on the summer day, starting later and stopping earlier. Still, this contribution appears to create a reduction in midday prices. In absolute terms, coal is the main supplier of needed flexibility to cover the variation of load over the day. However, it should be noted that in relative terms the increase in natural gas-fired production, especially in the evening peak, is larger.

### German hourly fuel mix, 29 January 2014

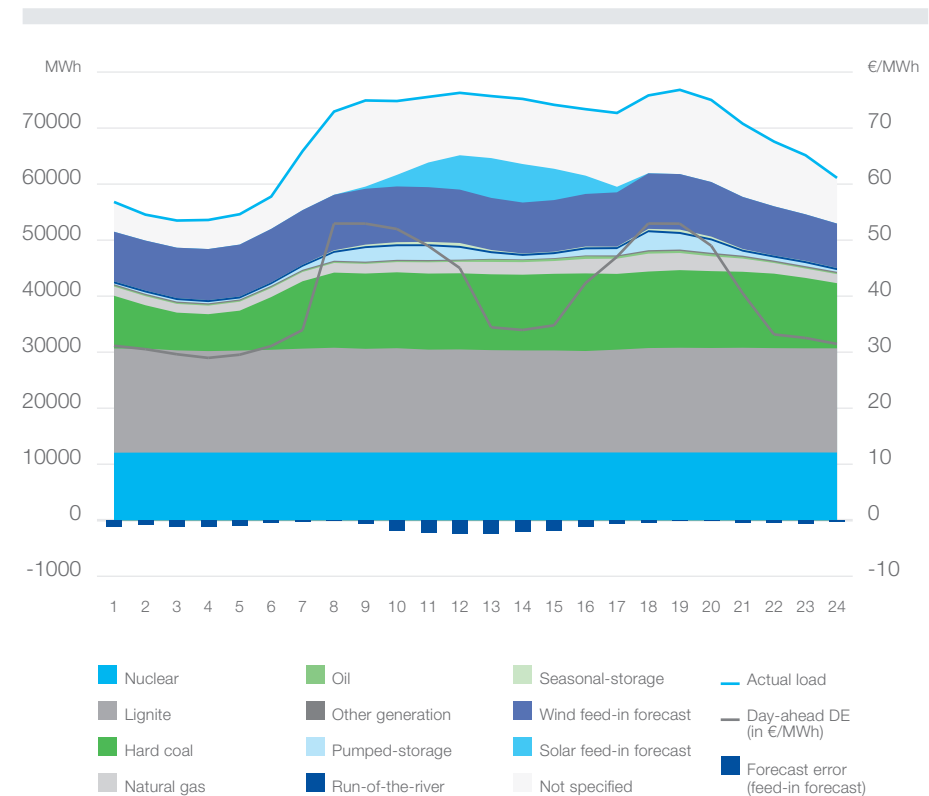


Figure 3.4 German Scheduled Hourly Fuel Mix, Forecast Error and Actual Total Load, 29 January 2014. Source: IAEW (data: EEX Transparency; EPEX Spot)



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In the Dutch picture [figure 3.5] for the same day it can be observed that also in the Netherlands coal is contributing to supply the required flexibility, especially in the early morning hours. Secondly, it is especially the price that is spiking at the early evening peak between 18:00 and 19:00 that draws the attention, being the hour of the day that the price difference between the Netherlands and Germany is smallest, as shown earlier in figure 3.1.

Dutch hourly fuel mix, 29 January 2014

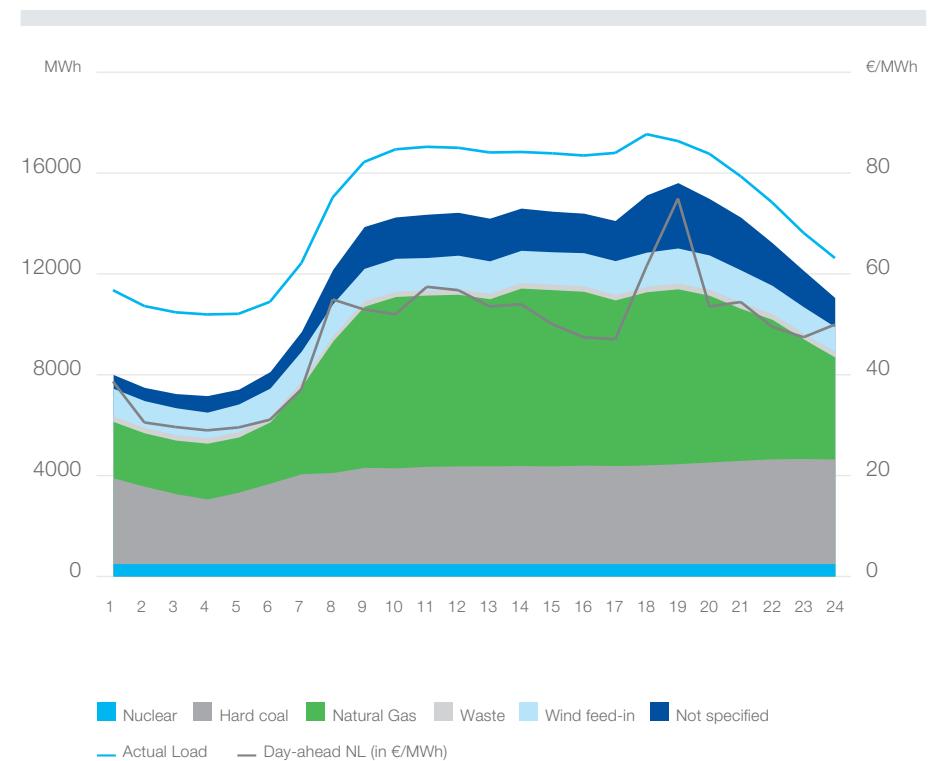


Figure 3.5 Dutch Actual Hourly Fuel Mix and Actual Total Load, 29 January 2014. Source Berenschot. (data: APX; TenneT; ENTSOE-E)



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### 3.3 The role of natural gas

To be able to look deeper into the role of gas-fired production in the system we plotted the natural gas-fired power production in the Netherlands for a period of three days in which relatively low prices occurred (below 20 €/MWh) [figure 3.6]. As could be seen in the previous pictures, gas-fired plants are also generating electricity in hours of low prices. In the Netherlands this contribution is significant. The marginal generation costs of this production is driven by factors other than the clean spark spread alone, they produce at prices well below the 40 €/MWh shown in figure 2.6 as the marginal costs for fuel and emission. Most often, these units are cogeneration plants driven by heat demand. Although the plants do not respond to electricity prices in the short run, low price levels do deteriorate their business case, causing industries with heat demand to turn to other options. Should price volatility increase and very low prices become more frequent, electricity could in some cases even be considered as a 'fuel' during low-priced hours.

On the other hand, a large contingent of gas-fired plants is adjusting production based on the price pattern, with several plants starting and stopping in peak and off-peak hours. These plants are highly likely to be 'at the margin'. Increasing production of spinning reserve can be assumed to bid in at marginal costs that are equal to the fuel and CO<sub>2</sub> costs. For peak units also, start-up costs will be part of the marginal costs. This causes the price peak to be more pronounced than the demand peak.

