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Quarterly Report on European Electricity Markets

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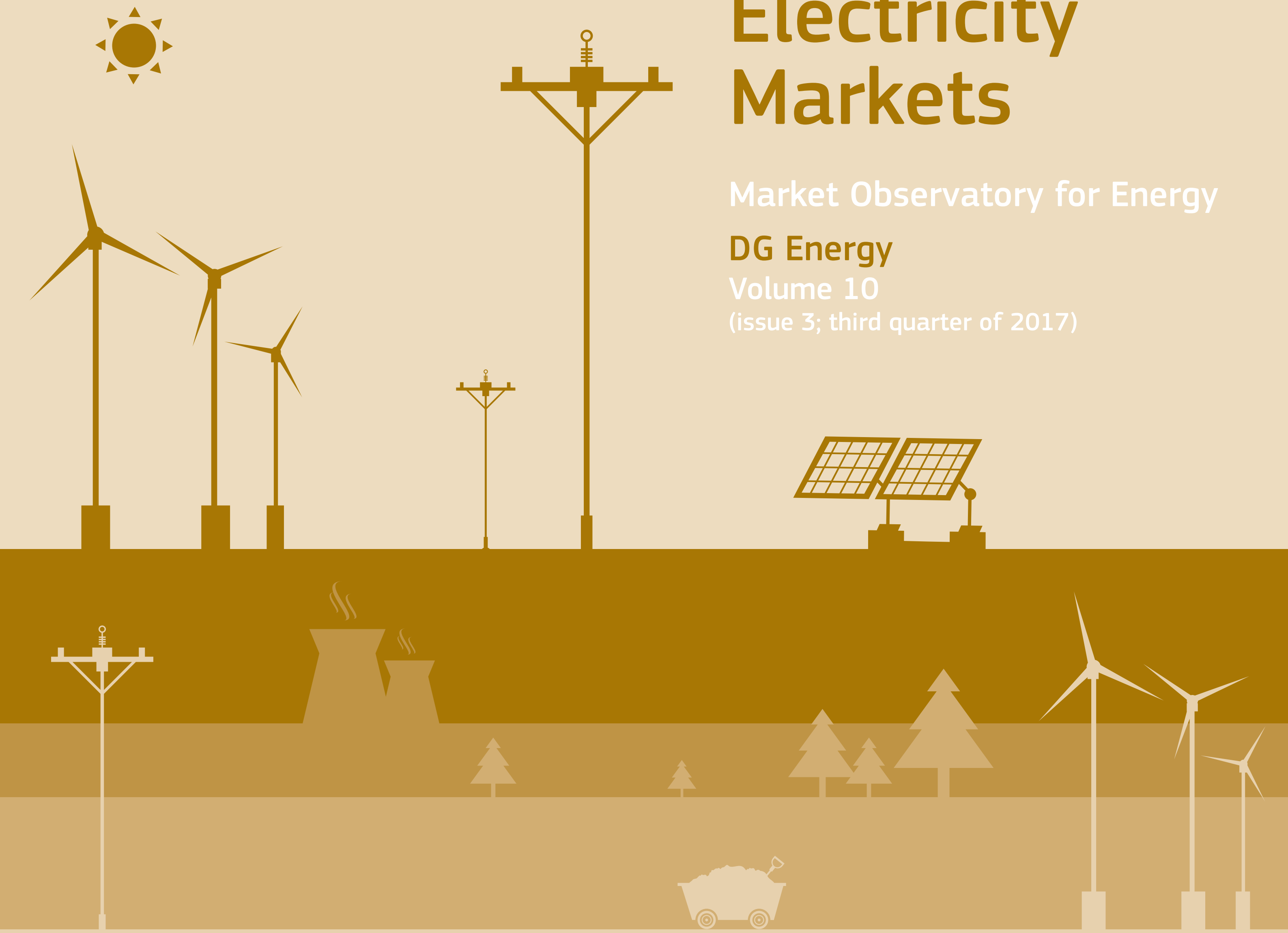

