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Quarterly Report on European Electricity Markets

Market Observatory for Energy

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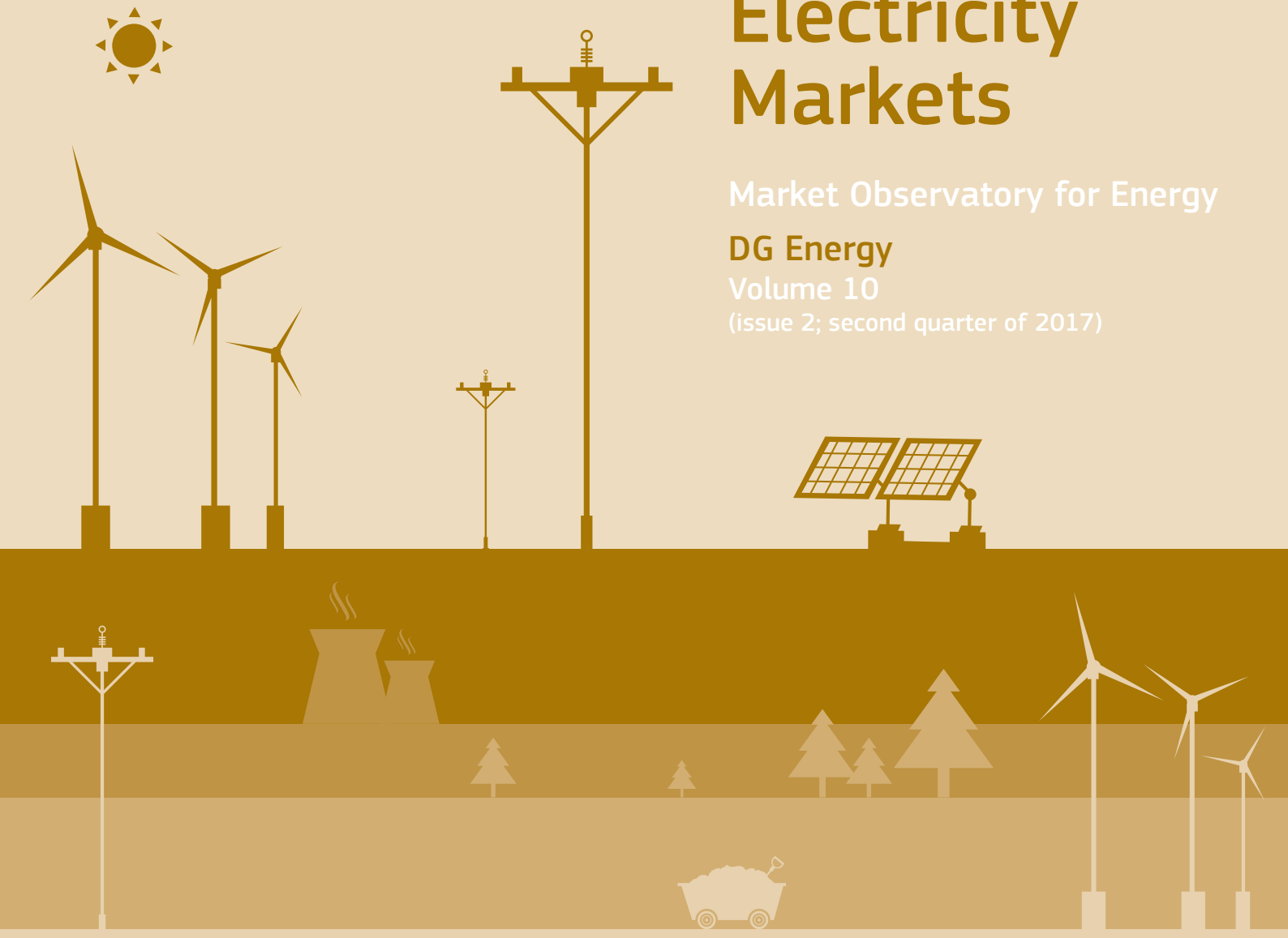

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QUARTERLY REPORT ON EUROPEAN ELECTRICITY MARKETS

CONTENT

HIGHLIGHTS OF THE REPORT

- **In the second quarter of 2017 wholesale electricity prices at EU level showed a great degree of stability. As both coal and natural gas prices were relatively stable in Q2 2017, marginal electricity generation costs and wholesale market prices were mainly affected by changes in the generation mixes.**

- **The profitability of both gas-fired and coal-fired generation decreased in Q2 2017 compared to the previous quarter. In the case of coal, clean dark spreads were in negative ranges in most of Europe, implying a further squeeze-out of coal from power generation.**

- **On 21 April 2017, for the first time ever, daily coal-fired power generation fell to zero in the United Kingdom. The share of coal in the UK generation mix was barely 2% on quarterly average in Q2 2017.**

- **In June 2017 solar power generation reached the highest monthly value ever recorded in Germany, France and the UK. In the same month renewable energy sources (hydro, wind, solar and biomass) assured 32% of the EU electricity generation mix.**

- **In the UK there were few occasions during Q2 2017 when receding variable renewable generation coincided with electricity cross-border capacity reductions, resulting in sudden wholesale market price spikes. Variable renewable sources need to be properly integrated in the grid and sufficient interconnections with neighbouring countries need to be assured.**

EXECUTIVE SUMMARY

- **In the second quarter of 2017 the European benchmark day-ahead baseload wholesale electricity price fluctuated in a narrow range of 35-40 €/MWh and reached 37 €/MWh on average**. Although in Q2 2017 there were significant differences in wholesale electricity prices across Europe, in the Nordic countries prices were generally lower than the European Power Benchmark, whereas in the southern countries they were normally higher. Electricity prices in different wholesale markets seemed to re-converge after the volatile first quarter of 2017.

- **Coal and natural gas prices were relatively stable during the second quarter of 2017**; implying that changes in **fossil fuel prices themselves did not exert too much influence on electricity generation costs**, **rather changes in the electricity generation mix had an impact on the wholesale price level**. In many markets the share of coal and natural gas decreased over the three months of Q2 2017, whereas the share of renewables went up.

- **Coal-fired generation became so unprofitable in the United Kingdom** that the share of coal fell to 2% in Q2 2017 in the country's electricity mix. Moreover, **on 21 April 2017, for the first time in more than a century, coal-fired generation fell to zero in the UK**. High unprofitability of coal-firing in the country was mainly due to decreasing wholesale electricity prices and the climate change levy, making coal-fired generation the costliest source.

- After the dry winter period, **hydro generation started to increase in many European markets in Q2 2017,** however, hydro reservoir levels were still below their long-term seasonal averages during the quarter. Following the usual behaviour, **wind generation started to recede in the second quarter of 2017** after the windy winter season, however, due to increasing installed wind capacities wind power generation was up by 18% in year-on-year comparison in the EU.

- Amid increasing daylight hours at springtime, **solar power generation picked up in Q2 2017 and in June 2017 in many EU countries, including Germany, France and the UK, it reached the highest ever recorded**. **In June 2017 however, the share of renewable energy sources amounted to 32% in total EU electricity generation.**

- **Variable renewable sources, such as wind and solar, need to be properly integrated in the grid and sufficient interconnections with neighbouring countries need to be assured.** On 17 May and 26 June 2017 there were two price spikes in the UK wholesale electricity market, lifting the day-ahead averages above 60 €/MWh. In both cases the anticipation of receding wind and solar generation coincided with reduction of the available interconnection capacities with France and the Netherlands, resulting in tight power supply margins.

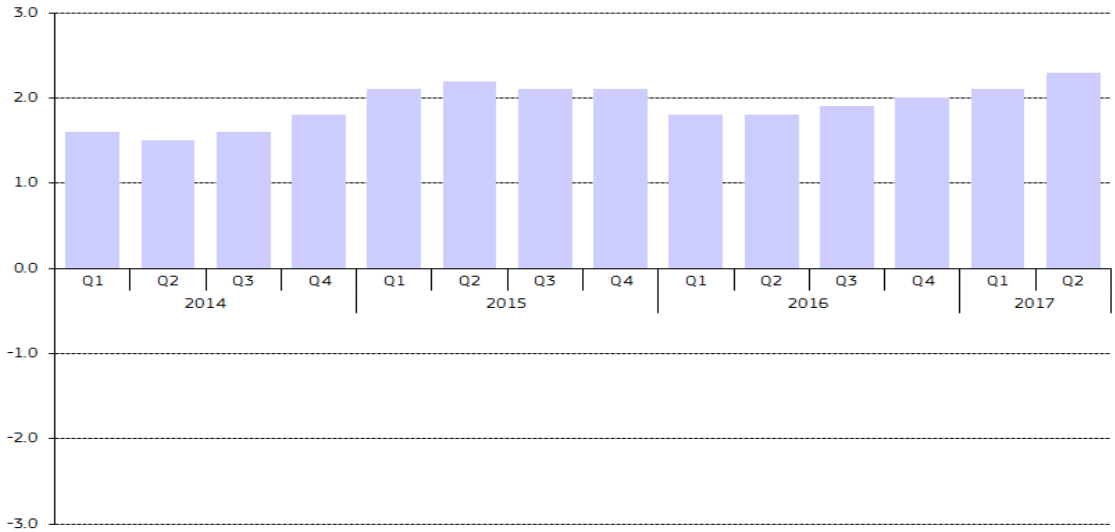
- **The second quarter of the year is usually the high season for power plant maintenance works** after the winter period. However, in Q2 2017 temporarily missing capacities did not result in significant generation adequacy issues or extremely high wholesale market prices; even if at the end of June 2017 there was a heat wave in many European countries that lifted residential cooling-related demand for electricity. **Nuclear availability in France and Belgium was still lower in Q2 2017** than in the same quarter of the previous two years; however, the gap was smaller than in the first quarter of 2017.

- **Retail electricity prices for household customers decreased by 1.2% between June 2016 and June 2017 in the European capital cities on average.** Changes in retail electricity prices were mainly driven by decreasing energy and supply costs, whereas changes in energy taxes and network costs together had an upward impact on the final retail electricity prices. In Nicosia, Warsaw and Tallinn double-digit percentage increases could be observed, while in Riga and Vilnius retail electricity prices decreased by more than 10 percent in June 2017 in year-on-year comparison.

1 Electricity demand drivers

Economic growth in the EU-28 remained strong in the second quarter of 2017. GDP grew by 2.3% in year-on-year, slightly faster than in the previous quarter (in Q1 2017 the economic growth was 2.1%). This was the biggest growth rate seen since the first quarter of 2011. The gross value added in the manufacturing sector was 3.2% higher in the second quarter of 2017 than a year earlier; this is the fastest growth since 2015.

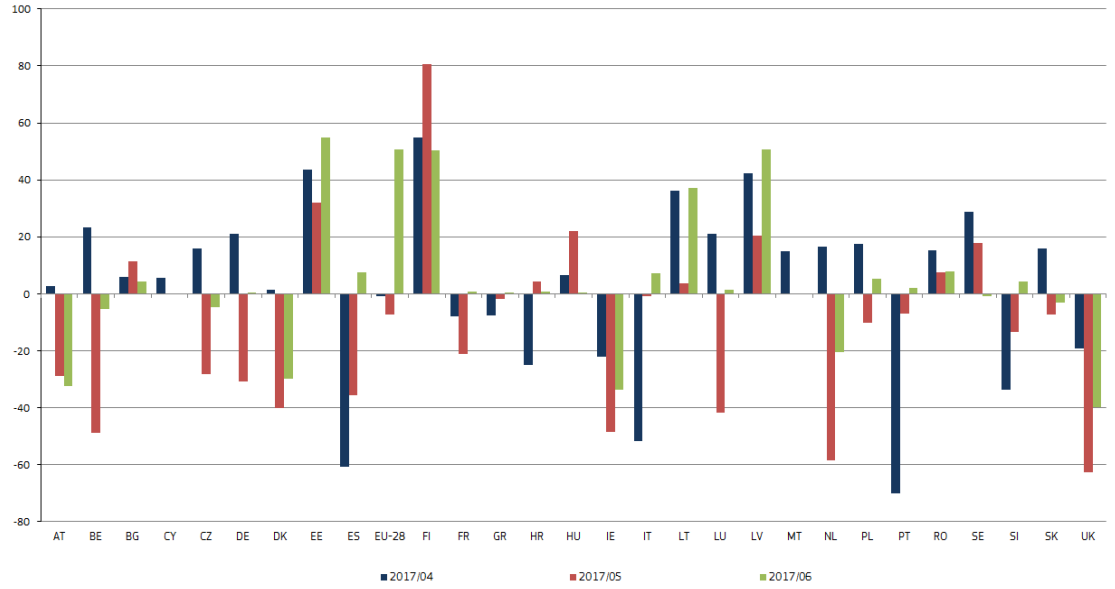
Figure 1 – *EU 28 GDP Q/Q-4 change (%)*



Source: Eurostat

- Figure 2 shows the monthly deviation of actual Heating Degree Days (HDDs) from the long term averages in April -June 2017 in the twenty-eight Member States of the EU. In April 2017 most of the continent, with the exception of some southern countries, faced colder than usual weather conditions, and this impacted wholesale electricity markets in many markets.
- However, in May and June 2017 temperatures were higher in most of the EU countries than the seasonal values, and the impact of heating related demand was less significant after the end of the heating season. In June 2017 in some southern and eastern countries higher than normal temperatures rather meant increasing cooling needs that impacted demand for electricity and the wholesale prices. The assessment of temperature driven demand for electricity can be found for each region in Chapter 4.

Figure 2 – *Deviation of actual Heating Degree Days (HDDs) from the long term average, in April-June 2017*



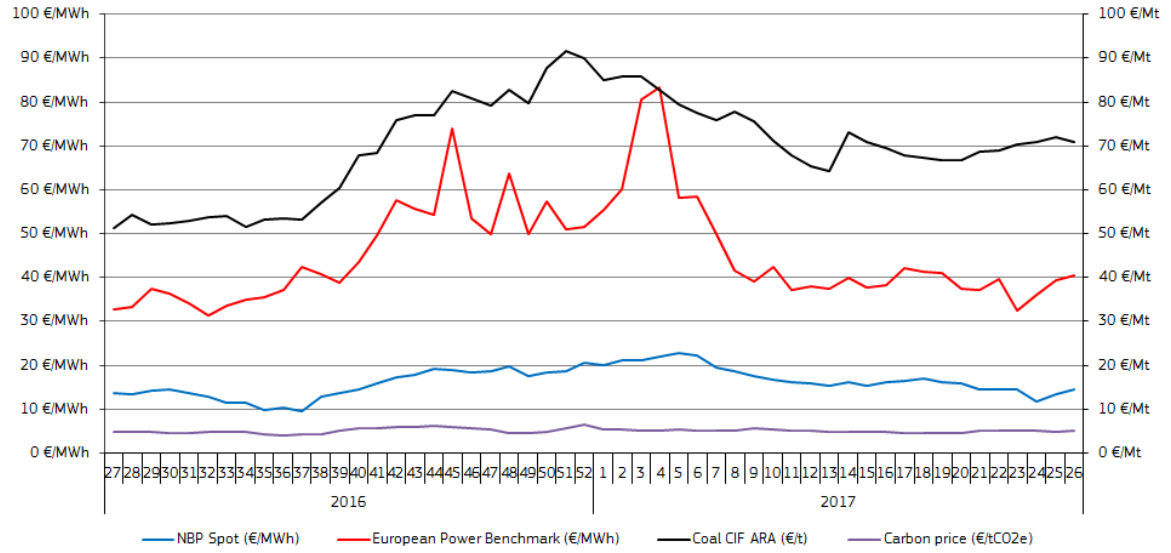
Source: JRC.
The colder is the weather, the higher is the number of HDDs

2 Evolution of commodity and power prices

2.1 Factors affecting power generation costs

- Coal prices (as represented by CIF ARA contracts, an import price benchmark widely used in North-Western Europe), as Figure 3 shows, were relatively stable during the second quarter of 2017 (week 14-26), and fluctuated in a narrow range around 70 €/Mt. The average coal price in Q2 2017 (69 €/Mt) was about 60% higher in year-on-year comparison that impacted the increase in wholesale electricity prices as well, if compared to the same period of 2016.
- Natural gas prices (represented by NBP, one of the most liquid hub prices in North-Western Europe) showed a gradual decrease in the second quartrer of 2017: The hub price[1] fell from 17 €/MWh at the beginning of April to 14 €/MWh by the end of June 2017. European emission allowance contracts remained in a very narrow range of 4-5 €/tCO2e, not exerting too much influence on the evolution of wholesale electricity prices in Q2 2017 in Europe.
- Relatively stable coal and gas prices during Q2 2017 implied that electricity generation costs were more influenced by the generation mix than the fuel costs. Therefore, wholesale electricity price evolution in Q2 2017, as Figure 3 below shows, was mostly influenced by the shift between conventional generation forms and renewables, and on the other side demand side factors, such as weather conditions.