Gas-fired generation in the Netherlands on selected days with low wholesale prices

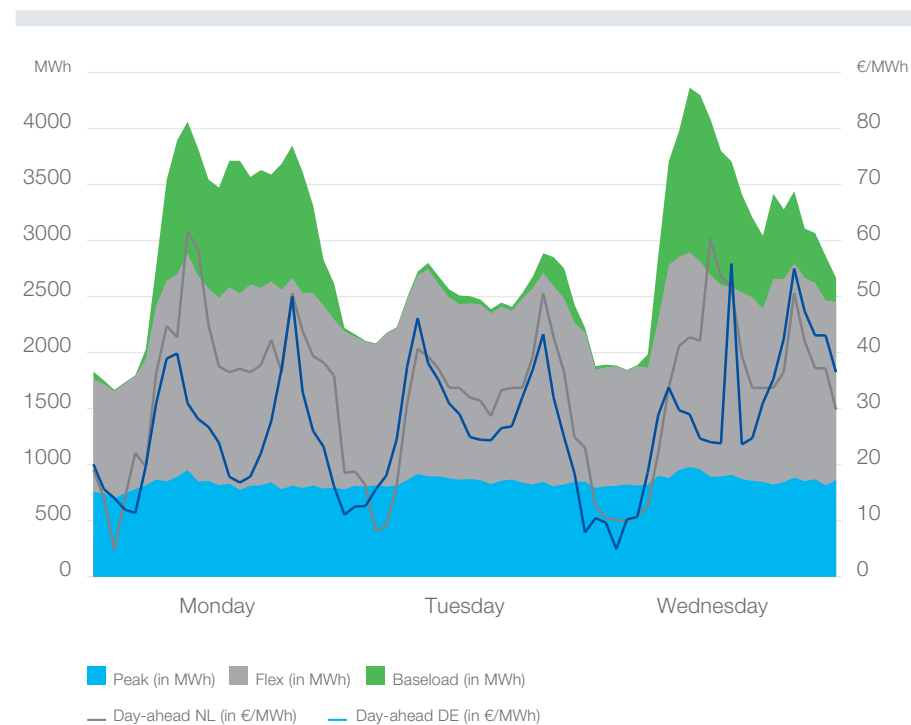


Figure 3.6 Gas-fired generation in the Netherlands on 19, 20 and 21 March, 2014 and Day-ahead wholesale prices for Germany and the Netherlands. Source: TenneT, APX and EPEX



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Figure 3.7 shows four days in the following week, a week that showed relatively high prices.

### Gas-fired generation in the Netherlands on selected days with high wholesale prices

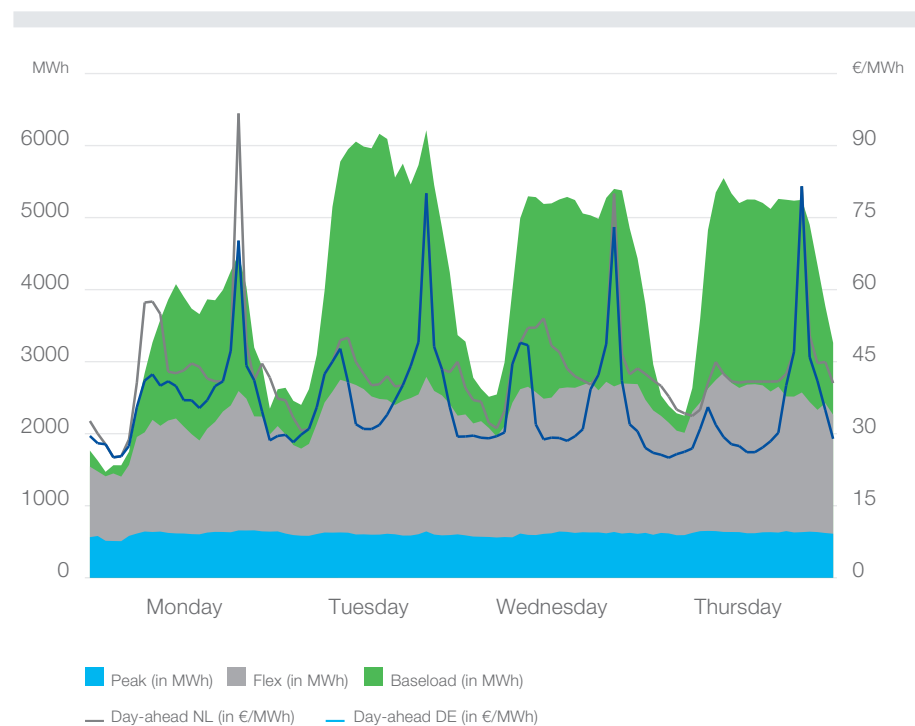


Figure 3.7 Gas-fired generation in the Netherlands on 24, 25, 26 and 27 March, 2014 and Day-ahead wholesale prices for Germany and the Netherlands. Source: TenneT, APX and EPEX

In line with what we observed in figure 3.1 (price convergence), we see the price difference being smallest in the morning and evening hours. We even see hours of price convergence. Still it is important to note that even in the hours with price peaks, German prices are still lower or equal to Dutch prices. This implies that the German electricity system shows no lack of either capacity or flexibility compared to the Dutch system.

Because of higher prices in the Netherlands, especially in the midday hours, conventional generation in the Netherlands has 'more hours per day' to make a margin than in Germany. Should this cause conventional capacity to be reduced more in Germany than in the Netherlands, the pattern of price convergence in the evening peak will become stronger. During these hours, Germany would reduce exports to the Netherlands, or, at some hours, import electricity. The current level of mere baseload exports gives the German system a large potential of flexibility. The appreciation, however, requires a regional perspective on the matter of generation adequacy.



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### 3.4 Example of renewables setting marginal prices

Clearly, not only gas-fired generation can set the marginal price. To illustrate the influence of renewables and the role of interconnection capacity on

Dutch hourly fuel mix, 11 May 2014

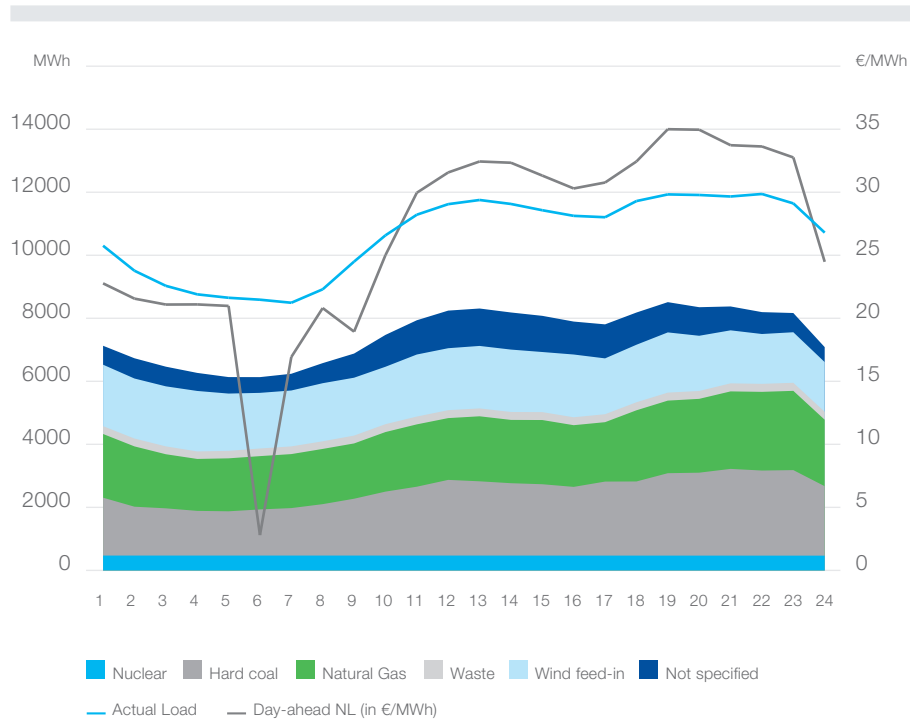


Figure 3.8 Dutch Actual Hourly Fuel Mix and Actual Total Load, 11 May 2014 (low German prices)  
Source: Berenschot (data: APX; TenneT; ENTSO-E)

managing the effect, we look at the price picture of May 11, 2014, a Sunday characterized by a high wind in-feed in Germany. The impact on the Dutch system is shown in figure 3.8.