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QUARTERLY REPORT ON EUROPEAN ELECTRICITY MARKETS

CONTENT

HIGHLIGHTS OF THE REPORT

- **In the third quarter of 2017 wholesale electricity prices at EU level showed a high degree of stability and the European Power Benchmark was 38 €/MWh on average.**

- **Economic growth continued in Q3 2017 in the EU, however, electricity consumption grew slower, pointing to a possible improvement in energy efficiency of the EU economy.**

- **The profitability of both coal-fired and gas-fired electricity generation decreased further in Q3 2017, as coal and natural gas prices, but also carbon emission prices showed a steady increase throughout the quarter.**

- **Although installed capacities increased, wind power generation in Q3 2017 showed only moderate increase in year-on-year comparison and solar generation practically did not change in annual comparison.**

- **In the UK temporary price spikes occurred in September 2017, as the capacity of both interconnectors with the continent was reduced to half due to maintenance works.**

- **In some southern and eastern EU countries heat waves in August 2017 resulted in high wholesale electricity prices, though generation adequacy problems did not occur.**

EXECUTIVE SUMMARY

- **In the third quarter of 2017 the European benchmark day-ahead baseload wholesale electricity price index showed a high degree of stability,** fluctuating in a narrow range between 35 €/MWh and 45 €/MWh, and reaching 38 €/MWh on average.

- **Economic growth in the EU accelerated further in the third quarter of 2017 and GDP grew by 2.6% in year-on-year comparison**, being the fastest growth rate since the beginning of 2011. Electricity consumption in the EU grew slower, by 2% in Q3 2017 compared to the same quarter of 2016, which might have implied an improving energy intensity of the EU economy.

- **Coal and natural gas prices were steadily increasing in the third quarter of 2017,** reaching the levels by the end of the quarter last seen at the beginning of 2017. In the case of gas, demand was driven by refilling of storages ahead of the winter heating period, while in the case of coal the price increase was also influenced by anticipation of lower than usual nuclear availability during wintertime in Central Western Europe, as coal might act as backup fuel in power generation.

- **The competitiveness of coal-fired electricity generation eroded further by increasing coal prices in the third quarter of 2017**, being aggravated by the slowly rising emission allowance prices. On average, gas-fired electricity generation became unprofitable in some EU countries, (e.g.: Germany), however, in Spain coal was substituted by relatively cheaper gas in the electricity generation mix. Due to its decreasing role in electricity generation, hard coal imports in the EU from third countries decreased over the last few years, however, Russia managed to increase its share in the total extra-EU coal imports.

- **After several reactors returned to the grid**, **nuclear availability in France and Germany improved compared to the second quarter of 2017** and in August nuclear generation was the highest in 2017 so far in Germany. Abundant electricity supply also contributed to low average wholesale electricity price in August 2017 in the Central Western Europe power region.

- **Hydro generation in the EU electricity mix recovered after a dry period at the beginning of 2017** and in several regions (Nordic, the Alps or the Balkans) hydro reserves and availability reached its long term seasonal average by the end of Q3 2017. In some countries in Central and Eastern Europe lower than usual hydro availability also contributed to high wholesale electricity prices during the early August heat wave.

- **Wind power generation showed a moderate increase in Q3 2017 in year-on-year comparison in the EU as a whole,** however, compared to the first half of the year the share of wind decreased in the EU electricity mix. In the third quarter of 2017 solar power generation, though being seasonally the strongest in this period of the year; did not show significant growth in the EU in year-on-year comparison, in spite of increasing solar panel installations across the continent.

- **In the UK the capacity of both electricity interconnectors with the continent (IFA with France and BritNed with the Netherlands) was reduced to half** as of mid-September 2017, due to planned maintenance works**.** This resulted in tighter supply margins, which in some cases led to temporary wholesale market price spikes, mainly in the case of dwindling variable renewable generation.