Figure 3 – *Weekly evolution of European average wholesale power prices compared with coal and gas prices*



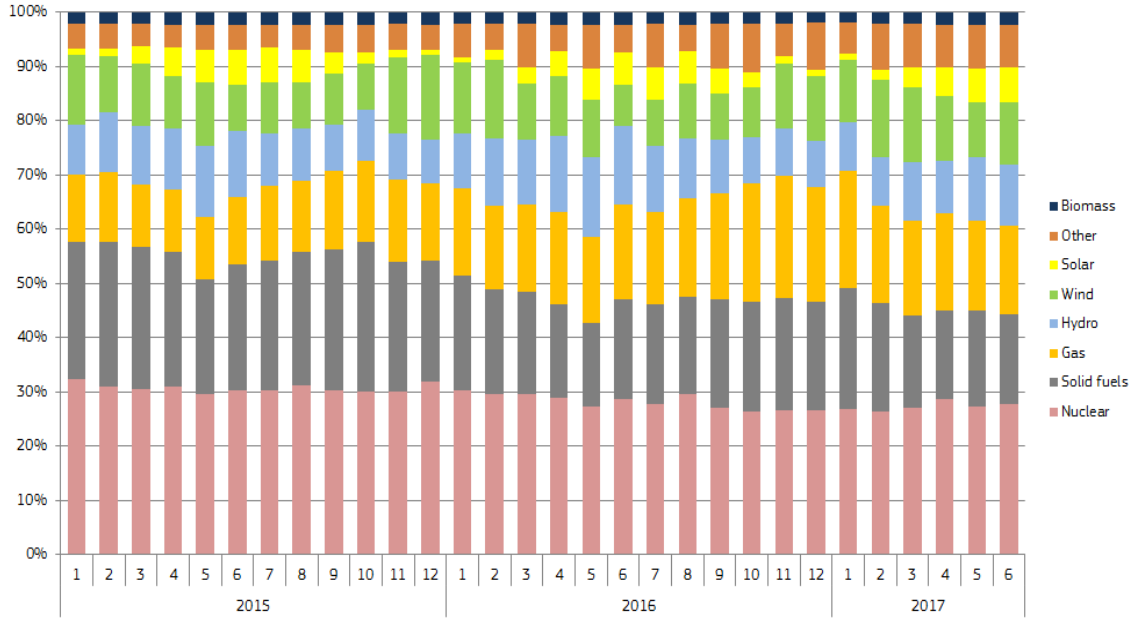
Source: Platts,
European Power Benchmark (in €/MWh) is the replacement of the Platts PEP as of January 2017, as PEP was discontinued at the end of 2016. See more detailed description in the Glossary.
Coal CIF ARA: Principal coal import price benchmark in North Western Europe (in €/Mt)
NBP spot stands for the National Balancing Point (UK) gas spot price (in €/MWh)
Carbon price: EUA emission allowance spot pirce, in €/t

- The next chart on the evolution of the electricity generation mix can in the EU-28 (Figure 4) shows that in Q2 2017 the share of conventional generation forms (fossil fuels and nuclear) slighltly receded, whereas the importance of renewables grew. The role of renewable energy sources, such as wind, solar, hydro and biomass in the electricity generation in the EU-28 can be followed on Figure 5, showing both the amount of generted power from renewables and the share of renewable sources in the electricity mix. As this chart shows, renewable generation has a strong seasonal character within the year and its share reaches the highest within the power mix during the spring-summer period. In June 2017 renewables assured around 32% of the EU-28 electricity mix.
- Although recovering from the dry winter period, hydro generation in the second quarter of 2017 was still lagging behind in year-on-year comparsion in the EU as a whole, which might be related to refilling hydro reservoirs in many countries in Europe.
- In contrast, wind generation, though following the usual decrease in the second quarter of the year after the windy winter period, was higher by 18% (12 TWh) than in Q2 2016, primarily owing to increasing installed wind

[1] For more information, see the Quarterly report on European gas markets, second quarter of 2017, Vol 10, Issue 2.

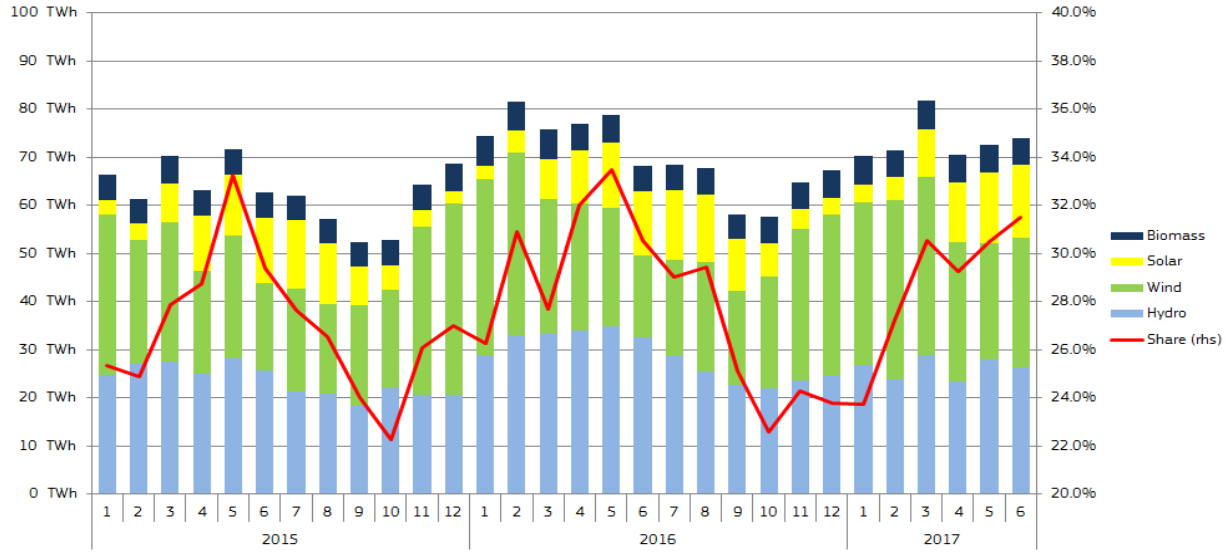
capacities across the European continent, as between Q2 2016 and Q2 2017 13 GW capacities were added to the exitsing wind power fleet in the EU. Solar power generation was also up by 11% (5 TWh) in Q2 2017 in year-on-year comparison, whereas biomass remained stable.

Figure 4 – Monthly electricity generation mix in the EU-28



Source: ENTSO-E

Figure 5 – *Monthly renewable electricity generation and the share of renewables in the electricity mix in EU-28*



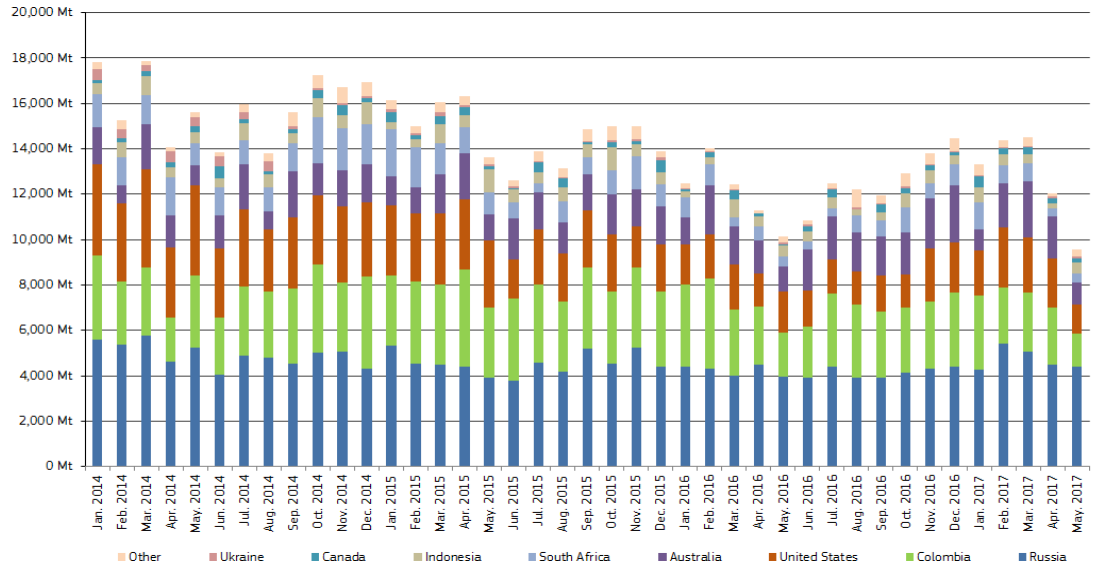
Source: ENTSO-E

- Figure 6 shows the major extra-EU coal import sources and the monthly amount of imported coal in the EU. In March-May 2017 coal imports from outside the EU reached 36,150 Mt, whereas in the same period of 2016 extra-EU imports amounted to 33,870 Mt. In year-on-year comparison this means an increase of 7%, however, compared to the same three months of 2015 coal imports decreased by 21%, and by 24% if we compare to the same period of 2014. This implies a decreasing import trend over time, and given the dwindling domestic coal production in the EU it points to the decreasing role of coal in power generation in many European countries.

- In March-May 2017 the largest chunk of extra EU coal imports came from Russia, with a share of 39% in the total, followed by Colombia 18%, the United States (16%) and Australia (15%). South Africa had a share of slightly more than 4% in the total extra-EU coal imports, while the share of Canada, Indonesia and Ukraine remained below 3% each.

- In March-May 2017 the estimated EU import bill of hard coal from extra-EU sources amounted to € 4.1 billion, while in the same period of the 2016 the extra-EU import bill was €1.95 billion, showing the impact of significantly higher coal import prices and slightly increasing coal import volumes.

Figure 6 – *The most important Extra-EU coal import sources and monthly imported quantity in the EU-28*

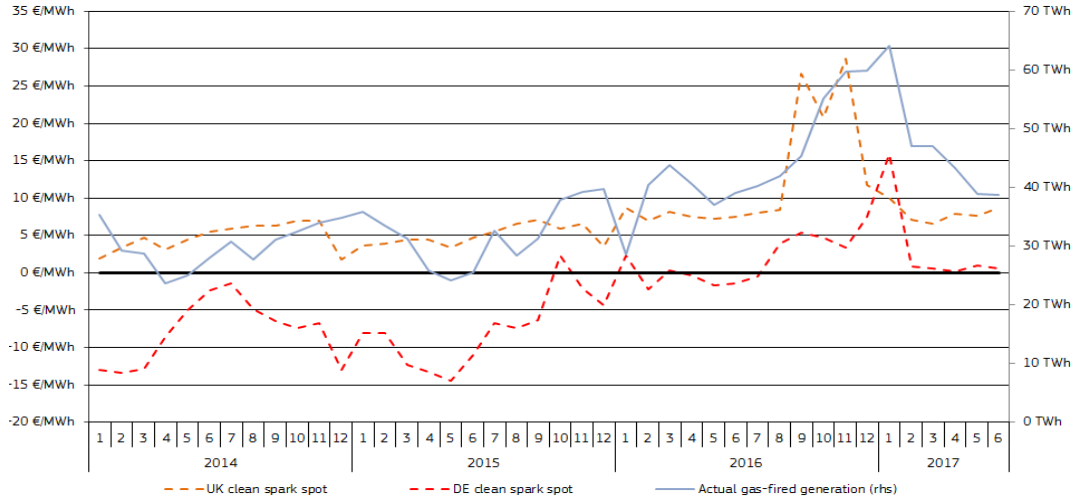


Source: Eurostat, COMEXT database

- In the second quarter of 2017, as wholesale electricity prices and natural gas prices stabilised after the volatile periods in Q1 2017, clean spark spreads[2], measuring the profitability of natural gas-fired electricity generation, became also stable (as CO_2 prices are did not show big movements either). However, the profitability of gas-firing (reflecting the variable costs of power generation from gas) decreased and clean spark spreads fell to zero in Germany and remained in a range of 5-10 €/MWh in the UK during Q2 2010, as Figure 7 shows. Higher wholesale electricity prices in the UK resulted in higher profitability of gas-fired generation compared to the continent. Most of the continental European markets might have faced clean spark spreads being similar to the German metric.
- In parallel with decreasing profitablity, the amount of electircity generated from gas fall to 40 TWh in June 2017, which is a significant drop compared to 65 TWh measured in January 2017 in the EU as a whole.
- Clean dark spreads, measuring the profitability (through reflecting the variable costs) of coal-fired generation fell deeply in the negative range during the second quarter of 2017 in the UK, showing the impact of decreasing electricity prices and the climate change levy, which latter significantly increased the costs of coal-fired generation in comparison to other sources, as Figure 8 shows. In Germany clean dark spreads were also below zero in Q2 2017, however, coal-firing was still facing better profitability prospects in continental Europe than in the UK.
- The monthly coal consumption in electricity generation in the EU-28 also fell significantly in the first half of 2017 (from 37 TWh to 17 TWh between Janaury and June 2017), following the annual seasonality and decreasing profitability of coal.

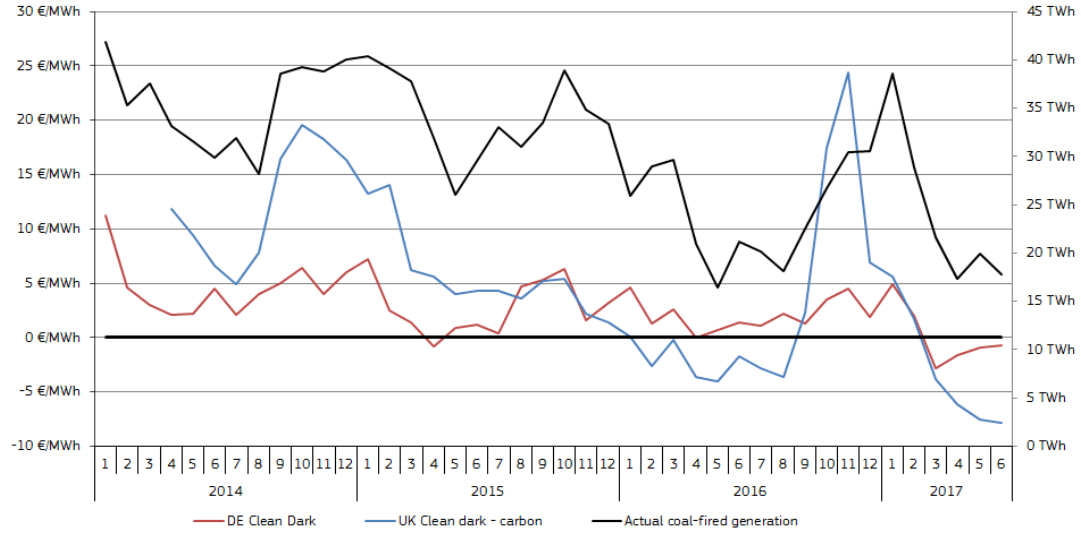
[2] For more technical details on spreads please see the Glossary in Chapter 7

Figure 7 – Evolution of *clean spark sreads in the UK and Germany, and electricity generation from natural gas in the EU*



Source: Platts and ENTSO-E Data are not available for Malta

Figure 8 - Evolution of *clean dark sreads in the UK and Germany, and electricity generation from coal in the EU*



Source: Platts and ENTSO-E Data are not available for Malta

2.2 Comparisons of wholesale electricity prices across European markets

- As the next map (Figure 9) shows, there were significant price differences in the wholesale electricity prices across the EU. More details on the drivers behind price changes in each market can be found in Chapter 4.

- The highest quarterly average wholesale electricity prices in the EU could be observed in Q2 2017 in Spain, Portugal, Greece and the UK (all of them around 47 €/MWh). At he same time the lowest quarterly wholesale averages could be found in Denmark and Sweden (both 29 €/MWh). Norway, being not an EU Member State, faced the lowest price in whole Europe in Q2 2017 (27 €/MWh on quarterly average), whereas the average price in Switzerland (33 €/MWh) was close to most of the prices in Central and Western European markets.

- In the second quarter of 2017 wholesale baseload electricity prices reached 37 €/MWh (European Power Benchmark) on average in Europe, which was 19% higher in year-on-year comparison. Comparing with Q2 2016, in the second quarter of 2017 prices increased by the most in Portugal (63%) and Spain (60%), whereas the biggest price decrease could be observed in Poland (11%).