Reversal of NorNed Nominations; storing Dutch and German wind energy in Norwegian hydro, 11 May 2014



Figure 3.9 Nominated capacity NL-NO border and Day-Ahead prices NL/NO/DE, 11 May 2014.  
Source: Berenschot, (data: APX; EPEX Spot; NordPool; TenneT)



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The large wind feed-in combined with low Sunday demand drove down German prices to as low as minus 60 €/MWh. Combined with a large domestic wind feed-in, this drove down prices in the Netherlands. On the peak hours, Dutch prices were still above the Norwegian prices and NorNed was fully importing into the Netherlands, in line with the normal pattern for the hours 10 until 24 [figure 3.9]. However, during the night hours, without market coupling the Dutch price would have been lower than the Norwegian price. This caused the flow to reverse. This stabilised the Dutch price, which cannot fall beneath the Norwegian price until NorNed is exporting at full capacity. This situation occurred in hours 6 and 7 with a fully exporting NorNed, constrained in the opposite direction, and Dutch prices dipping below Nordic prices.

The net effect of this is a storage of low-priced renewables input in the Norwegian hydro basins. This is a good example of 'spread and store' in practice in which the Norwegian system provides flexibility for Continental Europe. Access to this flexibility is a result of the system of market coupling and does not require control over the generation assets.

### 3.5 Conclusion

Converging prices of the primary energy sources hard coal and natural gas as well as above-average feed-in of RES could be identified as driving factors for the reduction of price differences as well as an explanation of the remaining price differences.

The price difference between Germany and the Netherlands shows a clear pattern. Despite the integration of a high amount of intermittent renewables, Germany can still supply electricity at peak hours at competitive prices and even export during those hours.

The current pattern of mere baseload export has created a situation where Germany has the full potential of the interconnection capacity as flexibility at its disposal, in case of reductions in domestic generation.

Even in hours of negative spark spreads, there is considerable production from gas-fired power plants in the Netherlands. This is mainly explained by cogeneration plants driven by heat demand. Alternatives to cover this heat demand could create additional flexibility.

Day-ahead markets are functioning well, further enhanced by the North West European Market Coupling. Since market action does not end at gate closure of the Day-ahead market and short-term deviations gain importance with higher RES feed-in, a closer look at the subsequent markets and mechanisms of Intraday trading and balancing is given in the following chapters.



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Intraday trading is vital for market parties to be able to efficiently deal with deviations from schedules and forecasts. The functioning of the German and the Dutch Intraday markets are therefore important to analyse. Here we highlight developments and differences.

## 4.1 Comparison of German and Dutch Intraday prices and volumes

At the Intraday market, participants trade continuously with 15-minute products differently to the Day-ahead market, which is organised as an auction with hourly products. So as to compare Intraday and Day-ahead prices, Intraday prices are shown with hourly averages in this chapter.

The Dutch and the German Intraday markets differ in both prices and trading volumes, as can be observed in figure 4.1 showing the data from the exchanges. Trades between market parties that are made bilaterally (over-the-counter) are not reflected here.

## Comparison of German and Dutch Intraday prices and volumes

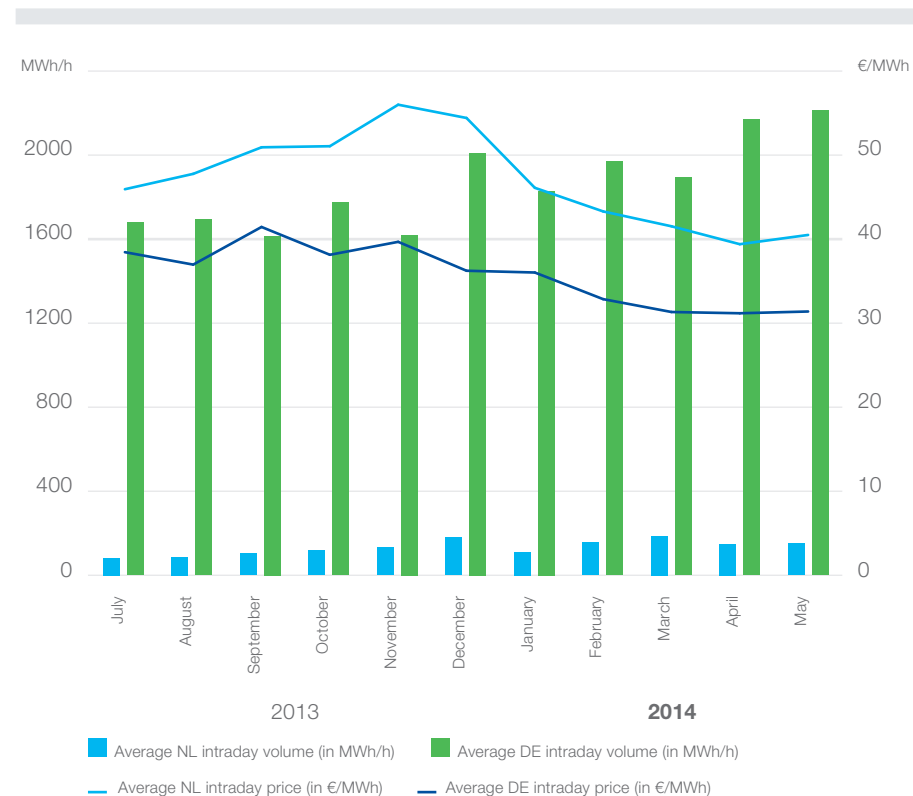


Figure 4.1 Comparison of German and Dutch Intraday prices and volumes, July 2013 - May 2014. Source: Berenschot (data: APX; EPEX Spot; NordPool)

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As in the Day-ahead (discussed in chapters 2 and 3), in the Intraday market the prices in Germany are also significantly lower than in the Netherlands.

Additionally, the difference in the trading volumes is obvious. The volume in the Netherlands is less than 10% of the volume in Germany. This can only be partly explained by the difference in market size, since the German market in general is about five times larger than the Dutch market. Thus, market parties are less active on the Intraday market in the Netherlands than in Germany. Similar differences in volumes can be observed between Germany and France (see paragraph 4.4).

There are two important explanations. On the one hand, German TSOs are obliged to try to even out forecasting errors for renewable generation within the Intraday market. This leads to significant trading volumes on the power exchange. On the other hand, the German system for imbalance prices might encourage market participants to trade their deviations from the generation schedule in the Intraday market (see chapter 5). In the following sections, different situations occurring in the interaction of the different markets are presented.

## 4.2 Impact of high renewables forecast error in Germany

The following section covers a situation in German short-term electricity markets with a rare market situation where a high overestimation of renewables feed-in occurs.

On the 5th of April, 2014, a high concentration of dust from the Sahara in the atmosphere over Germany threw off the forecast of solar feed-in. Figure 4.2 shows the German hourly fuel mix and the forecast error of this particular date. In this case, the Day-ahead forecast predicted a significantly higher feed-in of an additional 10 GWh/h than actually occurred. Deviations can be compensated by increasing thermal generation, reducing flexible load or adjusting exports.