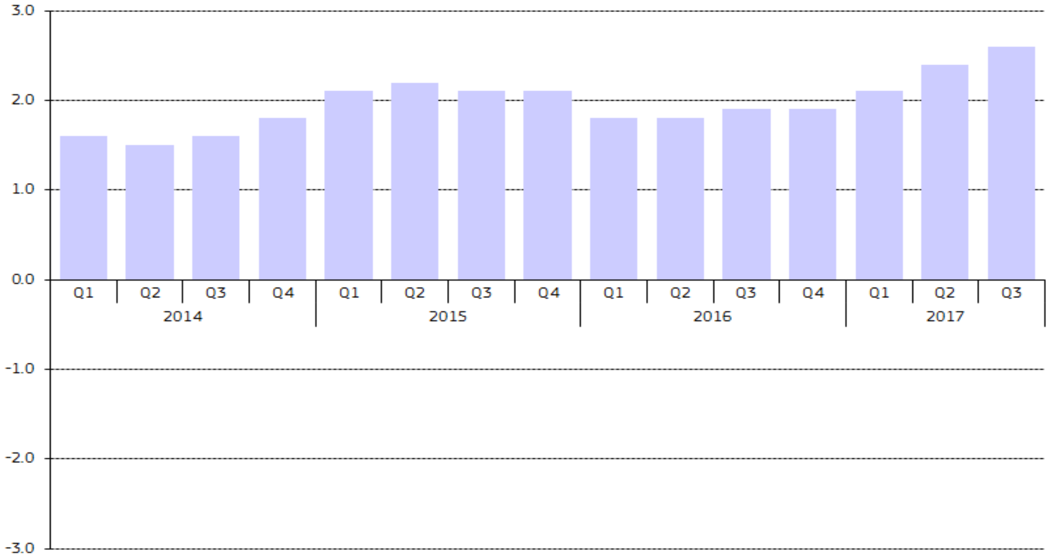
- **Retail electricity prices for household customers decreased by 2.4% between September 2016 and September 2017 in the European capital cities on average.** Changes in retail electricity prices were mainly driven by decreasing energy and supply costs and network costs, whereas changes in energy taxes had an upward impact on the final retail electricity prices.

1 Electricity market fundamentals

1.1 Demand side factors

Economic growth in the EU-28 continued to accelerate in the third quarter of 2017 and GDP grew by 2.6% in year-on-year comparison, slightly faster than in the previous quarter (in Q2 2017 the economic growth was 2.4%). This was the biggest growth rate seen since the first quarter of 2011. In Q3 2017, according to the data of the European Network of Transmission System Operators (ENTSO-E), consumption of electricity was up by 2% in year-on-year comparison, implying a lower growth rate than the GDP and improving energy efficiency in the European economy. However, gross value added in both manufacturing and construction sectors, was up by 3.9% compared to Q3 2016, pointing to increasing energy need in important energy consuming economic sectors.