Figure 9 – *Comparison of average wholesale baseload electricity prices, second quarter of 2017*

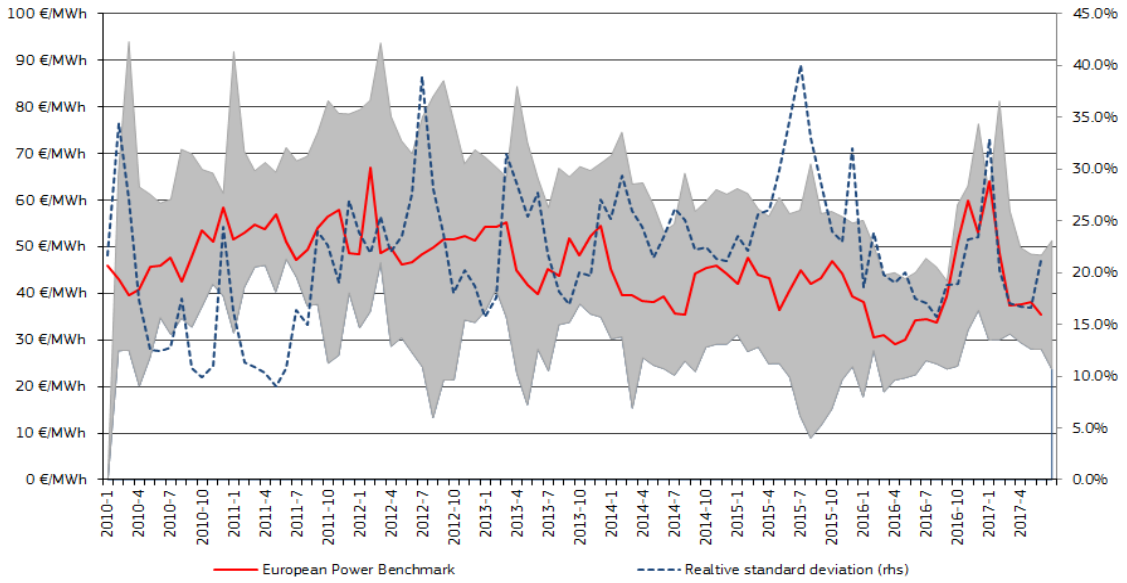
Source: European wholesale power exchanges

- As it was mentioned before in Q2 2017 the highest wholesale electricity prices could be observed in the Southern European markets (Spain, Portugal, Italy and Greece) and in the UK, whereas in the Nordpoolspot[3] market prices were the lowest in European comparison.

- Regional prices in Central Western Europe[4] (CWE), Central Eastern Europe[5] (CEE) were during most of the time in Q2 2017 between these two value ranges, as Figure 10 shows, and below the European Power Benchmark (EPB) as well.

- Both the shaded area with minimum-maximum differentials and the relative standard deviation metric show that after the volatility experienced in Q1 2017, in the second quarter of the year wholesale electricity prices re-converged across the European markets, however, in June 2017 there were some temporary divergence again.

Figure 10 - *The evolution of the lowest and the highest regional wholesale electricity prices in the EU and the relative standard deviation of the regional prices*



Source: Platts, European power exchanges – As of January 2017 Platts PEP has been replaced by a calculated EU average (European Power Benchmark)

3 Traded volumes, market liquidity and cross border trade of electricity

3.1 Comparison of wholesale market trading platforms and the over-the-counter (OTC) markets

- Figure 11 shows the monthly evolution of electricity traded volumes, including exchange executed trade and over the counter (OTC) market trade on the most liquid European hubs. Over the last few years, the highest trade volumes could be observed on the German market, followed by the Nordic markets, the UK and France. Traded volume of electricity shows a high degree of seasonality, following the higher consumption during winter periods.

- Figure 12 shows the comparison of volumes in different market segments in electricity trading on the most liquid electricity trading platforms in the EU. In order to show the significance of spot and forward traded volumes on organised trading platforms, as well as bilateral trade and cleared trade on the so-called over-the-counter (OTC) markets, two different columns represent on the chart the two types of electricity trade in each market.

- In year-on-year comparison the combined traded volume (exchange executed trade and OTC together) decreased in the second quarter of 2017 on the observed European markets by 21% (750 TWh), whereas the decrease was 12.5% (397 TWh), if compared to the previous quarter. With the exception of Central Eastern Europe (CEE), where traded volume of electricity increased by 29% (32 TWh) in year-on year comparison, all other observed markets

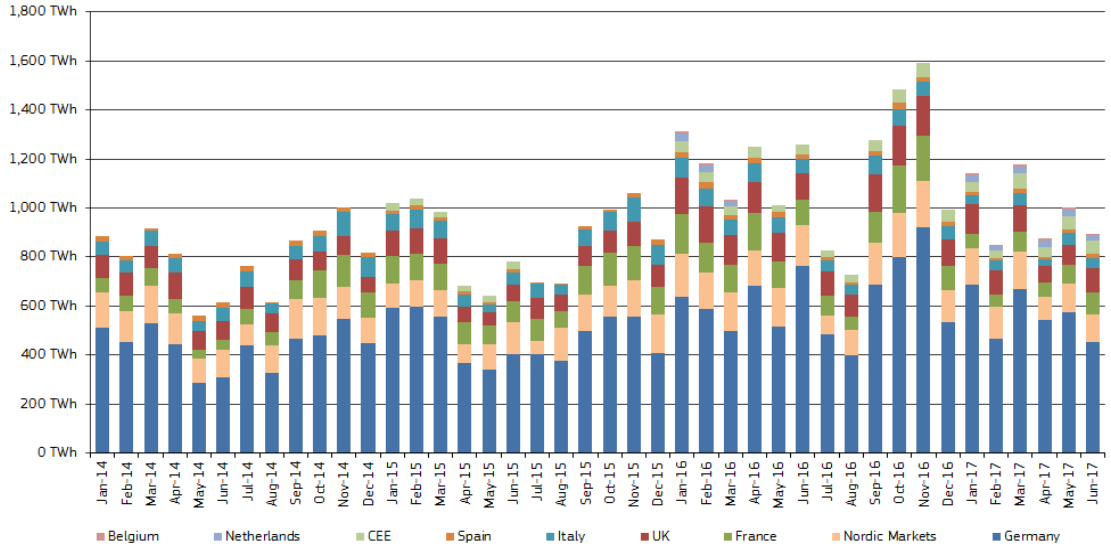
[3] Nordpoolspot includes Denmark, Estonia, Finland, Latvia, Lithuania, Norway and Sweden
[4] Central Western Europe includes Austria, Belgium, France, Germany, the Netherlands and Switzerland
[5] Central Eastern Europe includes Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia

underwent decreases of 20-40% in electricity traded volumes. Decreasing traded volumes might have been related to flat wholesale electricity prices on the markets, as low price volatility did not raise the need for trading strategies aiming at hedging future price developments.

- Traded volume of electricity decreased in all market segments in Q2 2017 in year-on-year comparison: the OTC bilateral traded volume decreased by 13%, the OTC brokered cleared volume by 33% and the exchange executed volume by 27% on the observed European markets. About three quarters of total electricity trade was carried out on the OTC markets in Q2 2017, whereas the share of exchange executed trade decreased from 28% to 25% in year-on-year comparison.

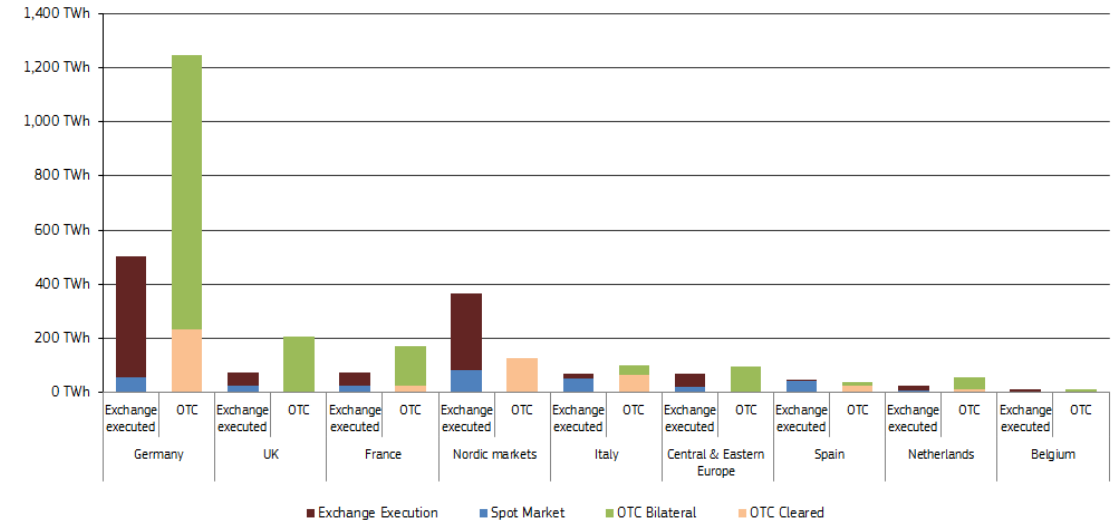
- Market liquidity can be measured by the so-called churn rates, providing information on the ratio of the total volume of power trade (including exchange executed and OTC markets) and electricity consumption in a given time period. Figure 13 shows the evolution of the quarterly regional churn rates between the beginning of 2014 until the first quarter of 2017.The decreasing volume in electricity trade also impacted the churn rates, as in Q1 2017 most of the observed markets had lower churn rates compared to first quarter of 2016. Although in Germany the churn rate increased from 13.9 to 14.3 and in the CEE region it went up slightly, from 1.6 to 1.8, in the UK it dropped from 4.6 to 4.0 and in France it was down from 2.8 to 1.4.

Figure 11 – Monthly traded volume of electricity (incl. exchange executed and OTC) on the most liquid European markets



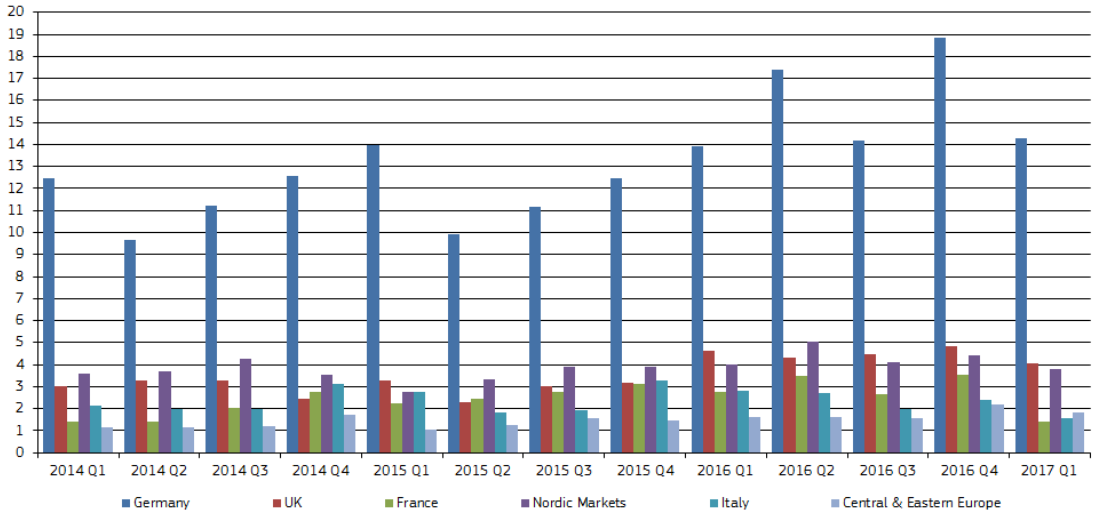
Source: Platts, wholesale power markets, Trayport, London Energy Brokers Association (LEBA) and DG ENER computations

Figure 12 - *Comparison of electricity traded volumes in some important day-ahead, forward and OTC markets, first quarter of 2017*



Source: Platts, wholesale power markets, Trayport, London Energy Brokers Association (LEBA) and DG ENER computations

Figure 13 *Quarterly churn rates on selected European wholesale electricity markets*

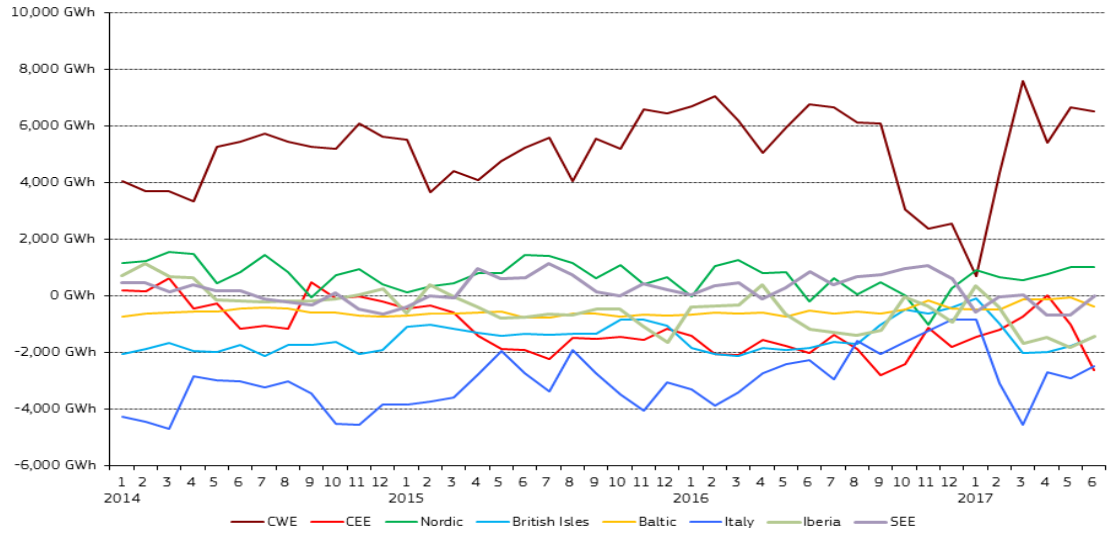


Source: Trayport, London Energy Brokers Association (LEBA), ENTSO-E and DG ENER computations

3.2 Cross-border trade of electricity

- As Figure 14 shows, in the second quarter of 2017 the Central Western Europe (CWE) power region regained its strong net electricity exporter position after the high-priced first quarter period of the year, and it exported an amount of 6.2 TWh electricity on monthly average. During the three months of Q2 2017 electricity exports to the Central Eastern Europe (CEE) region picked up, relating to the CEE wholesale electricity price premium to CWE markets.
- The Nordic region was in a slight net exporter position; however, given the similar price level in Germany and the Scandinavian countries, it could not significantly increase its exports to Central Europe.
- In Italy net imports followed the usual annual seasonal pattern and decreased in Q2 2017 compared to the winter period, as the share domestic power generation increased (in parallel with the recovery in renewable generation during the spring months) in the total consumption.

Figure 14 - *EU cross border monthly physical flows by region*



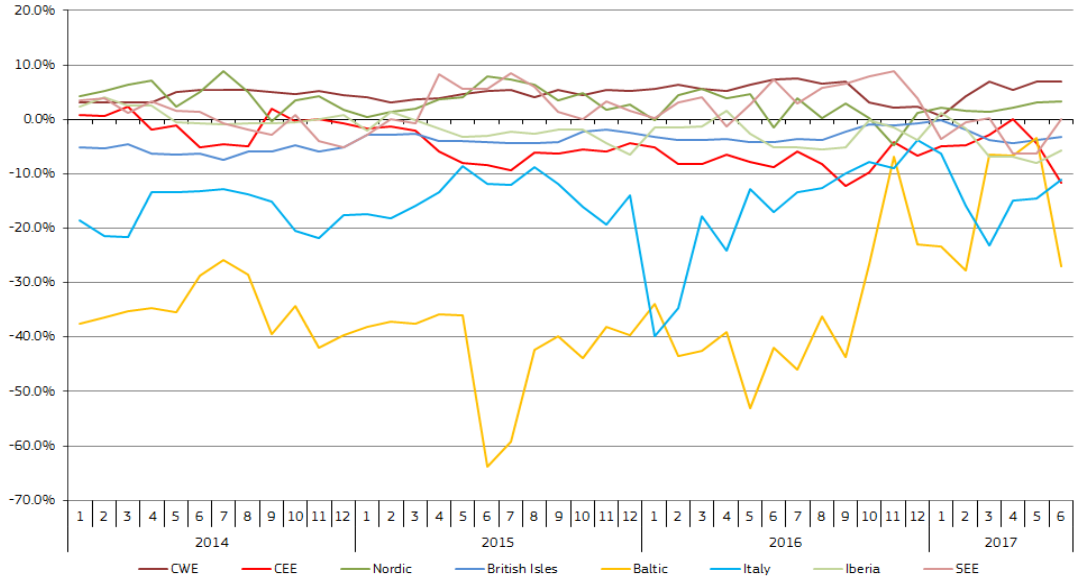
Source: ENTSO-E

European countries are grouped in the following regions:

Central Western Europe	*DE, NL, FR, LU, BE, AT, CH*	*Nordic*	*SE, FI, DK, NO*
Central Eastern Europe	*PL, CZ, HU, SK, HR, SI*	*British Isles*	*UK, IE*
Iberian-Peninsula	*ES, PT*	*Apennine Peninsula*	*IT*
South Eastern Europe	*RO, BG, GR, RS, BA, ME, FYROM, AL*	*Baltic*	*EE, LT, LV*

- Figure 15 shows the ratio of net electricity flow position to the domestic electricity generation in each region. The share of imports compared to domestic generation increased between April and June 2017 in the Baltic-states and the CEE region, as domestic energy consumption picked up in this period and increasing local wholesale market prices resulted in competitive electricity import opportunities to these regions. In contrast, the share of imports compared to the total domestic generation decreased in Italy due to the aforementioned reasons. The Baltic-states and Italy remained thus the two most unbalanced electricity regions in Europe. In all other regions the net electricity position (import or export) fluctuated in a narrow range of 10% of the total domestic generation in the second quarter of 2017.