German hourly fuel mix, 5 April 2014

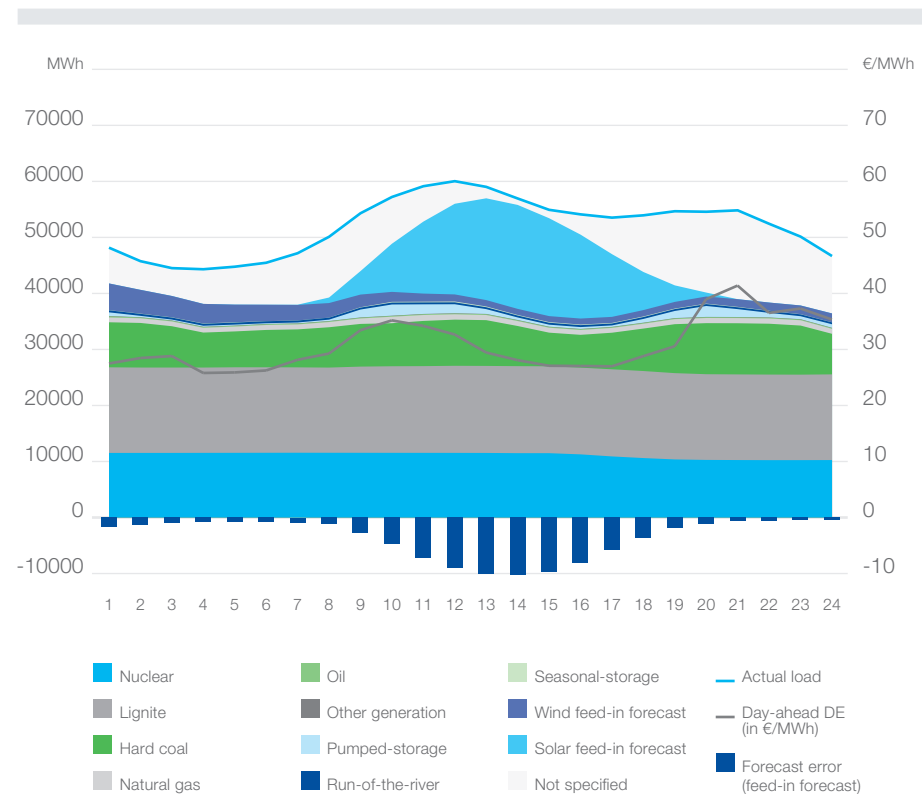


Figure 4.2 German Scheduled Hourly Fuel Mix, Forecast Error and Actual Load, 5 April 2014 (High renewables feed-in forecast error). Source: IAEW (data: EEX Transparency; EPEX Spot)



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All of these actions should be reflected by activities in the Intraday market.

As shown in figure 4.3, the missing generation determines higher prices at the Intraday market compared to Day-ahead, with spreads up to 20 €/MWh. Trading volumes are substantially above the average in hours with a high forecast error caused by trades which compensate the missing feed-in from renewables by additional generation in Germany itself or abroad.

**German Day-ahead and Intraday Prices 5 April 2014**

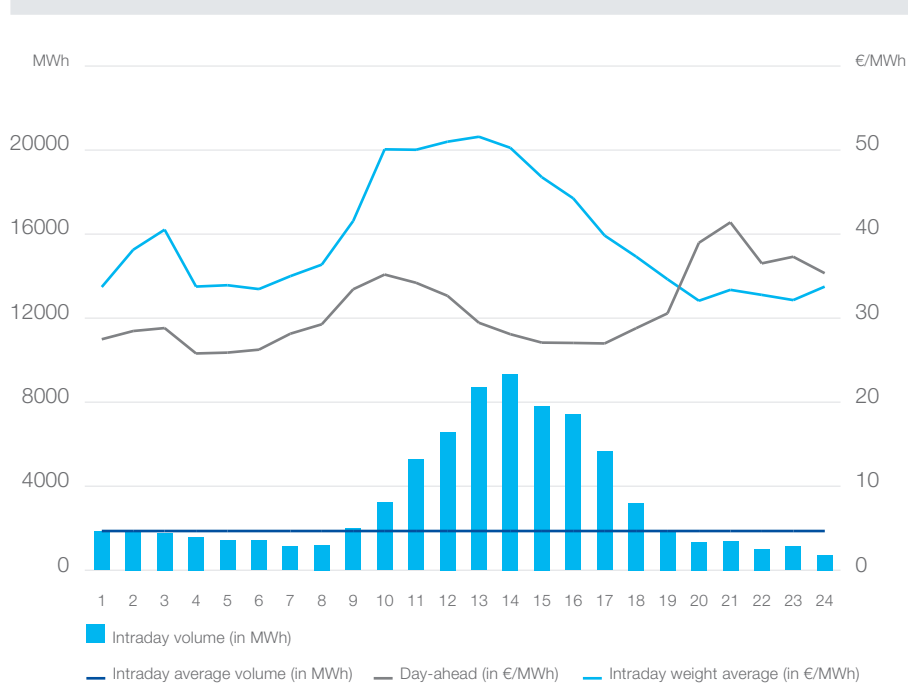


Figure 4.3 German Day-ahead and Intraday prices on 05.04.2014. Source: IAEW (data: EPEX Spot)

Compare this to the picture of 18 July, 2013 (corresponding to the fuel mix shown in the previous chapter), where the forecast error is close to zero, meaning the prediction of feed-in by renewable energy sources is accurate. Due to the precise prediction, the amount of compensating trades at the Intraday market are low and caused mainly by adjustments of the conventional power plant schedule. Day-ahead and Intraday prices follow the same pattern.

**German Day-ahead and Intraday Prices 18 July 2013**

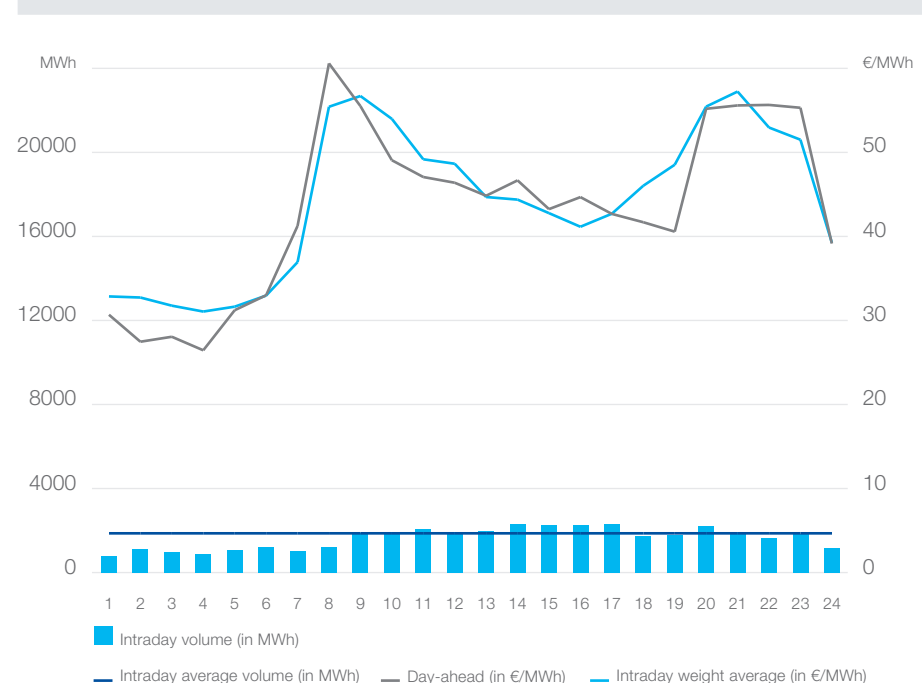


Figure 4.4 German Day-ahead and Intraday prices on 18.07.2013. Source: IAEW (data: EPEX Spot)

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The Intraday market reduces the needed reserve by forecasting errors of the German TSOs. Based on market results, TSOs organise and ensure a physical balance between demand and supply in real-time. Chapter 5 gives an overview of these subsequent balancing markets.

Due to the increasing role of wind and solar energy in Germany, the Intraday market becomes more important.