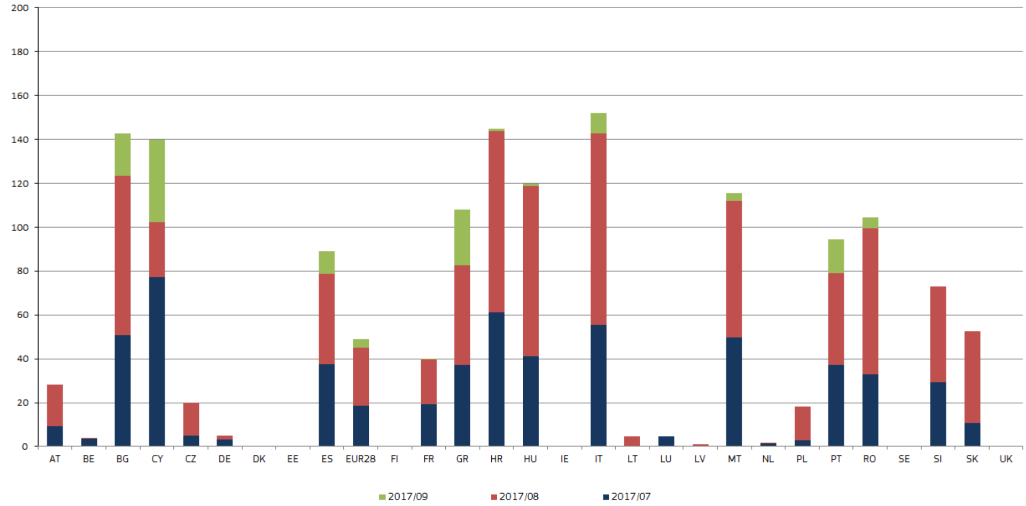
Figure 1 – *EU 28 GDP Q/Q-4 change (%)*



Source: Eurostat

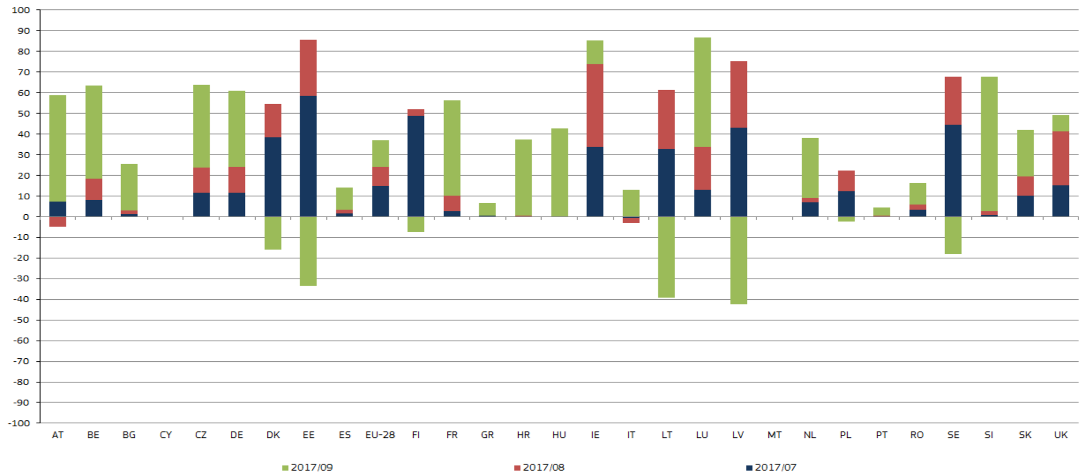
- Figure 2 and Figure 3 show the monthly deviation of actual Cooling Degree Days (CDDs) and Heating Degree Days (HDDs) from the long term averages in July-September 2017 in the twenty-eight Member States of the EU. July 2017 and especially August 2017 were warmer than usual in most countries of the European continent, resulting in increasing cooling needs that impacted wholesale electricity markets in many markets.
- At the beginning of the autumn, in September 2017, temperatures were lower than the seasonal averages (implying higher than usual HDDs) in most of the EU countries, which in parallel with increasing lighting needs, resulted in higher demand for electricity. The assessment of temperature driven demand for electricity can be found for each region in Chapter 4.

Figure 2 - *Deviation of actual Cooling Degree Days (CDDs) from the long-term average, in July-September 2017*



Source: JRC.
The warmer is the weather, the higher is the number of CDDs.