Figure 15 – *The ratio of the net electricity exporter position and the domestic generation in the regions*



Source: ENTSO-E, own computations

4 Regional wholesale electricity markets

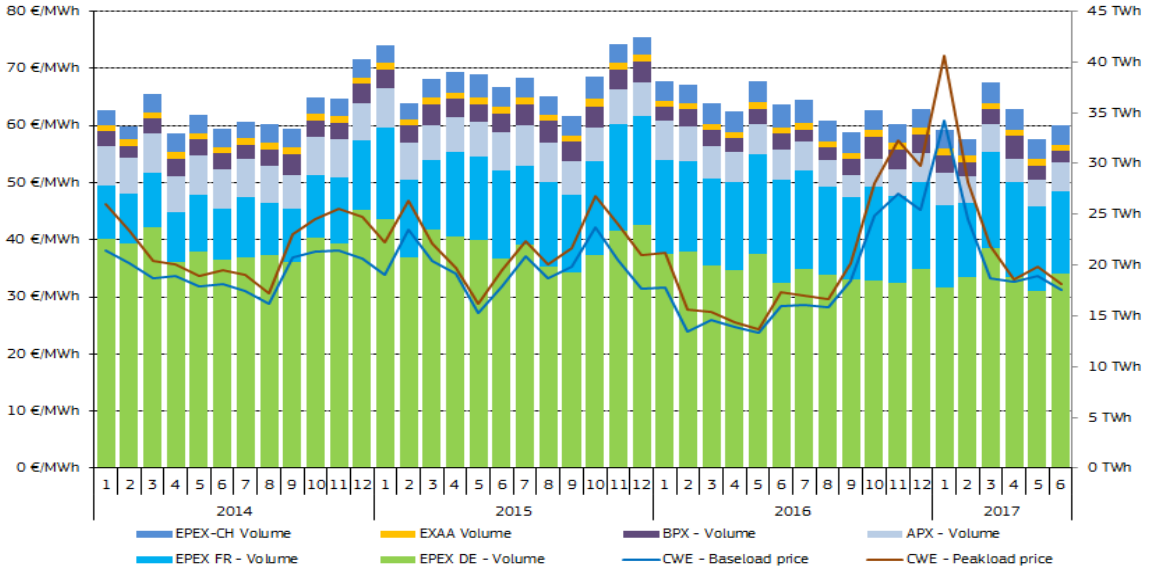
4.1 Central Western Europe (Austria, Belgium, France, Germany, the Netherlands, Switzerland)

- In the second quarter of 2017 wholesale baseload electricity prices in the CWE region showed relative stability, and fluctuated in a narrow range of 31-34 €/MWh on monthly average. At the same time the regional average monthly peakload price was between 32-35 €/MWh during Q2 2017, as Figure 16 shows. The daily average regional day-ahead price varied between 25 €/MWh and 38 €/MWh during the quarter, however, the quarterly peak on the Belgian market reached 58 €/MWh, whereas in Germany in mid-April the daily average price fell to as low as 11 €/MWh (on some Sundays – e.g.: on 16 and 23 of April 2017 even negative prices could be observed during several hours).
- Figure 17 shows the weekly average baseload contracts remained well-aligned during most of Q2 2017, however, during high renewable generation periods German prices were below the other peers in the region, while owing to low nuclear availability prices in Belgium had measurable premium to the other regional markets in some shorter periods.
- On the demand side of the market lower than usual temperatures between mid-April and mid-May 2017 resulted in higher wholesale electricity prices in countries like France, where domestic demand for electriciy largely depends on temperatures. On the other hand, in the second half of June 2017 there were several trading days when temperatures were 5-10 Celsius degrees above the long term daily averages, resulting in increasing domestic cooling needs that lifted wholesale electricity prices in most of the CWE region.
- On the supply side of the market, both coal and gas prices remained practically flat over the second quarter of 2017 or even showed some declines, and this reuslted in less influence on the regional wholesale electricity price levels than in the previous two quarters. However, other factors, such as the twenty-year low hydro reservoir levels

in France and Switzerland at the beginning of Q2 2017, which started to slowly recover afterwards, put an upward pressure on the regional wholesale electricity price level.

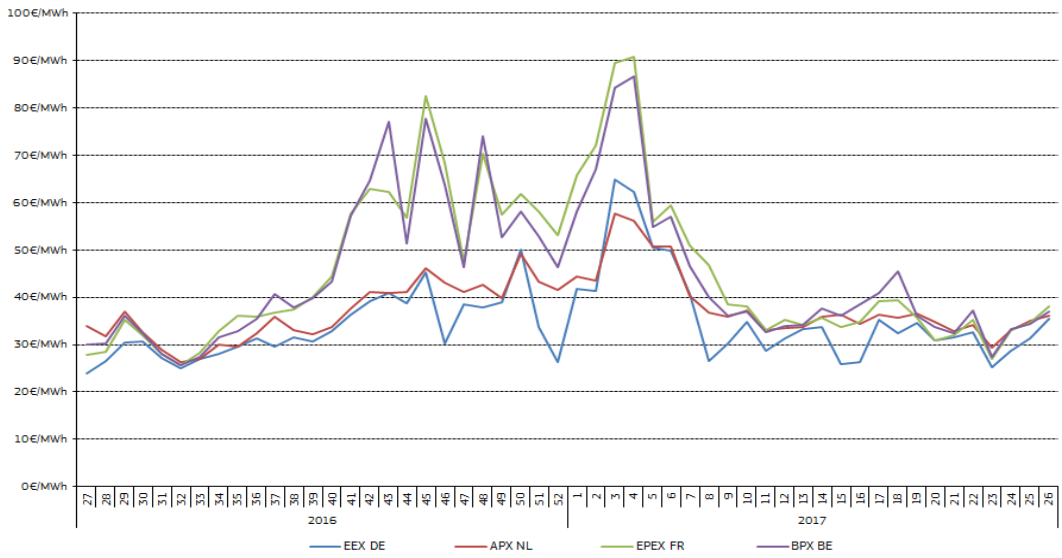
- Moreorver, nuclear availability and generation in both Germany and France (see Figure 18) was lower than in the previous two years during most of Q2 2017. In April some planned maintenance works redeuced nuclear plant avilability in both countries, however, as of May 2017 French nuclear generation was up by 2.5% in year-on-year comparison, and in Germany the Philippsbug-2 reactor returned to the grid. In June 2017 nuclear availability in Germany was still lower than usual (the Brokdorf nuclear power plant, having 1.4 GW nameplate capaicty, was still waiting for permission from the authorities to return to the grid), and in France nuclear generation decreased again in year-on-year comparison. Lower than usual hydro and nuclear availablity across the CWE region resulted in higher coal and gas fired electricity generation, having an upward impact on the regional wholesale electricity price.
- Solar power generation reached all-time monthly high in Germany in June 2017, amounting to 5.4 TWh and assuring 13% of the country's electricity production. In France solar power generation also rose to the highest in the last ten years (1.1 TWh). Wind power generation in Germany was up by 25% in April 2017 in year-on year comparison; in May it decreased significantly but in June it picked up again and made stong gains compared with the same month of 2016, resulting in cheap wholesale electricity prices in the country.

Figure 16 – *Monthly exchange traded volumes of day-ahead contracts and monthly average prices in Central Western Europe*



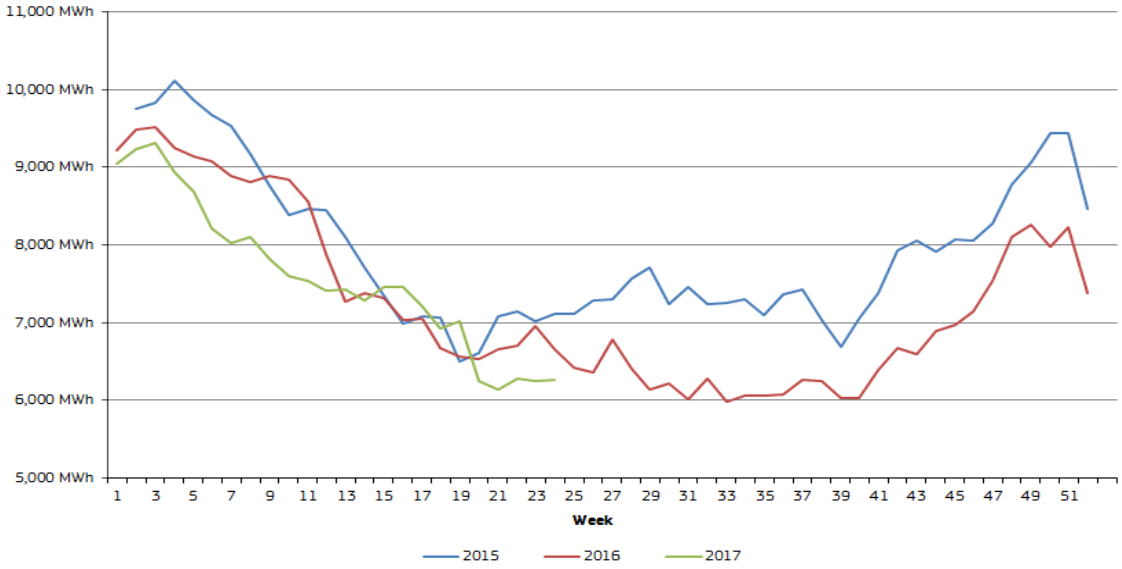
Source: Platts, EPEX

Figure 17 – *Daily average wholesale power prices in the CWE region*



Source: Platts.

Figure 18 – *The weekly amount of generated nuclear electricity in France*

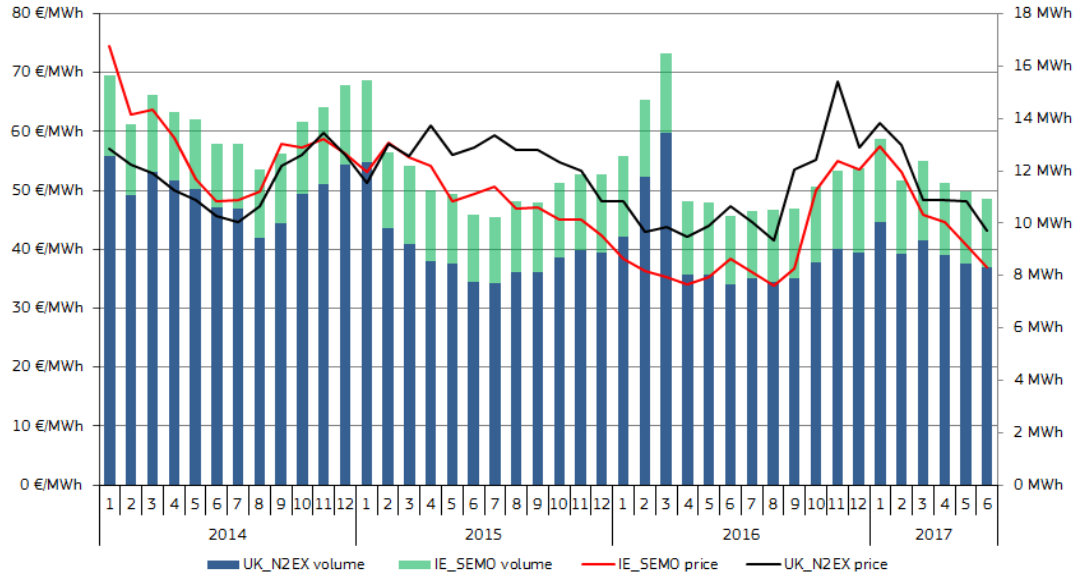


Source: ENTSO-E

4.2 British Isles (UK, Ireland)

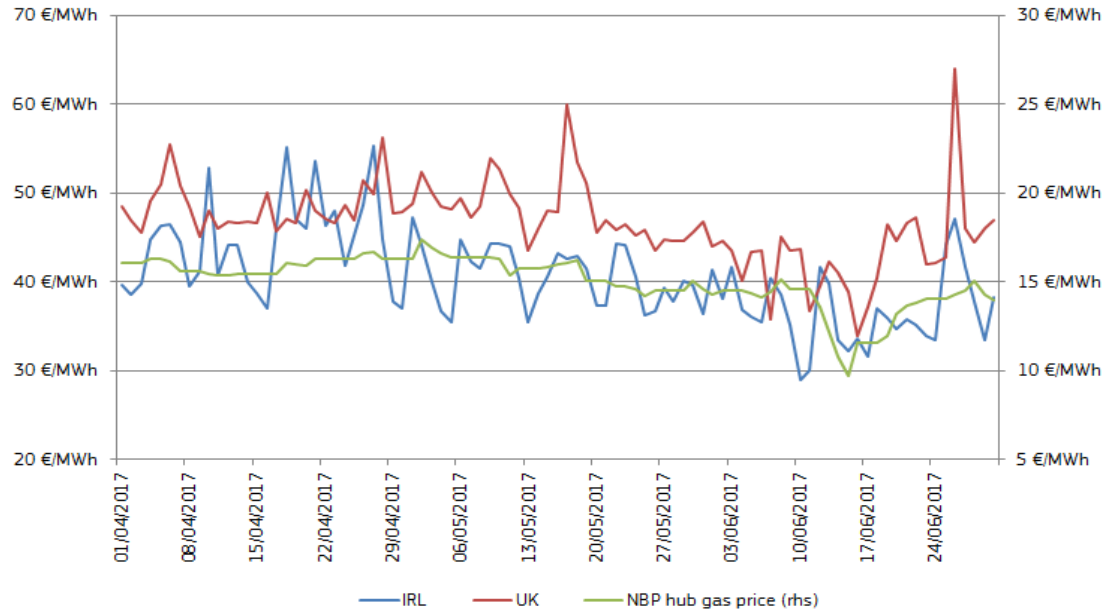
- Wholesale baseload electricity prices both in the UK and Ireland continued their downward trend in the second quarter of the year: while in March 2017 the monthly average baseload price was 48 €/MWh in the UK and 46 €/MWh in Ireland, in June it respectively fell to 43 €/MWh and 37 €/MWh, as Figure 19 shows.
- During most of Q2 2017 (see Figure 20), daily average wholesale electricity prices in the UK and Irish markets moved in parallel with decreasing natural gas prices after the end of the heating season. At the beginning of the second quarter of 2017 the price of natural gas on the NBP hub in the UK was above 15 €/MWh, while in mid-June it dropped below 10 €/MWh.
- However, it is worth noting that the natural gas price itself has been more and more influenced by decreasing demand for gas in power generation, as the increasing share of solar and wind in the UK electricity mix squeezed out gas in many periods in Q2 2017. In May and June 2017 solar power generation reached the highest (2.7 TWh) since the beginning of available data series (2010), assuring about 6-7% of the monthly electricity generation in the country. Wind power generation in the UK also picked up in May-June 2017, having a share of 12-15% of the electricity mix. In Ireland the amount of electricity generated from wind amounted to 1.1 TWh in June 2017, representing 29% of the monthly generation mix.
- Increasing share of variable renewable sources in domestic generation necessitates sufficient availability of electricity interconnectors with neighbouring countries. On 17 May and 26 June 2017 there were two price spikes on the UK wholesale electricity market, lifting the day-ahead averages above 60 €/MWh. In both cases the anticipation of receding wind and solar generation coincided with reduction of the available interconnection capacities with France and the Netherlands, resulting in tight supply margins.
- Figure 21 shows the weekly evolution of the electricity generation mix in the UK in the second half of 2016 and in the first half of 2017. The combined share of gas and coal-fired generation in the UK electricity mix fell to 43% in June 2017, being the lowest since the beginning of available data series. On quarterly average, in Q2 2017 coal assured only 2% of total electricity generation in the UK.
- Moreover, on 21 April 2017, for the first time in more than a century, electricity generation from coal dropped to zero in the UK, reflecting the highly unprofitable nature of coal-fired generation in the country, owing to high coal prices and the significant carbon tax, which penalises generation sources with high carbon emission. The profitability of natural gas-fired generation also turned into negative in the country, resulting in decreasing share of gas in the electricity mix (See Figure 7 and Figure 8)

Figure 19 – *Monthly electricity exchange traded volumes and average day-ahead wholesale baseload prices in the UK and Ireland*