## 4.3 Cross-border Intraday trades

We have seen in the previous chapters that Day-ahead price coupling leads to a dominant flow from Germany to the Netherlands, with the interconnection capacity fully used in this direction most of the time. This results in a low availability of interconnection capacity for Intraday trades for exports from Germany to the Netherlands and a high availability in the other direction. An overview is given in table 4.1 for the first six months of 2014 (4344 hrs).

	DE > NL	NL > DE
Availability of Intraday cross-border capacity Natural gas	1761 hr	4344 hr
Average available capacity in those hours	425 MW	4364 MW
Traded volume	253 GWh	290 GWh
Net Value of traded volume	<b>873 k€</b>	<b>-369 k€</b>
Value of economical trades	1168 k€	-898 k€
Value of uneconomical trades	-295 k€	529 k€
Number of hours capacity not fully utilized in the economical direction	711 hr	437 hr

Table 4.1 Overview of cross-border Intraday trade between Germany and the Netherlands for the first six months of 2014.

This overview shows that the market functions when looking at the bulk of flows, but that strong market imperfections persist. It should be noted that Dutch Intraday market prices used in this analysis are not always representative due to the lack of liquidity in the Dutch market.

Starting January 28, 2014, TenneT makes available an additional capacity of up to 100 MW (subject to market circumstances) of cross-border Intraday capacity on the Dutch-German border. Due to the high utilization rate of interconnection capacity from Germany to the Netherlands – resulting from Day-ahead market coupling – before this date there was often no, or limited, capacity available in this direction. Figure 4.5 shows the utilization rates of cross-border Intraday capacity before and after this date. All traded delivery hours with a nomination in the direction from Germany to the Netherlands have been included. It can be observed that the capacity is more frequently used by market parties now that a significant additional amount is being made available that is seemingly interesting for traders. Also more Intraday cross-border trading was done in the last five months (1202 hours) compared to the first seven months (1017 hours).



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Utilization of cross-border Intraday capacity before adding 100 MW

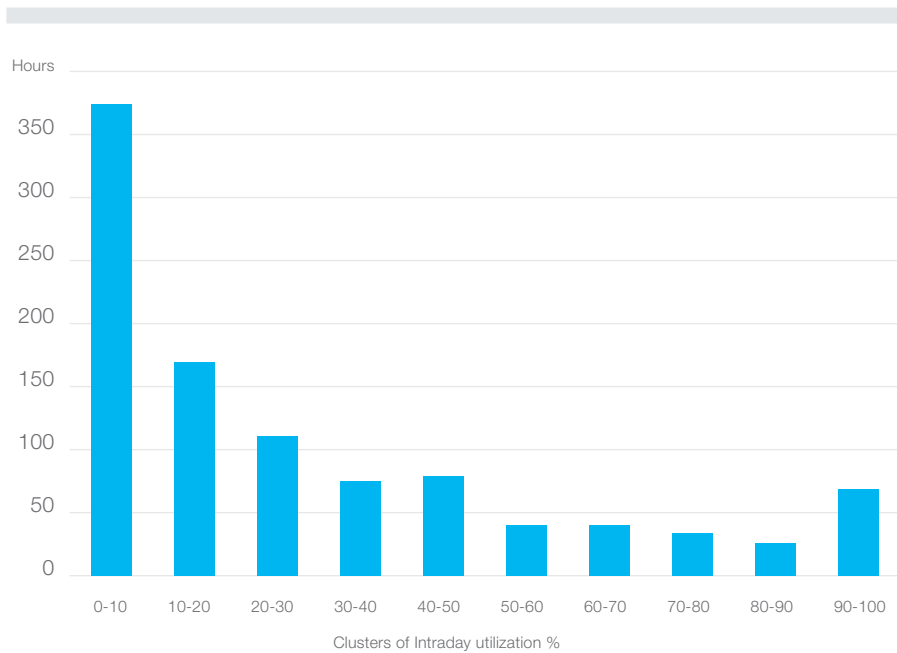


Figure 4.5a Frequency of Intraday utilization percentages DE > NL, 1 July 2013 - 27 January 2014 (before 100 MW Intraday capacity extension) Source: Berenschot (data: TenneT)

Utilization of cross-border Intraday capacity after adding 100 MW

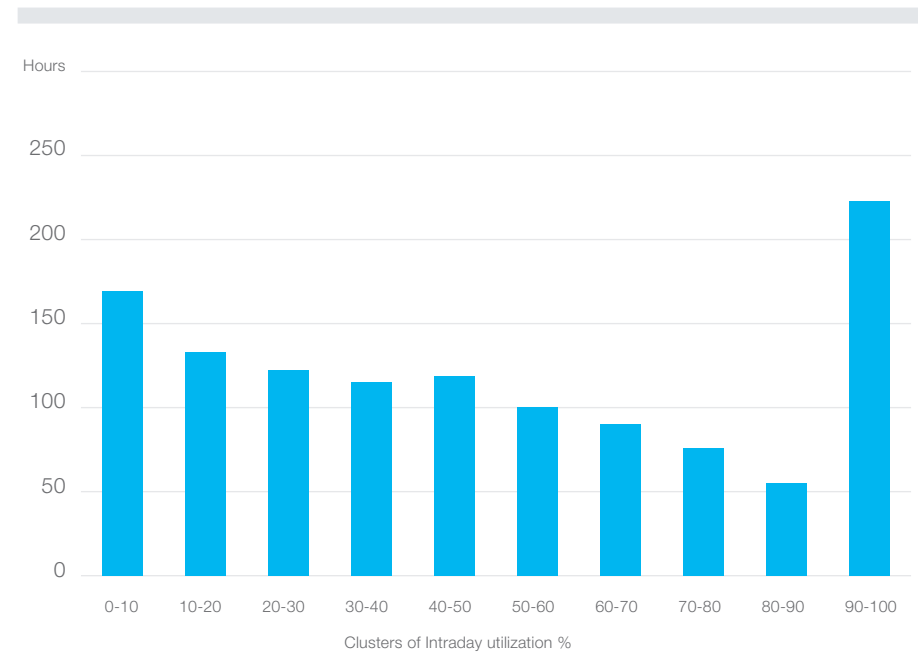


Figure 4.5b Frequency of Intraday utilization percentages DE > NL, 28 January 2014 - 30 June 2014 (after 100 MW Intraday capacity extension) Source: Berenschot (data: TenneT)



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## 4.4 French and German Intraday markets

Another border already being utilized for Intraday cross-border trading is the German-French border, which shows different developments and interdependencies in short-term trading. Therefore, figure 4.6 shows clusters of the price differences between the German and French Intraday markets (DE-FR) and the referring average trading volume in the two markets.