Figure 3 - *Deviation of actual Heating Degree Days (HDDs) from the long-term average, in July-September 2017*



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

1.2 Supply side factors

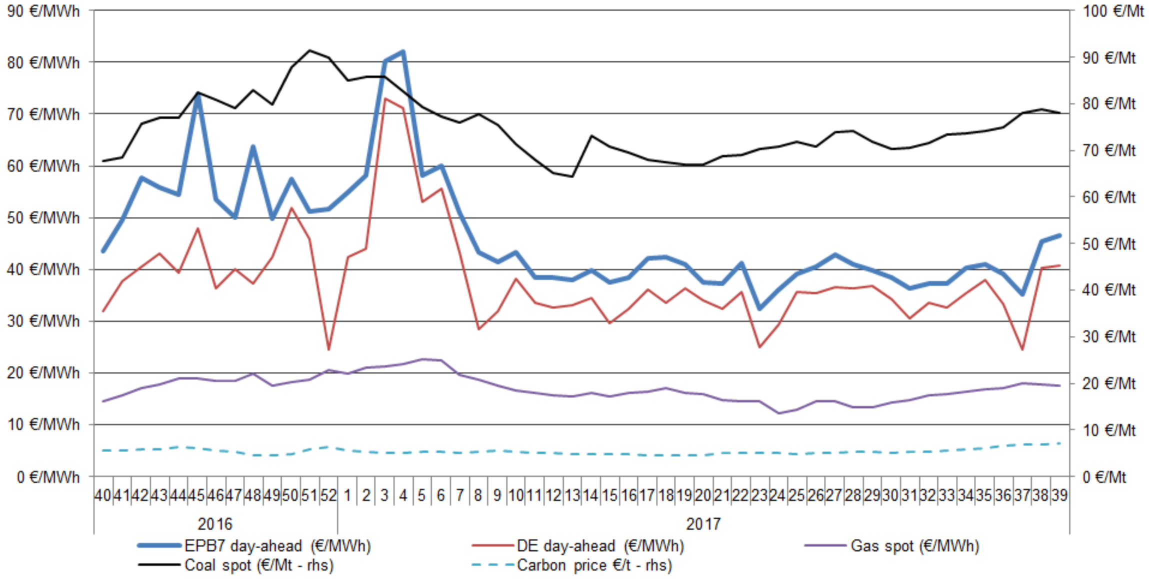
- Spot coal prices on Figure 4 (as represented by CIF ARA contracts, an import price benchmark widely used in North-Western Europe), showed a gradual increase during the third quarter of 2017 (week 27-39), and rose above 80 €/Mt by the end of the quarter, close to the level measured at the beginning of 2017. Demand for coal increased in Europe as ahead of the winter period there were uncertainties regarding the availability of nuclear capacites in some EU countries.

- Spot natural gas prices (represented by NBP, one of the most liquid hub prices in North-Western Europe) showed a gradual increase in the third quartrer of 2017 during the usual gas storage refilling period. European emission allowance contracts also underwent a slight increase during Q3 2017, (from 5 €/tCO2e to 7 €/tCO2e), in parallel with rising coal and gas prices. However, the impact of increasing carbon emission alllowance prices was limited on the evolution of wholesale electricity prices in Q3 2017.

- The wholesale electricity benchmark price followed the increasing coal and natural gas contracts in Q3 2017, which was reinforced by slightly decreasing share of renewable sources in the EU generation mix, providing for a higher share of costlier conventional generation sources.