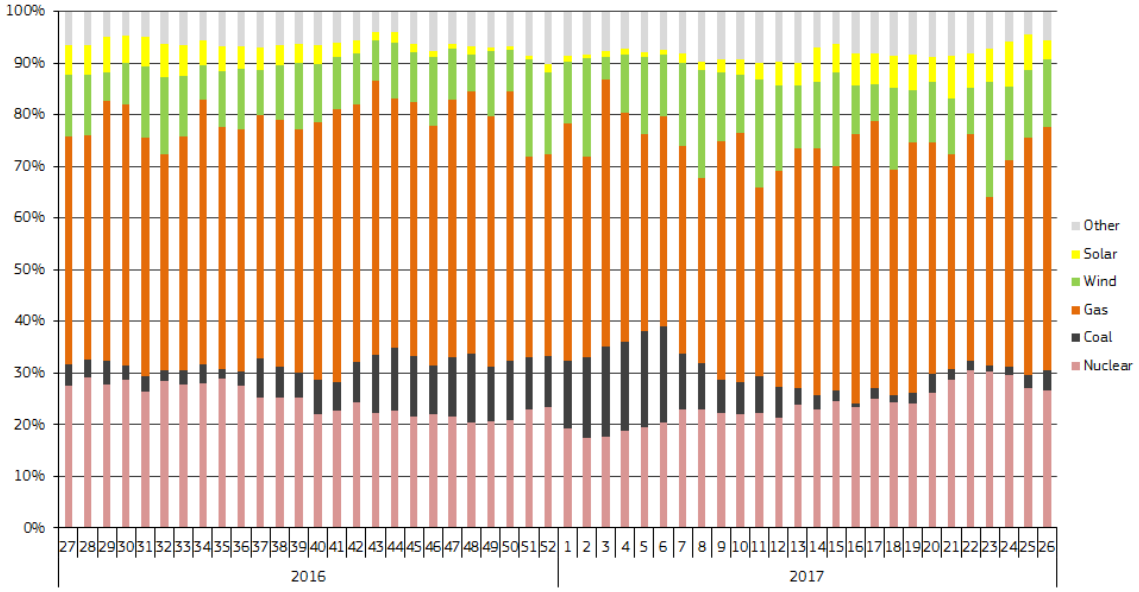
Source: Nordpool N2EX, SEMO

Figure 20 – *Daily average baseload electricity prices in the UK and Ireland*



Source: Nordpool N2EX SEMO

Figure 21 – *Weekly evolution of the electricity generation mix in the UK*

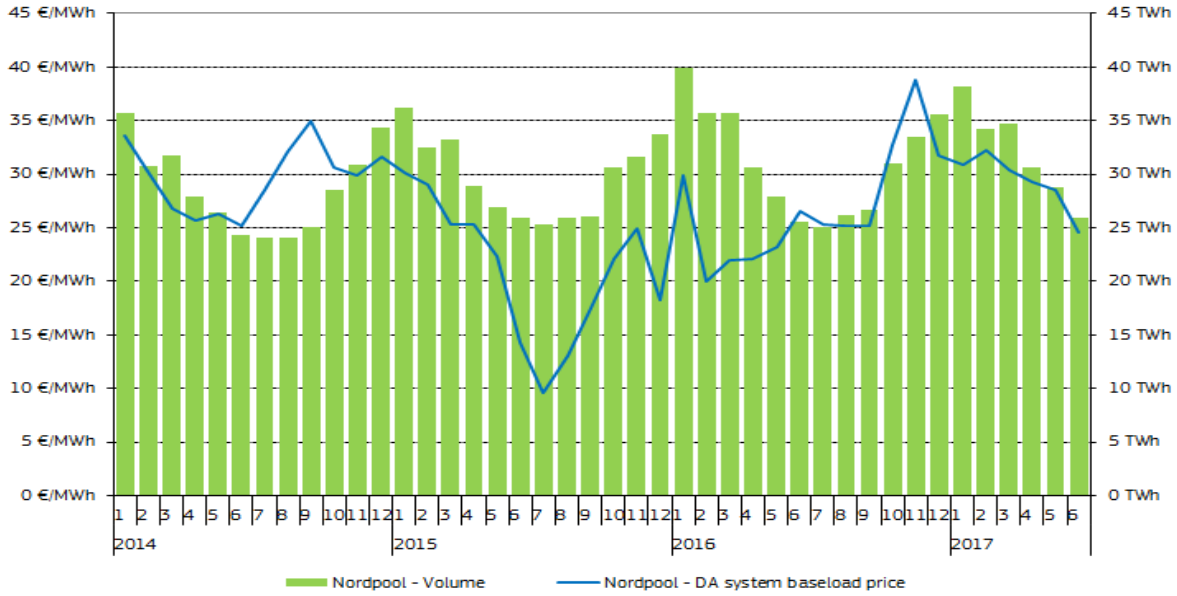


Source: ENTSO-E

4.3 Northern Europe (Denmark, Estonia, Finland, Latvia, Lithuania, Norway, Sweden)

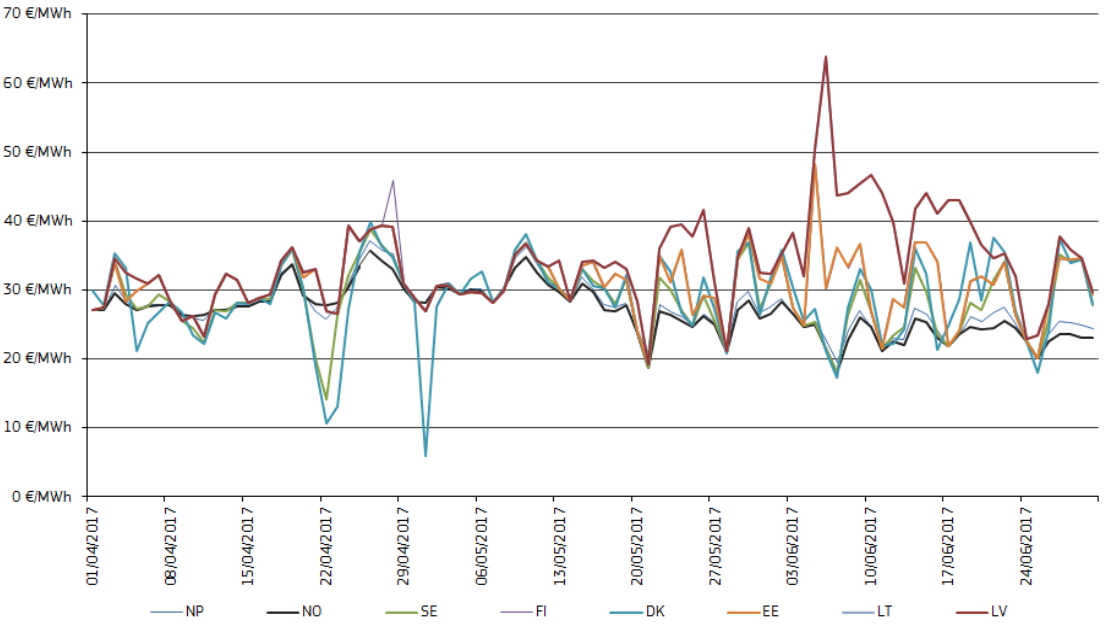
- As Figure 22 shows, in the second quarter of 2017 the monthly average wholesale system electricity price in the Nordpoolspot market slightly decreased (from 29 €/MWh to 25 €/MWh between March and June 2017). The monthly average of June 2017 corresponded to the usual values of the same month of the previous two-three years.
- In April and May 2017 different market wholesale prices in the region were well-aligned to each other (see Figure 23), however, in some high wind generation periods, especially during weekends or holidays (e.g.: 1 May 2017), Danish wholesale electricity prices showed significant drops.
- However, from the second half of May until the of Q2 2017 local market prices in Latvia and Lithuania showed significant premium to the Nordpoolspot system price, which might have been related to the structural net electricity import position of the these countries and limited import opportunities during warm summer periods with tighter supply margins in the neighbouring Poland.
- Hydro availability in the Nordic region in the second quarter of 2017, as it can be followed on Figure 24, started to improve at the beginning of May 2017, after being lower in the previous quarter and in April 2017 as well than in the same period of the preceding two-three years. As result, by the end of Q2 2017 the combined hydro reservoir level in Norway, Sweden and Finland managed to reach the average seasonal level. Improving hydro generation also contributed to decreasing system prices.

Figure 22 - *Monthly electricity exchange traded volumes of and the average day-ahead wholesale prices in Northern Europe*



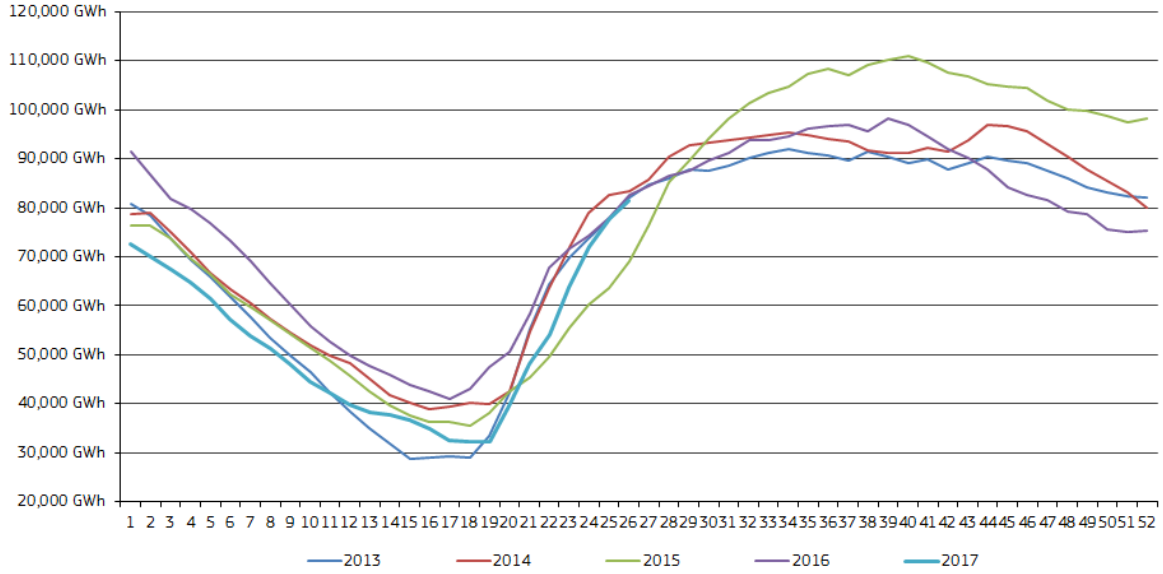
Source: Nordpool spot market

Figure 23 – *Daily average market prices in the Nordic region*



Source: Nordpool spot market

Figure 24 –*Weekly combined hydro reservoir levels (Norway, Sweden and Finland) in the Nordic region in different years*

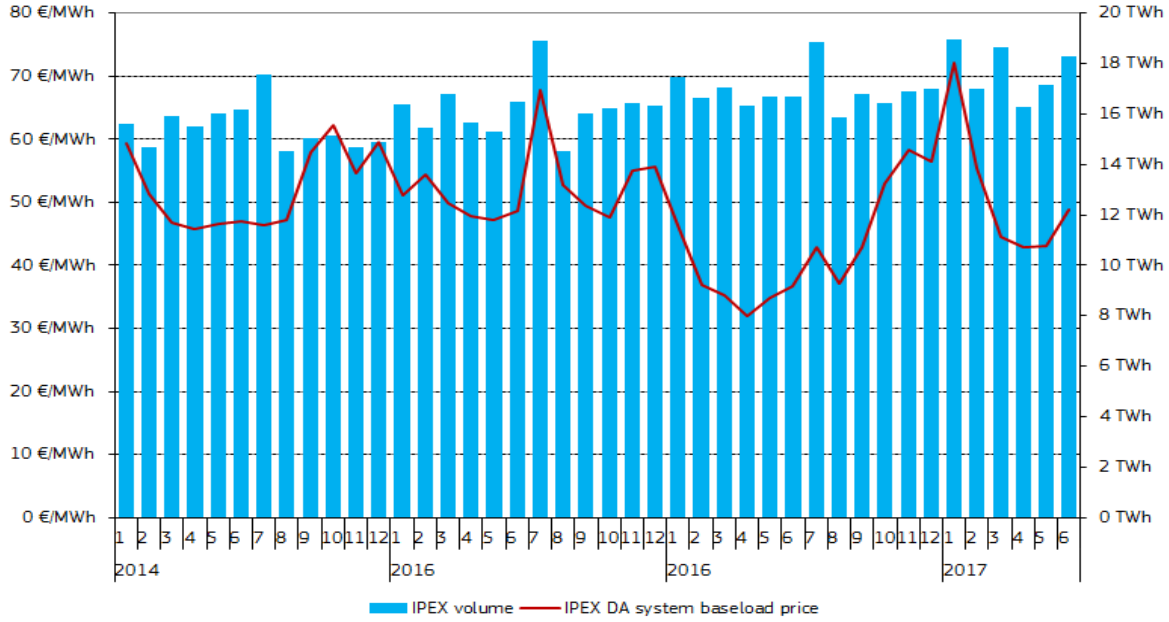


Source: Nordpool spot market

4.4 Apennine Peninsula (Italy)

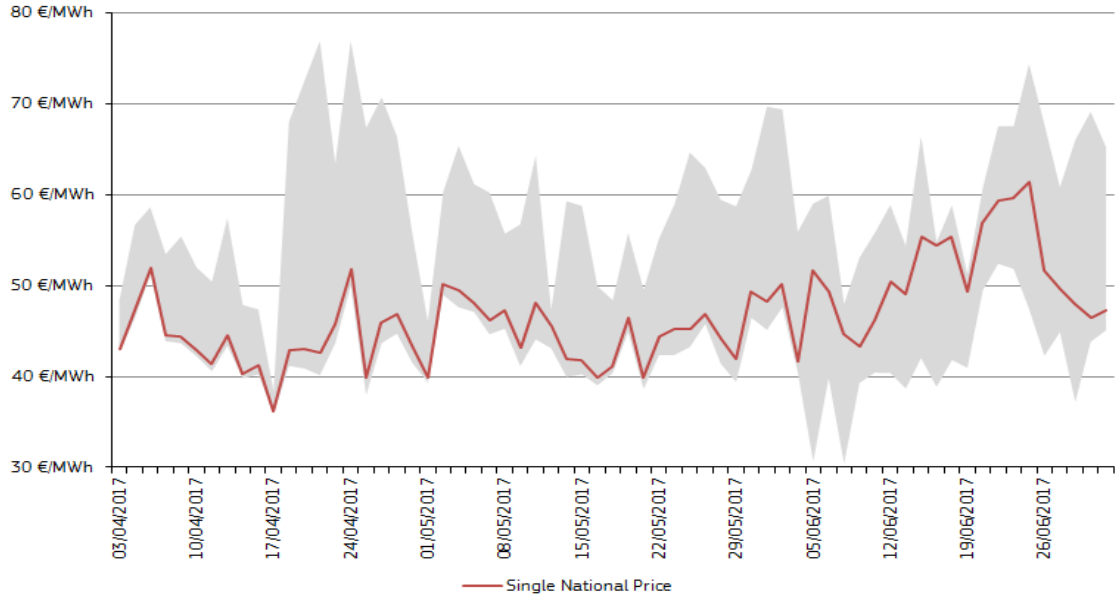
- The Italian wholesale baseload electricity price, as Figure 25 shows, underwent a gradual increase in the second quarter of 2017. On monthly average it reached 43 €/MWh in April 2017, while in June it rose to 49 €/MWh.
- Looking at the daily average single national wholesale price on Figure 26, it showed stability between the beginning of April and mid-May 2017, fluctuating in a range of 40-50 €/MWh, and afterwards it started to increase and in the second half of June 2017 it was close to 60 €/MWh. At the same time electricity area prices within Italy showed high volatility in some periods, and in areas like Sicily or Sardinia high prices could be observed, relating to the availability of interconnection capacities with the mainland and local generation plant availability.
- On the demand side daily average temperatures in May and June 2017 were higher than the long term daily averages during most of the time, resulting in an increase in domestic needs for cooling, which also exerted an upward pressure on wholesale electricity market prices.
- Regarding the changes in the electricity mix, the amount of power generated from solar was slightly higher during the months of the second quarter of 2017 than in Q2 2016. However, generation from hydro sources and generation from wind were lower in Q2 2017 than in the same quarter of the previous year. Consequently, the share of fossil fuels, mainly natural gas, was higher and this shift towards gas resulted in increasing generation costs and higher wholesale electricity prices in Italy.
- Besides increasing gas-fired generation, imports from Central West European countries also picked up in Q2 2017 (the total net electricity imports amounted to 8.1 TWh in this period as opposed to 7.4 TWh in Q2 2016), as higher prices in the Italian market provided for good electricity export opportunities to Italy.