French and German Intraday Markets

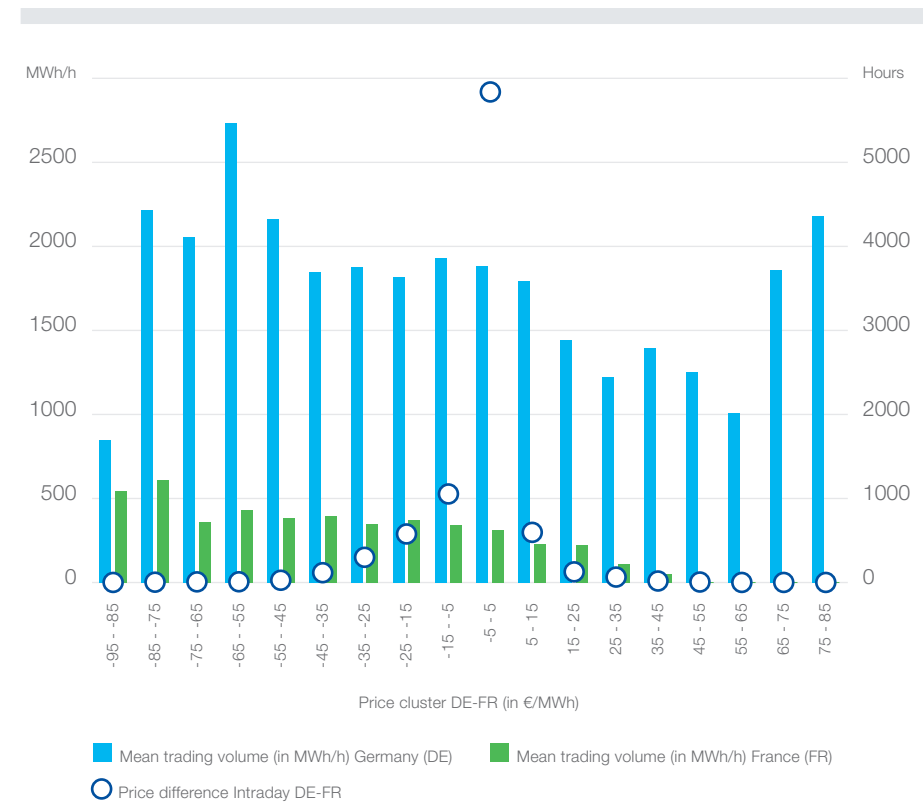


Figure 4.6 Comparison of German and French Intraday prices and trading volumes. Source: IAEW (data: EPEX Spot)



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It can be observed that in the majority of the hours the Intraday prices were either converging or close to each other, only deviating by as little as  $\pm 5$  €/MWh, showing the functioning and rising liquidity of this cross-border Intraday market. Nevertheless, price differences of up to 95 €/MWh occasionally occurred. However, the average trading volume seems not to be directly linked to the price differences. Additionally, in the case of France the lack of high amounts of short-term traded forecast errors is visible, resulting in lower trading volumes on the Intraday market, similar to the situation in the Netherlands.

## 4.5 Conclusion

Intraday markets seem to be of rising importance for the European electricity markets, especially for levelling short-term deviations such as forecast errors or outages of generation units. The markets and the price levels somewhat reflect the developments and patterns of the Day-ahead markets with high price convergence between Germany and France and limited convergence between the Netherlands and the Germany.

Consequently, the Intraday market in Germany seems to be of much higher liquidity, mainly due to the higher share of renewables compared to the Dutch and French markets. Additionally, the following mechanisms of treating the remaining imbalance and distributing the resulting costs for this have an impact on participation in the Intraday market. Therefore, the imbalance mechanisms in the Netherlands and Germany are analyzed in the following chapter.



# Balancing markets

The balancing regime in essence determines the risk for a market party for not fulfilling its obligations. This is therefore a key aspect for the risk management of market parties over all time frames, making the proper design of the balancing regime a crucial factor to achieve generation adequacy in a market-based system.

How imbalance volumes are allocated to market parties and how the imbalance prices are calculated at which these volumes are settled can be referred to as the 'balancing regime'. This balancing regime is a crucial aspect for the behaviour of market parties during the day to avoid imbalances at penalizing prices. It will also determine the amount of generation capacity a market party will hold in reserve in its Day-ahead planning. Moreover, it will set the constraints for the risk management of its sales and procurement portfolio in the medium term. Ultimately, in a well-functioning market, it will play an important role in its investment decisions. European harmonization and calibration of balancing regimes to increased amounts of intermittent generation calls for a further study of best practices within Europe. In this chapter the different characteristics of the Dutch and the German balancing regimes are discussed, based on the imbalance volumes and settlement prices in the first six months of 2014.

## 5.1 Calculation of Imbalance prices in Germany and the Netherlands

There are several differences between the way the Dutch and German balancing regimes function. One important difference is the way the imbalance price is calculated.

In the Dutch system, the imbalance price is equal to the marginal price for regulating upwards or downwards reserves. Most of the time this leads to a single imbalance price, but in some cases, where during a single imbalance settlement period of 15 minutes the TSO needs to regulate both upwards and downwards to maintain the power balance in the system, there will be two

separate imbalance prices: one for infeed and one for off-take. This method of pricing ensures a proper financial incentive for market participants to either actively support the system when there is a single imbalance price, because they can profit by deviating from their schedules in a way that supports the system, or to stay close to their own schedules in the case of a double imbalance price and there is no clear way in which they can support the system.

In order to assist market participants in actively balancing in real-time, TenneT TSO BV publishes real-time information with a granularity of one minute, for system imbalance and an imbalance price indication, allowing market participants to make informed decisions even when they are not entirely certain of their current imbalance position.

Germany, on the other hand, always carries a single imbalance price, which results from the energy costs the German TSOs pay for the activation of secondary and tertiary reserves<sup>5</sup> divided by the total imbalance in the control block. Afterwards, calculated prices are adjusted if necessary by cost limits (maximum reserve marginal costs), price limits (average weighted Intraday prices) and added premiums (if 80% of reserves were activated). The limits and premiums raise the imbalance price and improve the incentives. An effect of using the marginal price is that it eliminates the need for such premiums, as in that situation the benefits for a market party to adjust its position in the incentivised direction are equal to the cost for the TSO to improve the system balance.

<sup>5</sup> Reserves are acquired market-based by the TSOs through an auction. Such auctions are organised by the four German TSOs through the website [regelleistung.net](http://regelleistung.net).



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Due to the more complex calculation method, the imbalance price in Germany is not known until one month after real-time. Furthermore, market participants are not provided with real-time information about the state of the system balance<sup>6</sup>. Despite the single imbalance price, these insecurities ensure that the German market parties are incentivised to return to their schedules. If remaining flexibility in the portfolio of a market party is not made available to the system, this can lead to inefficiency, making that the system as a whole will require more reserves.

## 5.2 The relationship between imbalance volumes and prices

Both in Germany and the Netherlands, there is a relationship between the volumes of imbalance in the system and the imbalance price that follows from the system design. This relationship is shown in the graphs below for the two countries (figures 5.1 and 5.2). The imbalance volumes in these graphs are the netted imbalances of all market participants.

German imbalance price and volumes

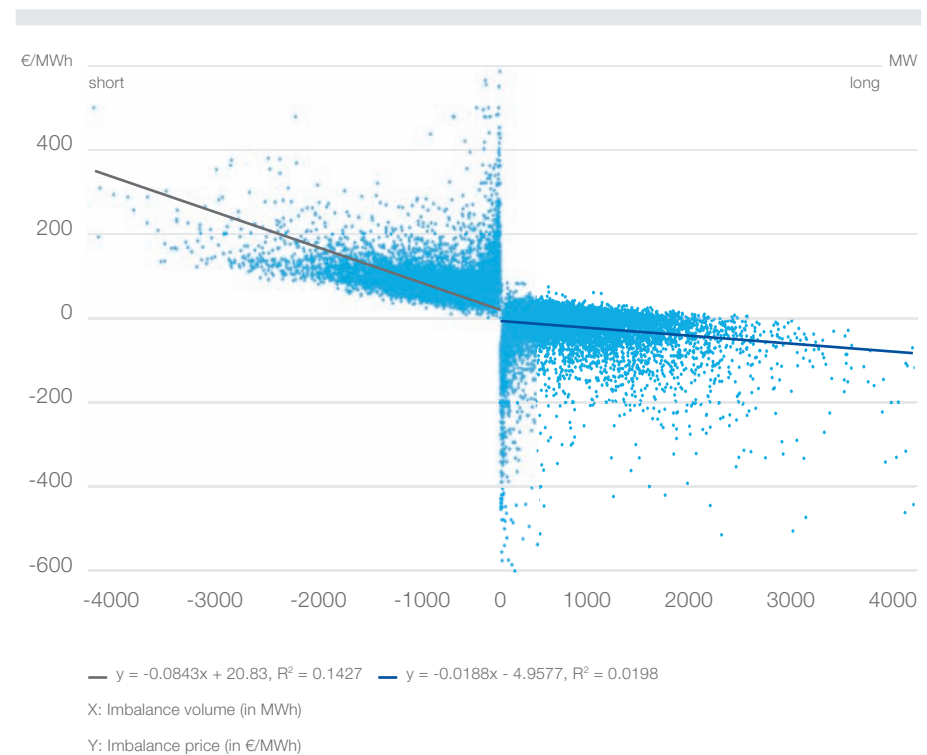


Figure 5.1 German imbalance prices against imbalance volumes. Source: IAEW (data: EPEX Spot)

<sup>6</sup> 'real-time' refers to publication during the respective imbalance settlement period.