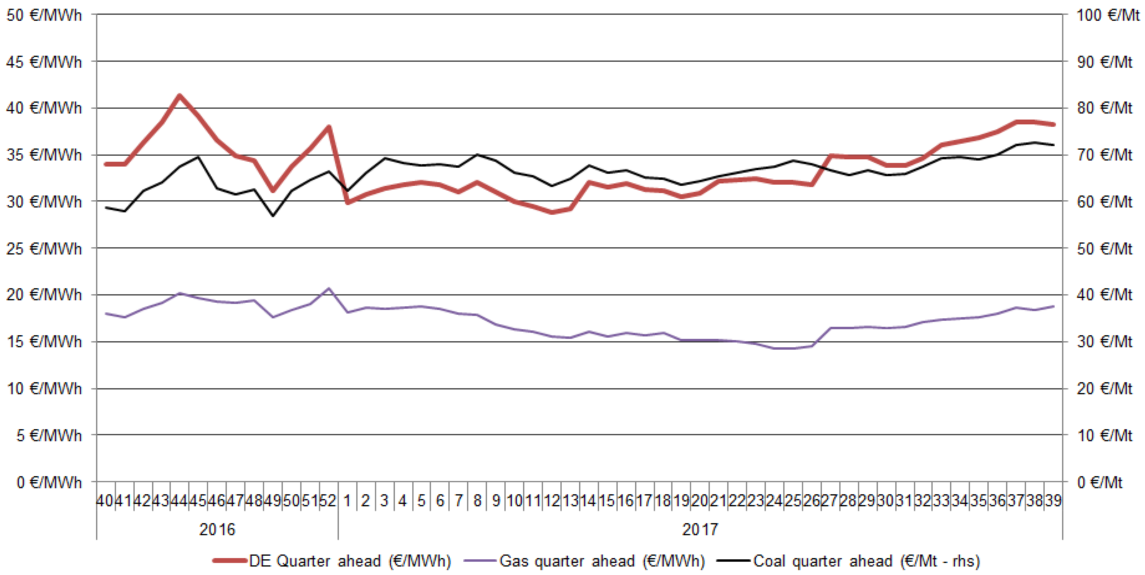
- On the curve, quarter-ahead and year-ahead coal and natural gas prices also increased during the third quarter of 2017, similary to the day-ahead contracts. This has also exerted an upward pressure on the quarter-ahead and year-ahead wholesale electricity price contracts (Figure 5 and Figure 6 shows the German contracts, being one of the most liquid markets in Europe with available forward curve price quoatations).

Figure 4 – *Weekly evolution of European average day-ahead wholesale power prices, compared with spot coal, gas and carbon prices*



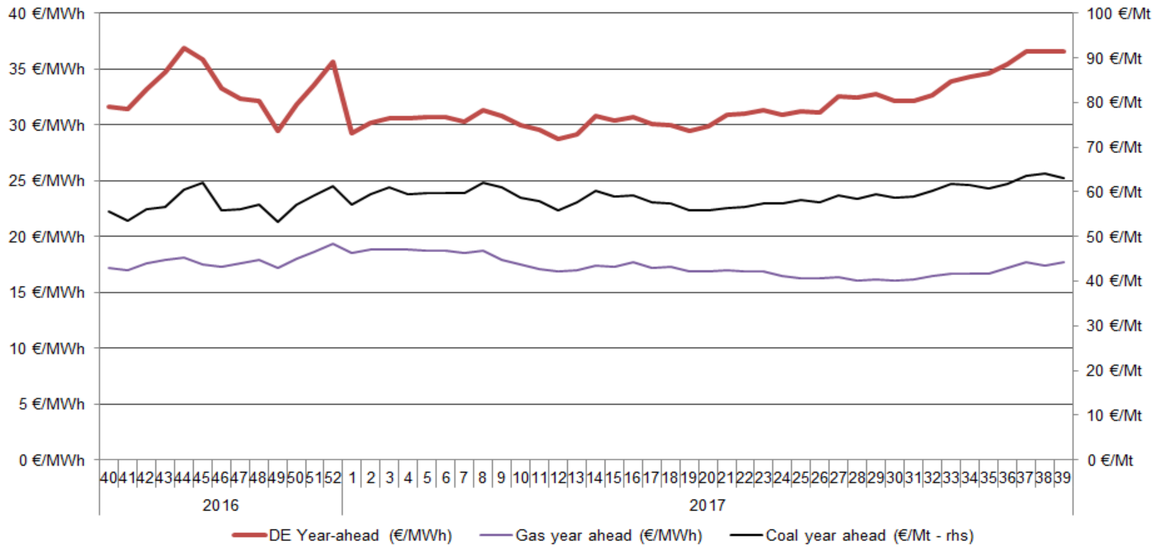
Source: Platts,
European Power Benchmark (in €/MWh) is the replacement of the Platts PEP as of January 2017, as PEP was discontinued at the end of 2016. See more detailed description in the Glossary.
Coal CIF ARA: Principal coal import price benchmark in North Western Europe (in €/Mt)
NBP spot stands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