Figure 25 – *Monthly electricity exchange traded volumes and average day-ahead wholesale prices in Italy*



Source: GME (IPEX)

Figure 26 – *Daily average wholesale electricity prices in the Italian market, within the range of different area prices*



Source: GME (IPEX)

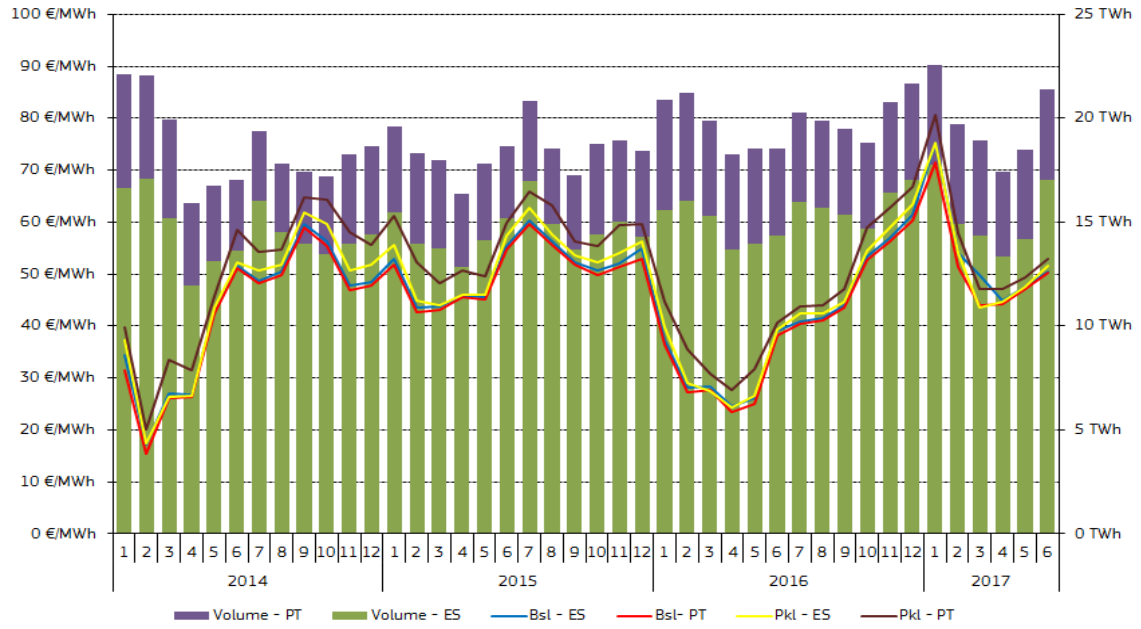
4.5 Iberian Peninsula (Spain and Portugal)

- In the second quarter of 2017 the monthly average wholesale baseload contracts in Spain and Portugal showed a moderate increase: Between April and June 2017 the monthly average price in Spain rose from 45 €/MWh 51 €/MWh, while at the same time in Portugal it went up from 44 €/MWh to 50 €/MWh – see Figure 27. Looking at the daily average prices on Figure 28, the well-aligned Spanish and Portuguese day-ahead contracts showed a steady increase throughout Q2 2017, increasing from around 40 €/MWh to 55 €/MWh between the beginning and the end of the quarter.
- Warmer than usual temperatures in May-June 2017 in both Spain and Portugal, which resulted in increasing residential cooling needs, could be one important factor behind the steady increase in wholesale prices. In these

two months there were several trading days when local temperatures were 5-10 Celsius degrees above the long-term daily averages.

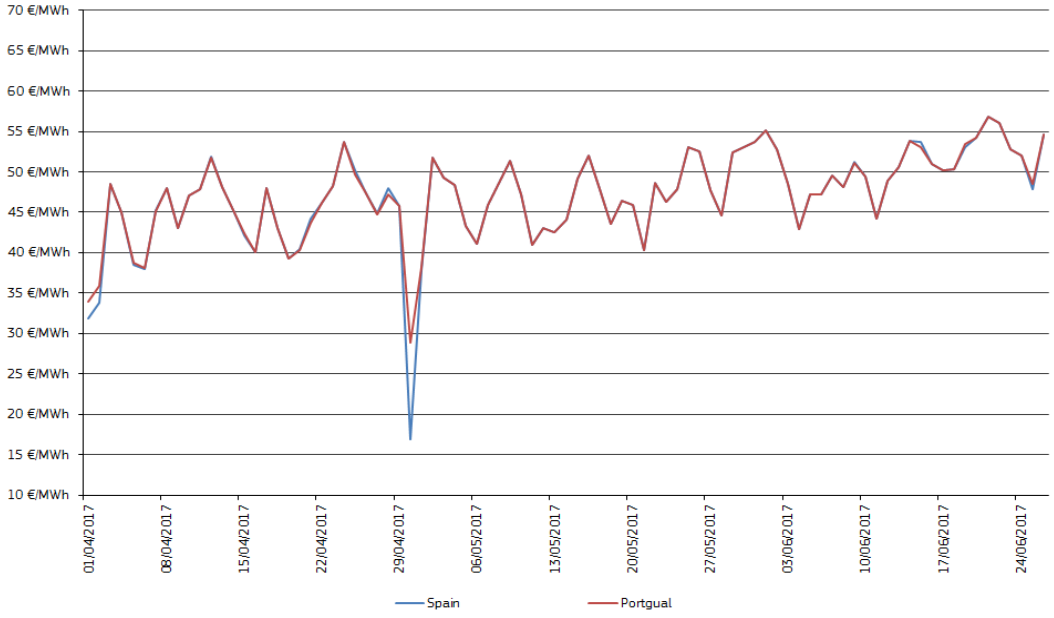
- As Figure 29 shows, during the second quarter 2017 the share of hydro, wind and nuclear generation decreased in the Spanish electricity mix: Between April and June 2017 the share of these sources in the monthly generation respectively went down from 12% to 8%, from 23% to 16% and from 28% to 20%. At the same time the share of coal went up from 11% to 21% and that of natural gas from 17% to 25%, resulting in a shift from cheaper power generation sources to costlier ones, giving a support to higher wholesale electricity market prices.
- The decrease in the share of nuclear in the Spanish power generation mix was the result of usual plant maintenance works during Q2 2017, with delayed return in case of some plants (e.g.: Asco-I). Hydro reservoir levels were lower than the ten-year average during the whole quarter and hydro output was 60% lower on average than in Q2 2016. In June 2017 net electricity imports from France also decreased, adding to the upward pressure on the wholesale electricity prices in the Iberian markets.

Figure 27 – *Monthly electricity exchange traded volumes and average day-ahead prices in the Iberian Peninsula*



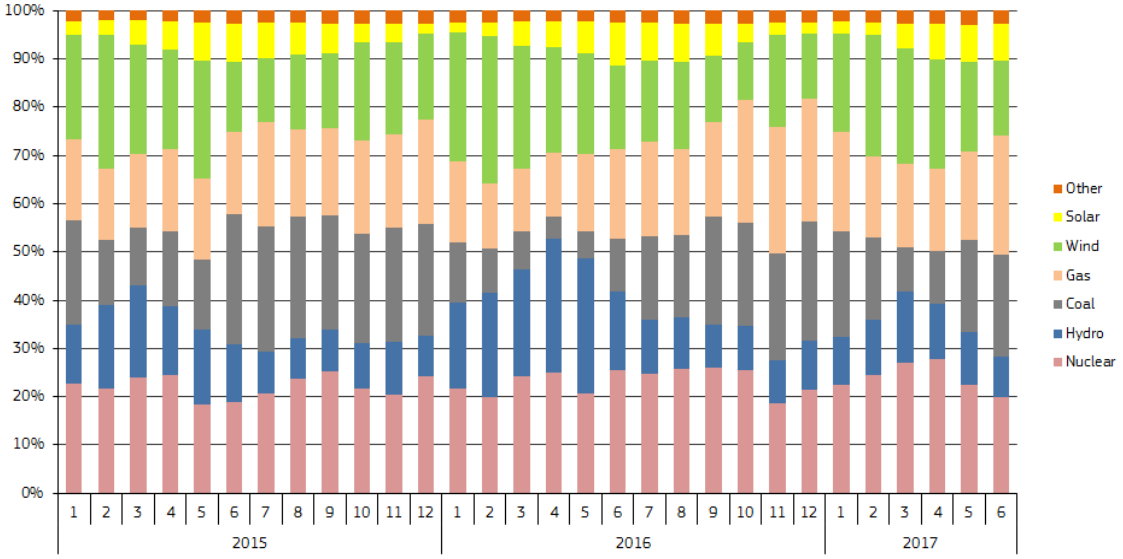
Source: Platts, OMEL

Figure 28 – *Daily average wholesale electricity prices in Spain and Portugal*



Source: Platts, OMEL

Figure 29 - *Weekly evolution of the electricity generation mix in Spain*



Source: ENTSO-E

4.6 Central Eastern Europe (Czech Republic, Hungary, Poland, Romania, Slovakia, Slovenia)

- The regional monthly average baseload price in Central and Eastern Europe (CEE) slightly rose in the second quarter of 2017 and reached 40 €/MWh in June 2017, up from 35 €/MWh measured in April, while the monthly average peakload contract rose from 41 €/MWh to 48 €/MWh in the same period, as Figure 30 shows.

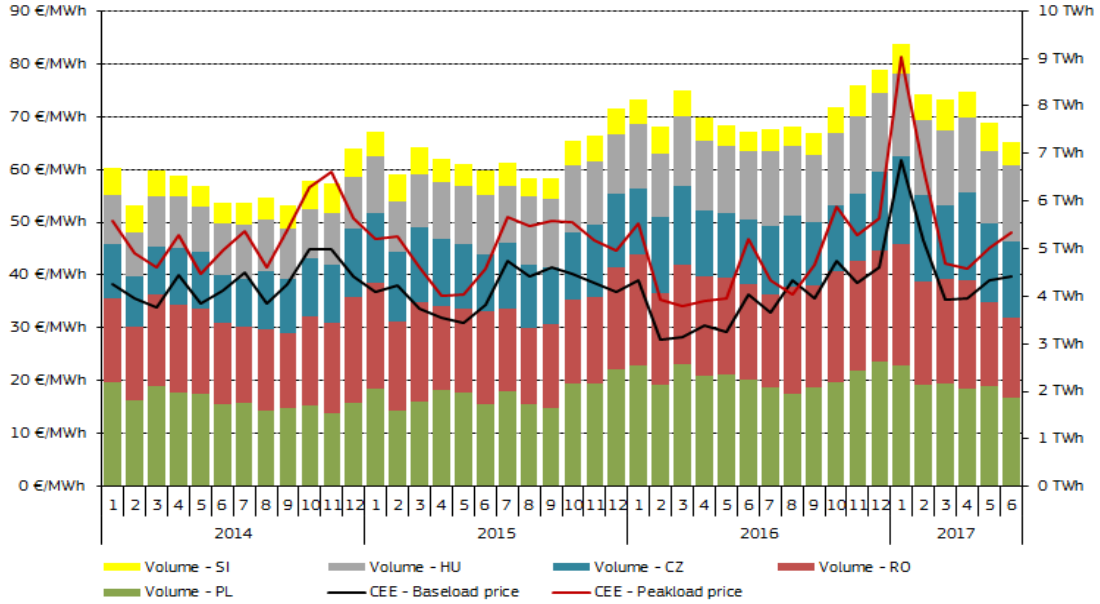
- In April 2017 there were many trading days when daily temperatures in most of the regional countries were several degrees lower than the long term daily average; however, this did not result in significant impact on the wholesale electricity prices. In contrast, at the end of June 2017 when temperatures were higher by several degrees than the long term daily average, local market prices in Romania and Hungary, and to a lesser extent, in Poland and the Czech Republic, turned up measurably. In the last week of June 2017 the average price in Hungary and Romania were above 50 €/MWh, being the highest since the end of February 2017, as Figure 31 shows.

- In Poland wind power generation in Q2 2017 was 50% higher than in the same period of the previous year, and assured more than 9% of the country's generation mix. Besides cheap domestic coal and lignite sources, increasing share of wind power generation has contributed to keeping the local wholesale price level competitive compared with other countries of the region.

- Hydro availability across the CEE region started to improve in the second quarter of 2017; however, the amount of electricity generated from hydro grew slower than the reservoir levels, being in a need for refill after the long and dry wintry period. This provided for limited power export opportunities from the Balkans to Hungary. In Romania electricity generation from hydro was almost a quarter lower in Q2 2017 in year-on-year comparison.

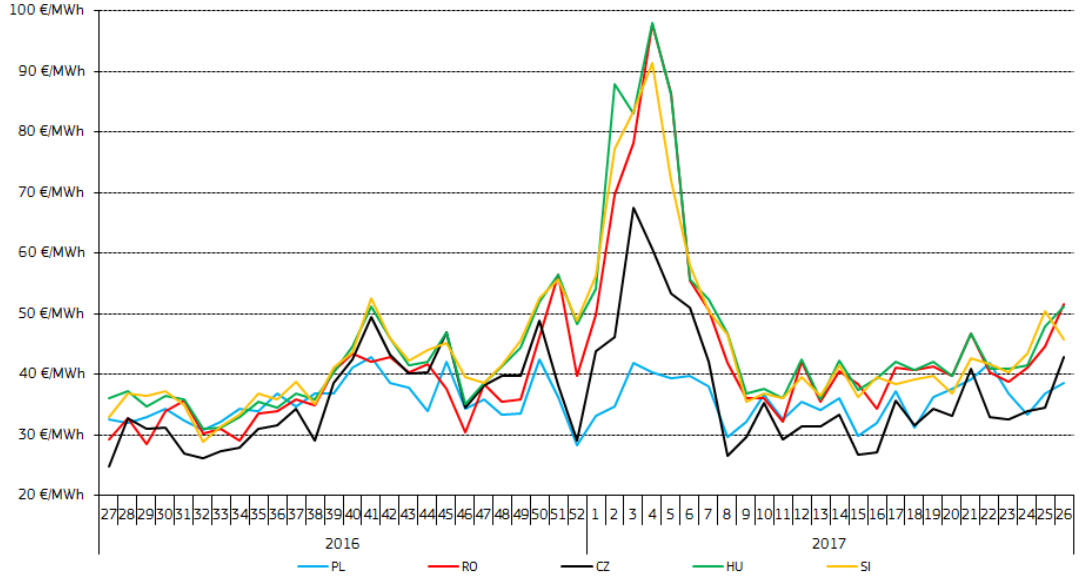
- Conventional thermal generation plant availability was fairly good over Q2 2017 in the CEE region; however, in the Czech Republic Temelin-2 nuclear power plant with 1 GW capacity was taken offline for planned maintenance of several months' duration as of 19 May. In Hungary and Slovakia some smaller outages occurred during the high temperature period in June, adding an additional pressure on wholesale electricity market supply margins and prices.

Figure 30 - *Monthly electricity exchange traded volumes and average day-ahead prices in Central Eastern Europe*



Source: Regional power exchanges, Central and Eastern Europe (CEE)

Figure 31 – *Weekly average wholesale power prices in the CEE region*



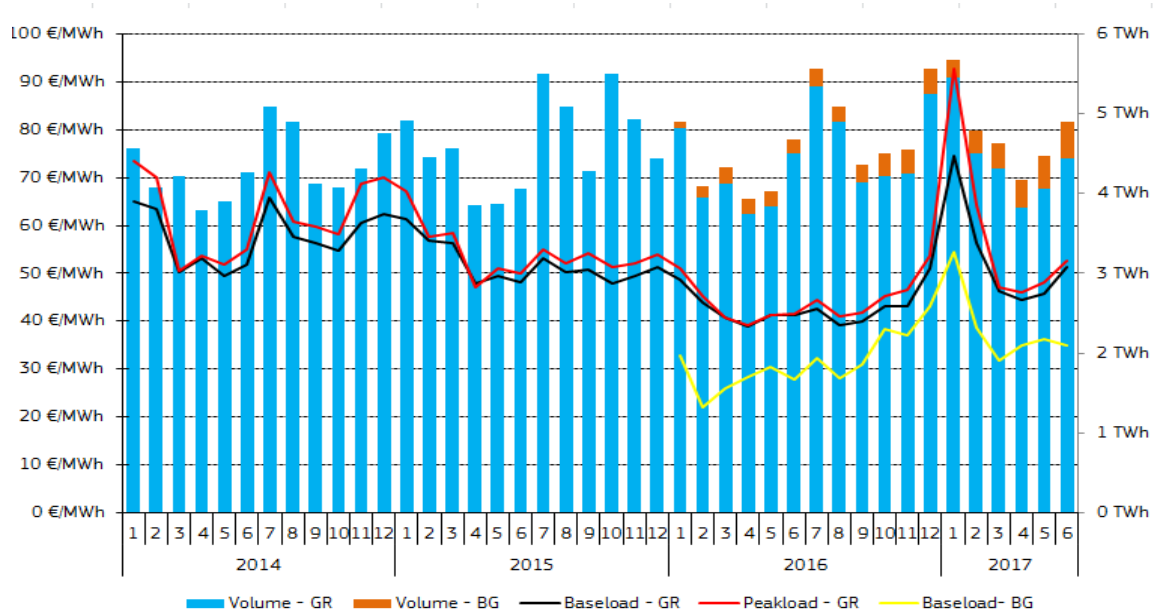
Source: Platts, CEE Regional power exchanges

4.7 South Eastern Europe (Greece and Bulgaria)

- Similarly to most of the European markets, wholesale electricity prices in Greece showed a slight upturn during the second quarter of the year, as, it can be followed on Figure 32. The monthly average baseload price rose between April and June 2017 from 45 €/MWh to 51 €/MWh, while at the same time the monthly average peakload went up from 46 €/MWh to 53 €/MWh. In Bulgaria the monthly average baseload price remained stable in a narrow range of 35-36 €/MWh during Q2 2017.
- Compared to regional peers, Greek wholesale electricity market prices were the highest in the second quarter of 2017, whereas Romanian prices were lower during most of the time and the lowest wholesale prices could be observed in Bulgaria, as Figure 33 shows. In the last week of June 2017, due to high temperatures across the region, both Greek and Bulgarian prices rose to the highest since mid-February 2017.