<sup>7</sup> 99.97% out of all situations of the considered period are shown. Ten extreme cases are not visualized due to illustration reasons.



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## Dutch imbalance price and volumes (off-take)

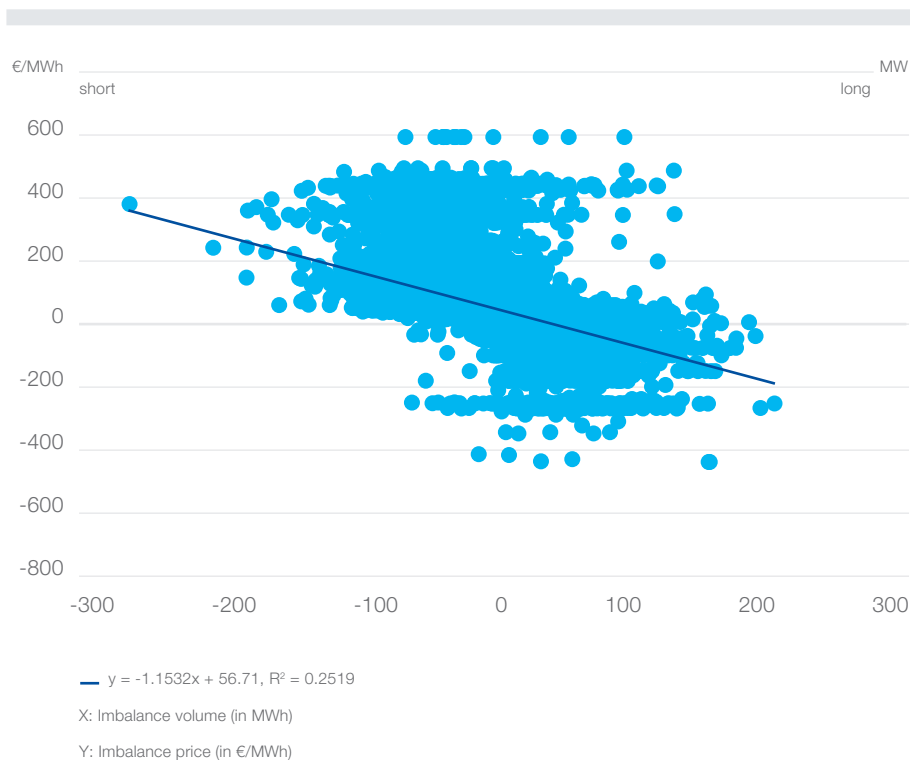


Figure 5.2 Dutch imbalance prices against imbalance volumes. Source: Berenschot (data: TenneT)

In the German situation, the imbalance price is high if the costs for the activated secondary and tertiary reserves are high with minor control area imbalances. Often imbalance volumes and prices are high or low simultaneously, but that link is rather weak because of periodically changing reserve costs and unpredictability of imbalances.

In contrast, the link between imbalance volumes and prices in the Netherlands is stronger, as is apparent from the graphs. This difference is the result of the different methods of calculating the imbalance prices in Germany and in the Netherlands, and is consistent with the remarks on the incentives: the stronger relationship between imbalance volumes and prices in the Netherlands puts a financial responsibility on market participants for the system balance. Moreover, financial benefits are also possible when contributing to a reduction of the system imbalance. The ex post calculation of imbalance prices in Germany contributes to making the financial risk of deviating from the schedule predominant. The more liquid German Intraday market, discussed in the previous chapter, enables market parties to act and reduce this risk.

<sup>8</sup> This graph shows the in-feed price. Since, in a small percentage of the imbalance settlement periods, the Dutch system has two imbalance prices, a similar graph with the off-take price could be created. In this representation, no optical difference is observed. The R2 for the correlation with off-take price is 0,2519.



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The following graph [figure 5.3] shows a comparison of the consequences for market participants that have an imbalance that aggravates the system imbalance for both TenneT TSO BV (TenneT NL) and TenneT TSO GmbH (TenneT DE). The difference between the imbalance price and the wholesale electricity price has been calculated for a market participant that has an imbalance aggravating the system imbalance. This price difference, the delta, is an indicator of the loss or profit of such a market participant having such an imbalance in relation to him having traded that amount on wholesale markets at prevailing prices. The graphs also include a histogram of the system imbalances, for which we can assume that the size of control areas for TenneT NL and TenneT DE are somewhat comparable<sup>9</sup>.

<sup>9</sup> One way of comparing the size of the control area of TenneT in the Netherlands to the control area of TenneT in Germany is by looking at the peak load, which is 17 GW and 22 GW respectively.



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## Net Imbalance and Balancing Incentives for Germany and the Netherlands