Figure 5 – *Weekly evolution of quarter-ahead German wholesale electricity prices, compared with coal and gas quarter-ahead contracts*



Source: Platts

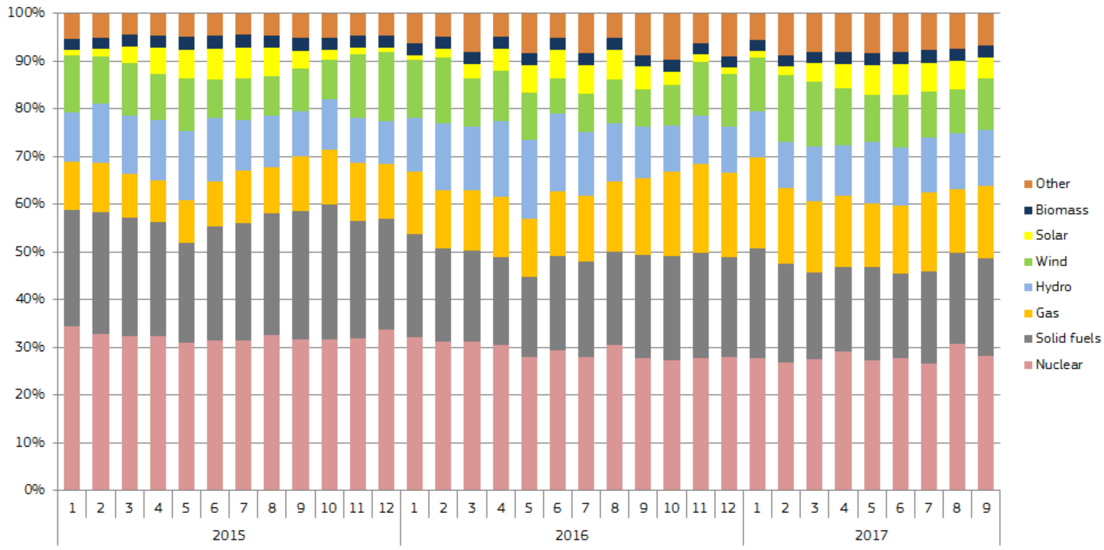
Figure 6 - *Weekly evolution of year-ahead German wholesale electricity prices, compared with coal and gas year-ahead contracts*



Source: Platts

- The next chart (Figure 7) shows the evolution of the electricity generation mix in the EU-28. Compared to the previous quarter, the share of renewable energy sources, such as wind, solar, hydro and biomass in the electricity generation slightly receded in Q3 2017, leaving more room for fossil generation sources. Renewable generation decreased principally owing to the seasonal dwindling of solar generation. The share of hydro sources remained still lower compared to earlier years. These changes exerted an upward pressure on the European wholesale electrcity prices.
- Since the beginning of 2015 conventional generation sources, such as fossil fuels and nuclear, lost ground and variable renewable sources gained higher importance in the EU-28 generation mix, as wind and solar became more and more competitive in electricity generation in the EU.