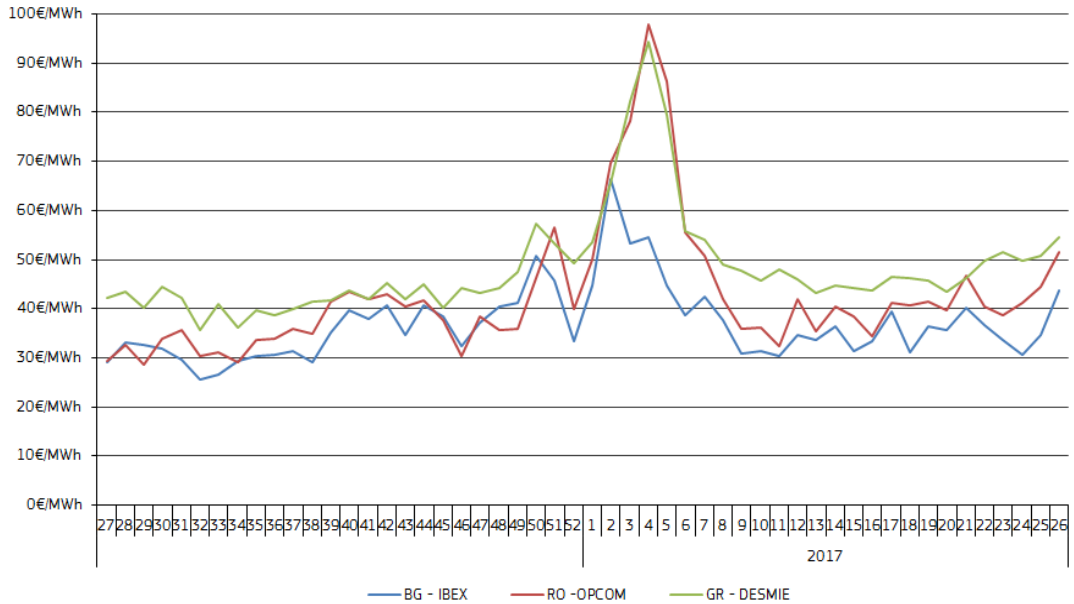
- On the supply side of the Greek wholesale market, increasing lignite and gas fired generation in Q2 2017 compared to the same period of 2016, combined with stagnating wind and solar generation and decreasing electricity imports from the Balkans between April and June 2017 all contributed to increasing electricity generation costs, putting an upward pressure on the wholesale market price.

Figure 32 - *Monthly traded volumes and prices in Greece and Bulgaria*



Source: LAGIE, IBEX

Figure 33 – Comparison of daily average day-ahead prices in Bulgaria, Greece and Romania



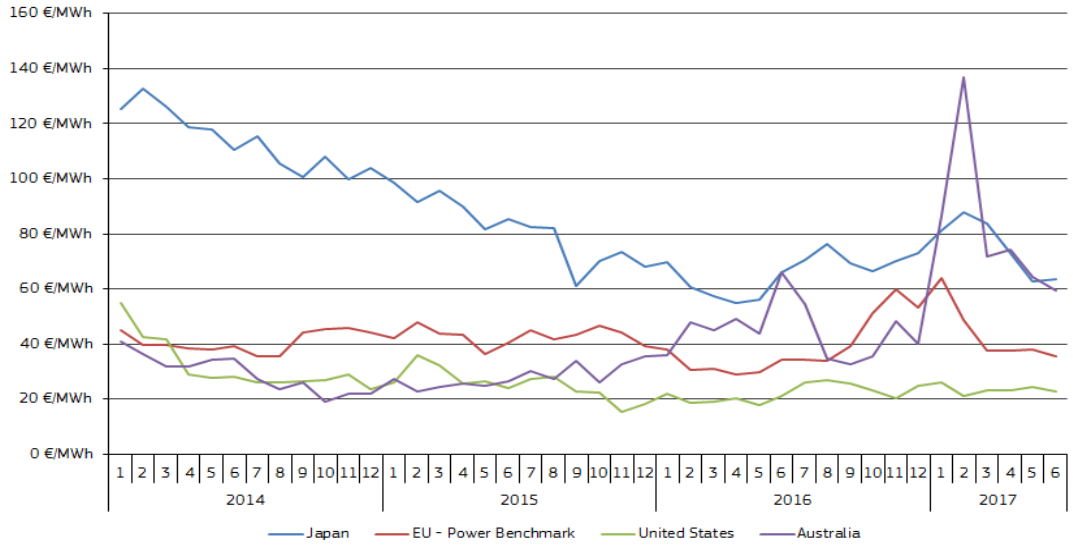
Source: IBEX, LAGIE, OPCOM

5 International outlook – comparing EU power prices with international peers

- As Figure 34 shows, in the second quarter of 2017 the gap between wholesale electricity prices in Europe and the US shrunk, as the high-priced period of Q1 2017 in Europe was over and prices in the US remained stable. The quarterly EU/US wholesale electricity price ratio was 1.6 in Q2 2017, implying that the wholesale electricity price gap between the EU and the US was the smallest since Q3 2016.

- By the end of Q2 2017 wholesale electricity prices in Japan fell to twelve months' low as Japanese LNG landed prices decreased, impacting the generation costs in the country. In Australia wholesale prices fell back from the highs of Q1 2017 after the end of the heat waves in the summer, though they remained still higher than in the period of 2014-2016.

Figure 34 – *Comparison of the monthly average wholesale electricity prices in Europe, US, Japan and Australia*



Source: European Power Benchmark, JPEX (Japan), AEMO (Australia) and the average of PJM West and ERCOT regional wholesale markets in the United States

6 Retail electricity prices in the EU

- Figure 35 and Figure 36 show the monthly estimated retail electricity prices in June 2017 in the 28 EU Member States for industrial customers and households for three different levels of annual electricity consumption (Eurostat bands I_B, I_C and I_F for the industrial customers and bands D_B D_c D_d for households). Normally the lower is the annual electricity consumption of a given customer, the higher price this customer needs to pay per kWh.

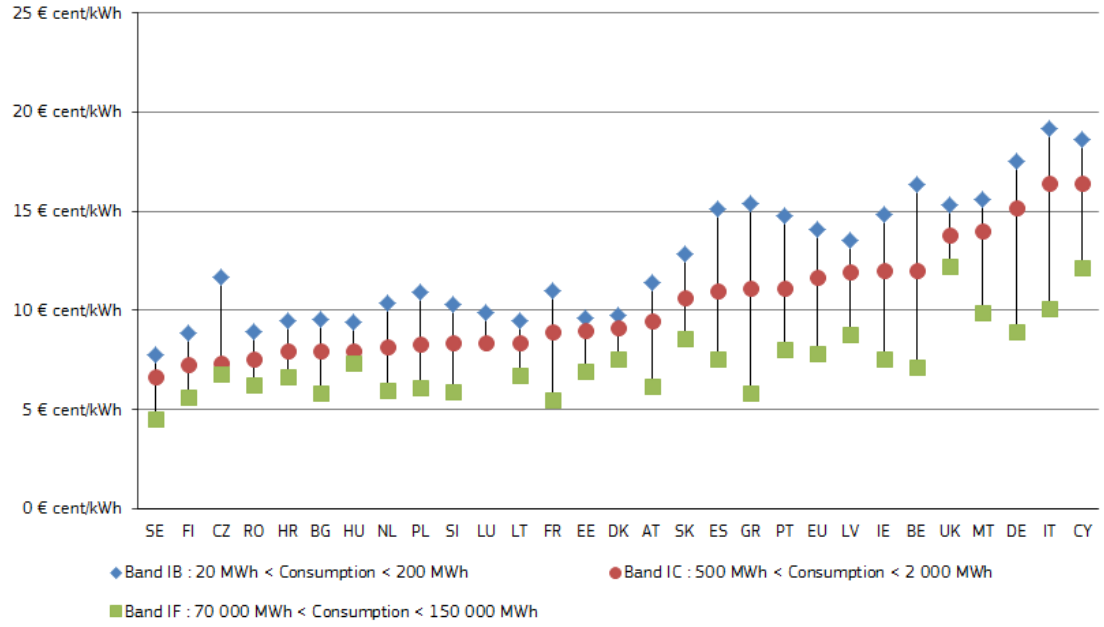
- Retail prices paid by households include all taxes, while retail prices paid by industrial customers are prices without VAT and recoverable taxes and levies. Monthly retail electricity prices are estimated by using the Harmonised Consumer Price Indices (HICP) based on the time series of twice-yearly retail energy price data from Eurostat.

- In the case of industrial customers with low annual consumption in June 2017 Italy was the most expensive country (with a price of 19.1 Eurocent/kWh), while Sweden was the cheapest (7.8 Eurocent/kWh). At the same time in the case of households, retail electricity prices were the lowest in Bulgaria (9.5 Eurocent/kWh), while households with low annual consumption had to pay the most in Germany (33.5 Eurocent/kWh).

- In the case of industrial customers, having medium level annual electricity consumption (Band I_C), the monthly ratio of the highest and the lowest price in the EU was 2.5 (6.7 Eurocent/kWh in Sweden, 16.4 Eurocent/kWh in Cyprus), while in the case of large industrial customers it was 2.7 (4.5 Eurocent/kWh in Sweden, 12.2 Eurocent/kWh in the United Kingdom) in June 2017. In the same month, in the case of households with medium level annual

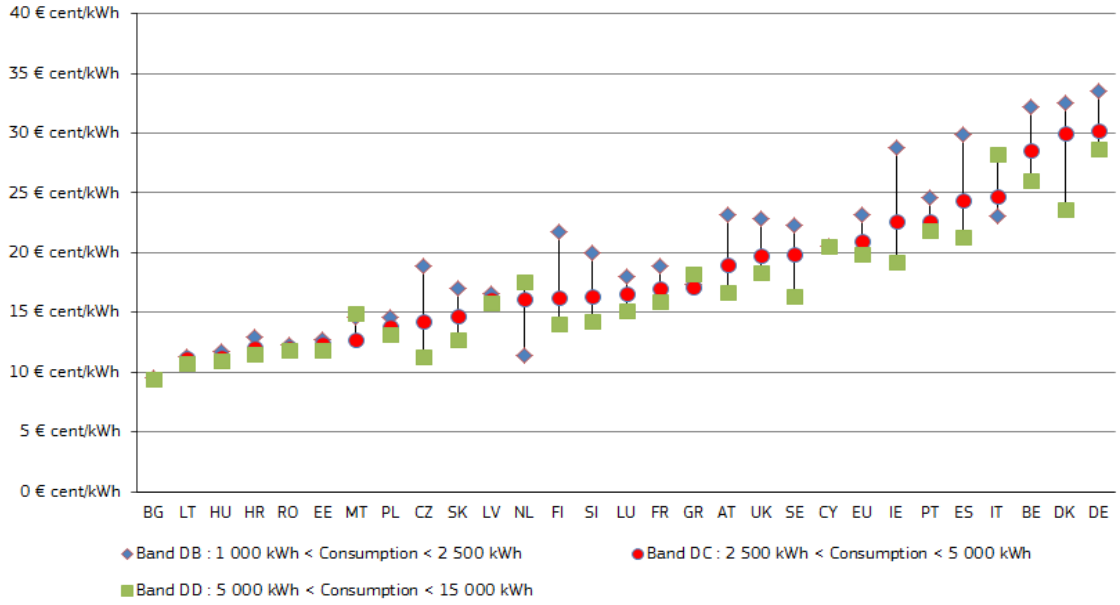
consumption (Band D_C) the highest-lowest price ratio was 3.2 (9.5 Eurocent/kWh in Bulgaria, 30.3 Eurocent/kWh in Germany).

Figure 35 – *Estimated industrial retail electricity prices, June 2017 –without VAT and recoverable taxes and levies*



Source: Eurostat, DG ENER

Figure 36 - *Estimated household retail electricity prices, June 2017 –all taxes included*

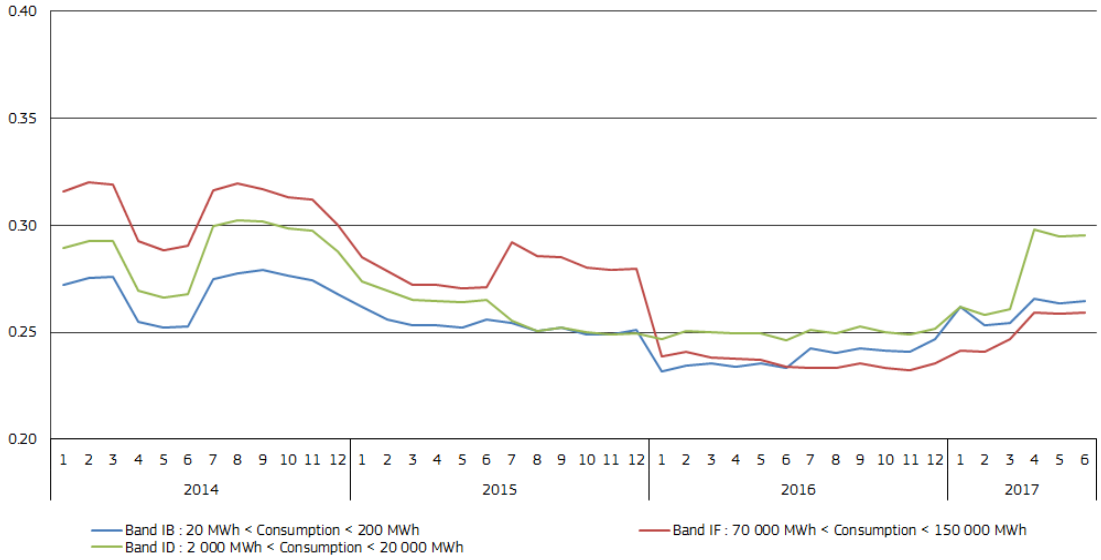


Source: Eurostat, DG ENER

- Figure 37 and Figure 38 show the different behaviour of industrial and household retail price convergence across the EU, using relative standard deviation of the retail electricity prices as metric. Relative standard deviation enables to compare the dispersion of values of different magnitudes, as by dividing the standard deviation by the average the impact of absolute values is eliminated, making possible the comparison of different time series on a single chart. In the case of industrial customers there had been a convergence in retail electricity prices over the last few quarters, and the relative standard deviation mostly decreased over time. However, at the beginning of Q2 2017, signs of divergence occurred for industrial customers for all of the three different annual consumption categories and price dispersion became higher across the EU.

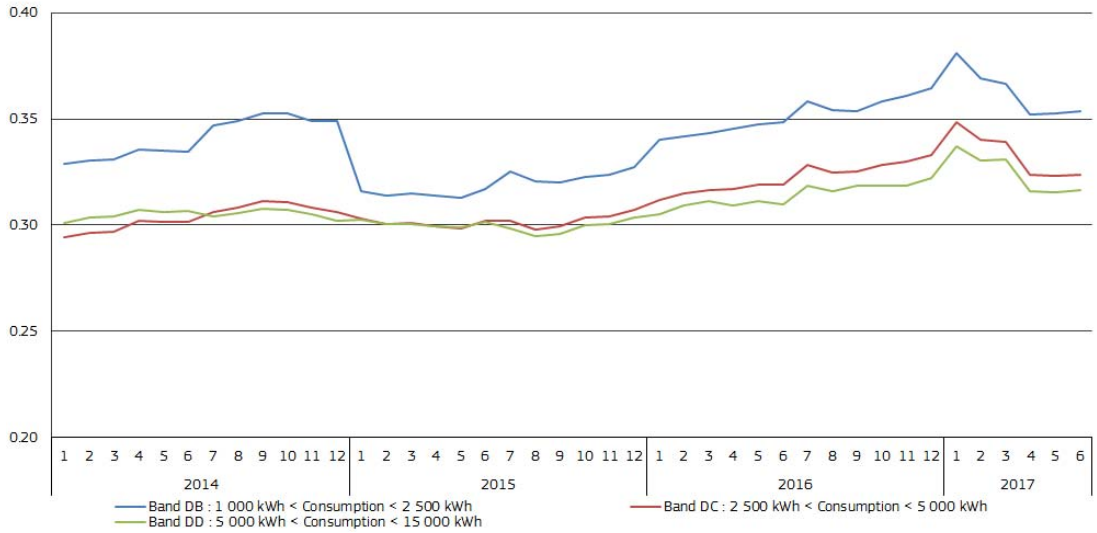
- In contrast, retail electricity prices paid by households showed a higher degree of convergence in Q2 2017 and the standard deviation of retail prices decreased for all of the three observed categories of annual electricity consumption. However, we need to see the data of the next periods to judge whether it is a temporary event or the start of a gradual convergence.