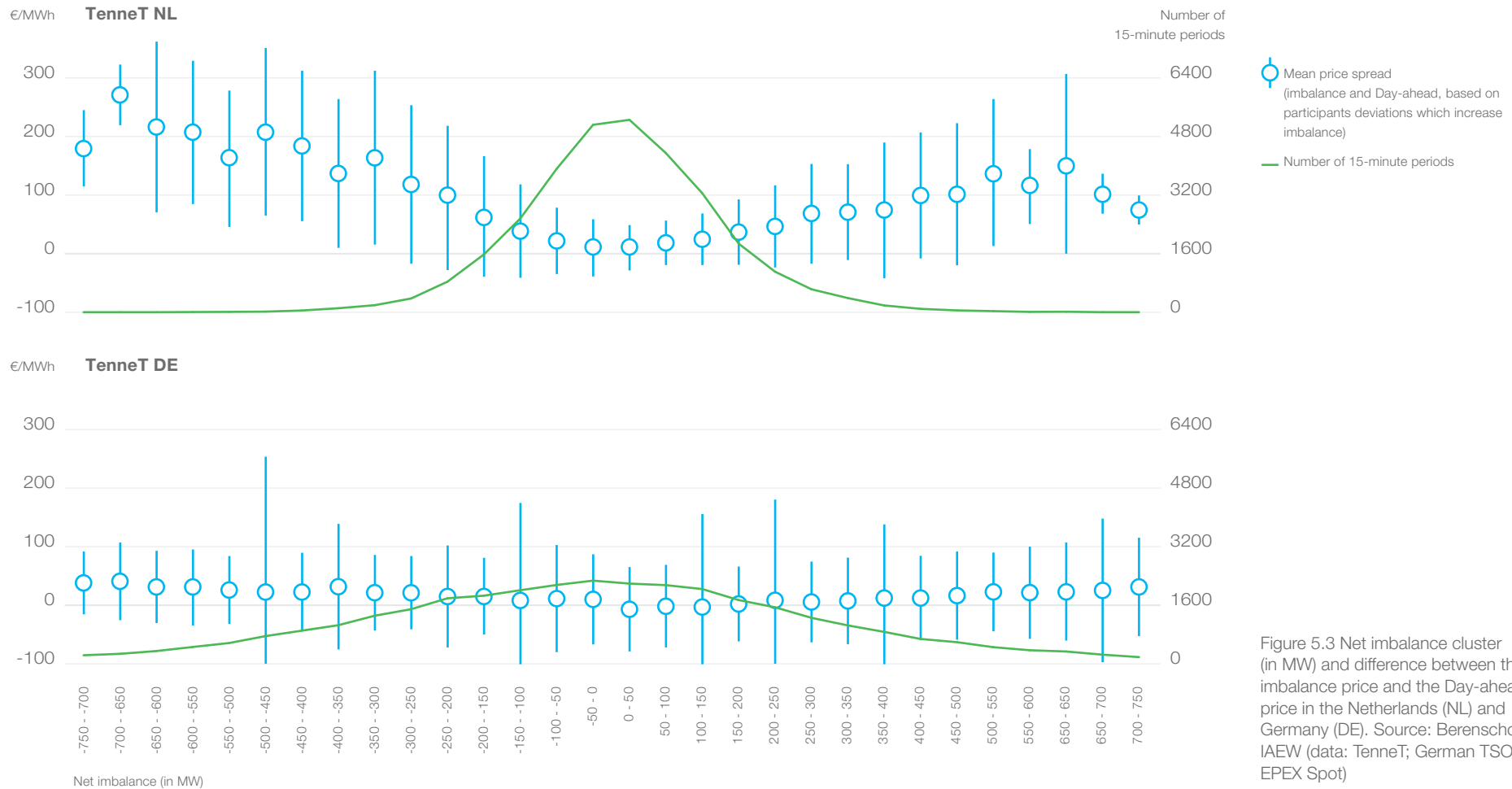


Figure 5.3 Net imbalance cluster (in MW) and difference between the imbalance price and the Day-ahead price in the Netherlands (NL) and Germany (DE). Source: Berenschot/IAEW (data: TenneT; German TSOs; EPEX Spot)

# Balancing markets

It is interesting to note that the histogram of system imbalances is much steeper for TenneT NL. This indicates that the system imbalances have a tendency to be closer to zero in the Dutch system than in the control area of TenneT DE. Perhaps even more interesting, however, is the clear difference in the relationship between the delta and the net imbalances. The unpredictability of the German system clearly shows in relatively large spreads in the delta for the same system imbalances, and little correlation between volumes and the delta. The Dutch system, however, clearly provides stronger incentives at larger system imbalances. Since the imbalances in the Dutch system tend to be closer to zero, these graphs suggest that incentives focused on reducing the system imbalance are more efficient for achieving that goal than incentives focused specifically on maintaining the balance of individual market participants.

## 5.4 Conclusion

As should be apparent from the above, there is not enough harmonisation between the German and Dutch balancing regimes for any conclusions to be drawn from a direct comparison between imbalance prices in Germany and the Netherlands. A comparison of balancing volumes and prices is therefore not a comparison of the physical capabilities or actual costs to keep the system balanced but more a comparison of balancing regimes. However, that does not mean that such a comparison is not useful.

The purpose of any balancing market and any imbalance price is to provide the right incentives for the market in order to help the TSO maintain the system balance. Ideally, the incentives lead to an efficient system in which no energy imbalances remain and the TSO only deals with power imbalances during each imbalance settlement period. Marginal pricing and real-time information, allowing market parties to make an informed decision, can create a stronger correlation between imbalance volumes, imbalance prices and market prices. In the Netherlands, the incentives stimulate market participants to actively support the system balance, even if it means that their own imbalance becomes larger. In Germany, the incentives stimulate market participants to trade expected imbalances at the Intraday market and stay as close as possible to their own schedules, even if this means the system imbalance becomes larger.





# Main Findings

In this Market Review we analysed general developments in wholesale prices of the Day-ahead market and explored their underlying causes. Furthermore, we took a more in-depth look into the functioning of the Intraday and the balancing markets. Below we highlight some of the additional insights we gained from this analysis.

In the first half of 2014 we saw decreasing wholesale prices in the CWE countries. As prices in the Netherlands decreased more than those in Germany, the price gap between these countries decreased. Still we observe a continuing price difference, with almost full utilization of the interconnection capacity in the direction from Germany towards the Netherlands.

The price decrease in the Netherlands mainly resulted from a substantial decrease of the spot gas price, developing gradually from February to June 2014. With marginal generation cost of gas-fired generation setting the clearing price in the peak hours, this resulted in declining electricity prices in these hours. The decrease in spot gas prices followed the mild winter of 2013/2014. Therefore the spot gas price reduction might be a temporary effect, as is illustrated by the mid-2014 price levels of gas futures for 2015 and onward.

The developments of the price differences between the Netherlands, Germany and Belgium can be explained partly by these gas price developments. Another part is explained by the direct effect of the mild winter temperatures in early 2014 on electricity demand in France. Finally, further explanations of price developments lie in the temporary outage of NorNed interconnector at the end of 2013, and the outage of nuclear power plants in Belgium from April 2014 onward.

Studying the role of gas-fired generation, we found a substantial share of this production during the off-peak. This indicates that a substantial share of gas-fired generation in the Netherlands is not spark spread driven but dictated by other constraints, mainly heat demand in the case of cogeneration plants.

Electricity price differences between the Netherlands and Germany are smallest during the ramp-up in the morning and during ramp-down in the evening. At noon and in the night hours, price differences are largest. Despite the integration of large amounts of intermittent generation in Germany, electricity can still be supplied at lower prices than in the Netherlands during hours of ramping and peak demand electricity. This indicates that, in comparison to the Dutch system, the German system is not tight on generation capacity or flexibility in the average ramping hour.

In the first half of 2014 we saw examples of the contribution of interconnection capacity to the integration of wind energy in the European system. Combinations of high wind energy and low demand in Germany and the Netherlands can cause the flow on NorNed to reverse, meaning that the flexibility of Norwegian hydro is used to accommodate wind energy in the system. This is an example of 'spread and store' in practice.



# Main Findings

A wave of mothballing of plants has occurred in both the Netherlands and Germany. This is the result of persisting low spark spreads, which, in their turn result from overcapacity in both market areas. Despite overcapacity at a national level, closures of plants can still cause local concerns with respect to transportation bottlenecks or voltage control. This local scarcity is not reflected by price signals that are set per market area.

The Intraday market can be expected to be of increasing importance when integrating more generation prone to forecast errors, like wind and solar energy. This trend can be observed in the German Intraday market, which shows much higher trade volumes than the Dutch or the French market. A well-functioning Intraday market is even more important for the German system since the responsibility for forecasting, and therefore the risk of forecast errors, lies predominantly with the TSOs, which do not own (flexible) generation capacity.

Since the end of January, TenneT has made available an additional amount of 100 MW of Intraday cross-border capacity between the Netherlands and Germany. The increased utilization rates indicate that this additional amount is interesting for market parties to make more active use of this scarce capacity in the direction from Germany to the Netherlands.

The balancing regime is a determining factor for the way in which market parties manage their risk of non-performance. Therefore it is important to study best practices in balancing regimes for reasons of generation adequacy concerns resulting from reduction of conventional generation plants and because of the goal of further European integration. Preliminary analysis of the Dutch and German systems shows that marginal pricing and real-time information and the possibility to act are factors that create incentives to support system balance.



# Colophon

This Market Review is a publication of TenneT

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TenneT is Europe's first cross-border grid operator for electricity. With approximately 21,000 kilometres of (Extra) High Voltage lines and 36 million end users in the Netherlands and Germany, we rank among the top five grid operators in Europe. Our focus is to develop a north-west European energy market and to integrate renewable energy.

**Taking power further.**