Figure 37 – ***Relative standard deviation of retail electricity prices in the EU Member States in three industrial customer consumption groups***



Source: Eurostat, DG ENER

Figure 38 - ***Relative standard deviation of retail electricity prices in the EU Member States in three household customer consumption groups***



Source: Eurostat, DG ENER

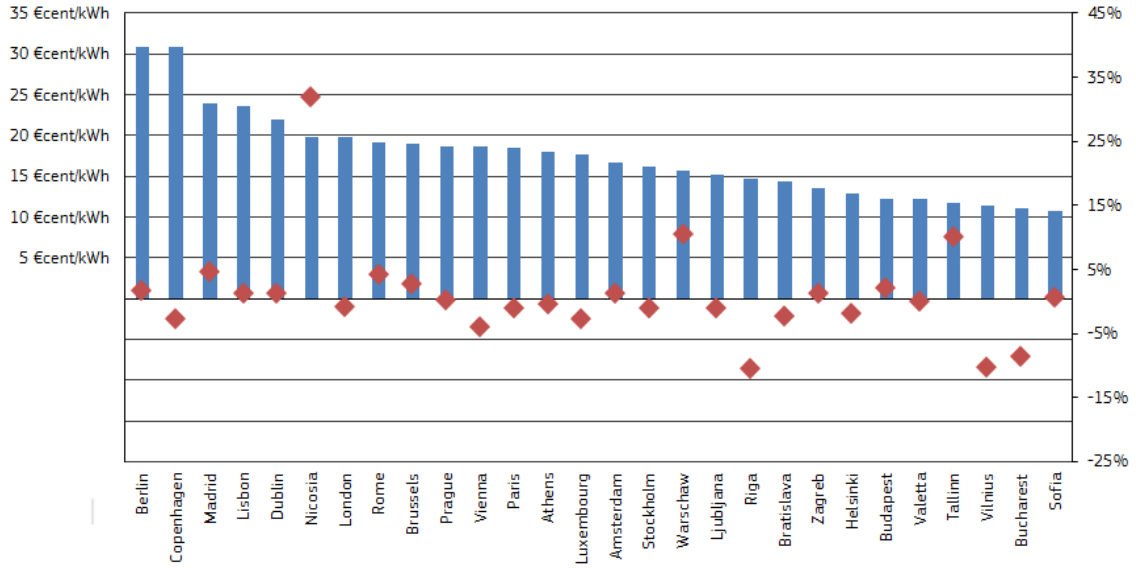
- Figure 39 shows the retail electricity price element of the so-called Household Energy Price Index (HEPI), calculated with a methodology developed by Vaasaett on the basis of monthly collection of electricity invoices in the capital cities of the EU. In June 2017 the highest retail electricity prices paid by households could be observed in Berlin and Copenhagen (both 30.9 Eurocent/kWh), while the cheapest capitals in the EU were Sofia, Bucharest and Vilnius (10.7 Eurocent/kWh, 11.1 Eurocent/kWh and 11.4 Eurocent/kWh, respectively). Compared with June 2017, an outstandingly high price increase could be observed in Nicosia (32%) and in Warsaw and Tallinn the increase in retail prices was also above 10%. Retail electricity prices decreased the most in Riga and Vilnius (in both cities by slightly more than 10%) and in Bucharest (9%).

- Figure 40 shows the change in household retail electricity prices between June 2016 and June 2017, expressed in Eurocent/kWh, and the contribution of the cost components (energy costs, transmission and distribution costs, energy taxes and VAT) to the price change in the European capital cities. Besides Nicosia where oil-fired electricity generation costs were largely influenced by increasing oil prices in year-on-year comparison, energy costs increased by the most in Rome (by 1 Eurocent/kWh) and Madrid (0.8 Eurocent/kWh).Energy costs decreased by the most in Vilnius and Berlin (0.8 Eurocent/kWh and 0.7 Eurocent/kWh).

- Energy taxes increased measurably in Madrid and Bratislava, though it was the consequence of reclassification of retail price components between taxes and network costs, resulting in decreases in these two cities in transmission and distribution costs[6]. Energy taxes went down significantly in Copenhagen (1.1 Eurocent/kWh).

- Transmission and distribution costs had the biggest downward impact on the final retail prices in Riga (1.2 Eurocent/kWh), while in Warsaw they resulted in the increase of final prices (0.8 Eurocent/kWh).

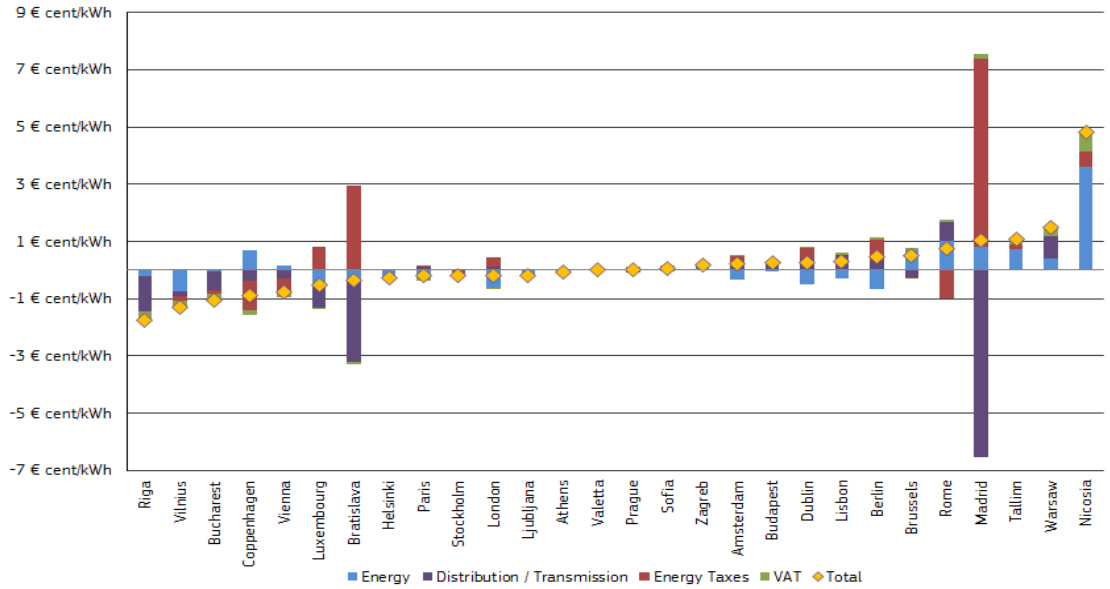
Figure 39 – *The Household Energy Price Index (HEPI) in the European capital cities - Electricity prices in June2017, and changes in household electricity prices compared to June2016*



Source: Vaasaett

[6] See Quarterly Report on European Electricity Markets, Vol. 10, first quarter of 2017

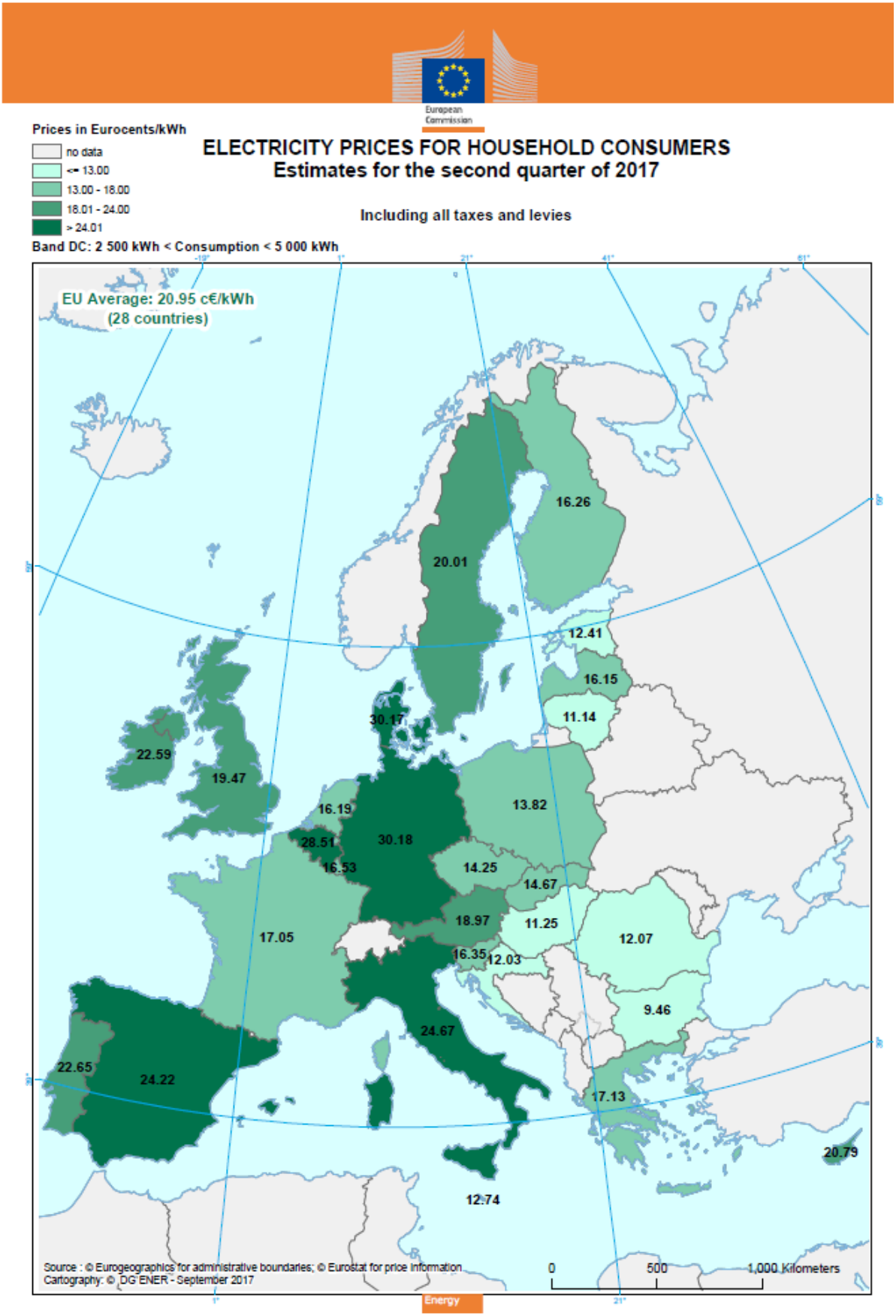
Figure 40 – *Change in electricity prices and their cost components in the European capital cities, between June 2016 and June 2017, in* Eurocent/kWh



Source: Vaasaett

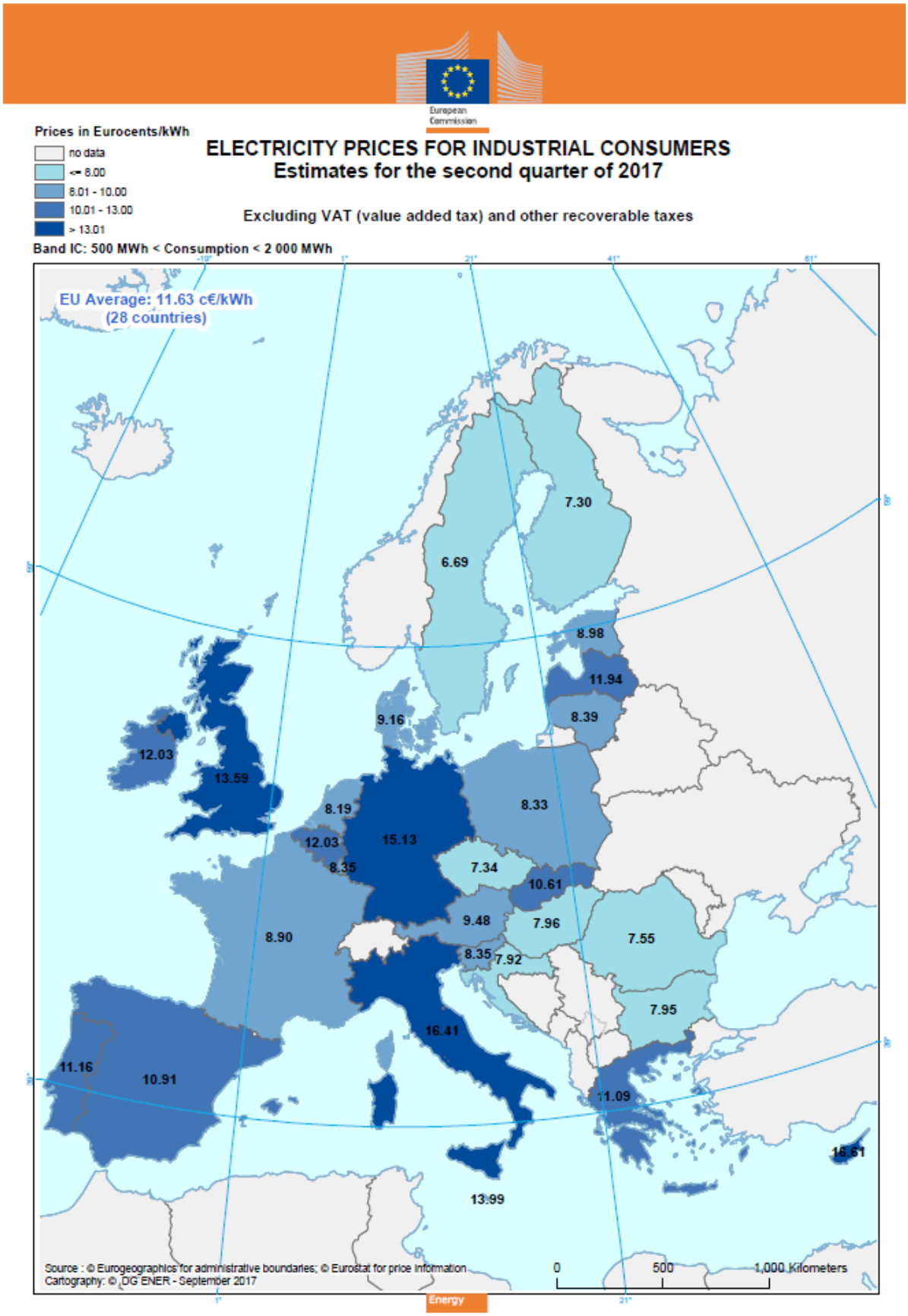
- The two maps (Figure 41 and Figure 42) show the estimated quarterly average retail electricity prices paid by households and industrial customers, having medium level of annual electricity consumption, in the second quarter of 2017.

Figure 41- ***Electricity prices (inclusive of taxes) – Households – Estimated for the second quarter of 2017***



Source : Data computed from Eurostat half-yearly retail electricity prices and consumper price indices

Figure 42 – *Electricity prices (without VAT and non-recoverable taxes) – Industrial consumers – Estimated for the second quarter of 2017*



Source : Data computed from Eurostat half-yearly retail electricity prices and consumper price indices

7 Glossary

Backwardation occurs when the closer-to-maturity contract is priced higher than the contract which matures at a later stage.

Clean dark spreads are defined as the average difference between the price of coal and carbon emission, and the equivalent price of electricity. If the level of dark spreads is above 0, coal power plant operators are competitive in the observed period. *See dark spreads.*

Clean spark spreads are defined as the average difference between the cost of gas and emissions, and the equivalent price of electricity. If the level of spark spreads is above 0, gas power plant operators are competitive in the observed period. *See spark spreads.*

Contango: A situation of contango arises in the when the closer to maturity contract has a lower price than the contract which is longer to maturity on the forward curve.

Cooling degree days (CDDs) are defined in a similar manner as Heating Degree Days (HDDs); the higher the outdoor temperature is, the higher is the number of CDDs. On those days, when the daily average outdoor temperature is higher than 21°C, CDD values are in the range of positive numbers, otherwise CDD equals zero.

Dark spreads are reported as indicative prices giving the average difference between the cost of coal delivered ex-ship and the power price. As such, they do not include operation, maintenance or transport costs. Spreads are defined for a coal-fired plant with 35 % efficiency. Dark spreads are given in this publication for UK and Germany, with the coal and power reference price as reported by *Platts*.

European Power Benchmark (EPB7) is a replacement of the former Platt's PEP index discontinued at the end of 2016, computed as weighted average of seven major European markets' (Belgium, France, Germany, Netherlands, Spain, Switzerland, United Kingdom) day-ahead contracts.

Flow against price differentials (FAPDs): By combining hourly price and flow data, FAPDs are designed to give a measure of the consistency of economic decisions of market participants in the context of close to real time operation of electrical systems.
With the closure of the day-ahead markets (D-1), the prices for each hourly slot of day D are known by market participants. Based on the information from the power exchanges of two neighbouring areas, market participants can establish hourly price differentials. Later in D-1, market participants also nominate commercial schedules for day D. An event named 'flow against price differentials' (FAPD) occurs when commercial nominations for cross border capacities are such that power is set to flow from a higher price area to a lower price area. The FAPD chart in this quarterly report provides detailed information on adverse flows, presenting the ratio of the number of hours with adverse flows to the number of total trading hours in a quarter.

Heating degree days (HDDs) express the severity of a meteorological condition for a given area and in a specific time period. HDDs are defined relative to the outdoor temperature and to what is considered as comfortable room temperature. The colder is the weather, the higher is the number of HDDs. These quantitative indices are designed to reflect the demand for energy needed to heat a building.

Relative standard deviation is the ratio of standard deviation (measuring the dispersion within a statistical set of values from the mean) and the mean (statistical average) of the given set of values. It measures in percentage how the data points of the dataset are close to the mean (the higher is the standard deviation, the higher is the dispersion).

Spark spreads are reported as indicative prices giving the average difference between the cost of natural gas delivered ex-ship and the power price. As such, they do not include operation, maintenance or transport costs. Spreads are defined for a gas-fired plant with 50 % efficiency. Spark spreads are given for UK and Germany in this publication, with the gas and power reference price as reported by *Platts*.

Tariff deficit expresses the difference between the price (called a tariff) that a *regulated utility*, such as an electricity producer is allowed to charge and its generation cost per unit.