Figure 7 – *Monthly electricity generation mix in EU-28*



Source: ENTSO-E

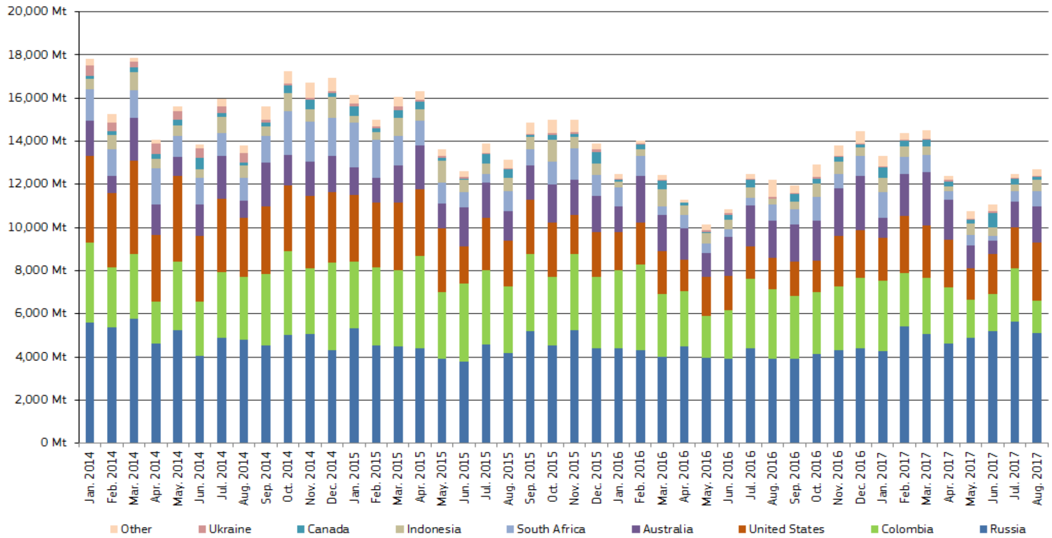
- Figure 8 shows the major extra-EU coal import sources and the monthly amount of imported coal in the EU. In June-August 2017 coal imports from outside the EU reached 36,300 Mt, whereas in the same period of 2016 extra-EU imports amounted to 35,500 Mt. In year-on-year comparison this means a slight increase of 2%, however, compared to the same three months of 2015 coal imports were still down by 9%, and by 17% 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 (which also can be followed on Figure 7), as the competitiveness of coal-fired generation diminished over time.

- In June-August 2017 the largest chunk of extra EU coal imports came from Russia, with a share of 44% in the total. The share of Russian coal imports reached the highest in the last ten years, as it seems that Russia managed to export practically the same amount of hard coal to the EU over this period, though overall EU imports decreased significantly in the last decade. This might be related to competitive mining costs and freight rates in Russia compared to other sources (railway freight costs compared to sea shipments).

- The second most important import coal import source was the United States (18%), overtaking Colombia (16%) All other import sources had a share below 10% in this period, such as Australia (9.6%). South Africa and Indonesia (4% each) and Canada (3%).

- In June-August 2017 the estimated EU import bill of hard coal from extra-EU sources amounted to € 3.7 billion, while in the same period of the 2016 the extra-EU import bill was €2.4 billion, showing the impact of higher coal import prices and slightly increasing coal import volumes.

Figure 8 – *The most important Extra-EU coal import sources and monthly imported quantity in the EU-28*



Source: Eurostat, COMEXT database

- In the third quarter of 2017, in parallel with slightly increasing wholesale electricity prices and natural gas prices clean spark spreads[1], measuring the profitability of natural gas-fired electricity generation, remained stable (it is worth to mention that CO_2 prices also showed a slight increase during the quarter). In the UK wholesale electricity prices being higher than in most of continental Europe ensured gas-firing a measurable profitability and clean spark spreads were around 7-11 €/MWh in Q3 2017. In Germany however, and presumably on most of the continent the profitability of gas-fired power generation remained limited (or even turned into negative, as clean spark spreads in Germany fell below zero in August-September 2017 - see Figure 9). Most of the continental European markets might have faced clean spark spreads being similar to the German metric, primarily depending on the local wholesale electricity price.

- In parallel with low or negative profitablity of gas-fired generation in most of the EU countries, the amount of electircity generated from gas fell to 27 TWh in August 2017, being the lowest since June 2016, though on quarterly average it was around 31 TWh, similarly to the previous quarter.

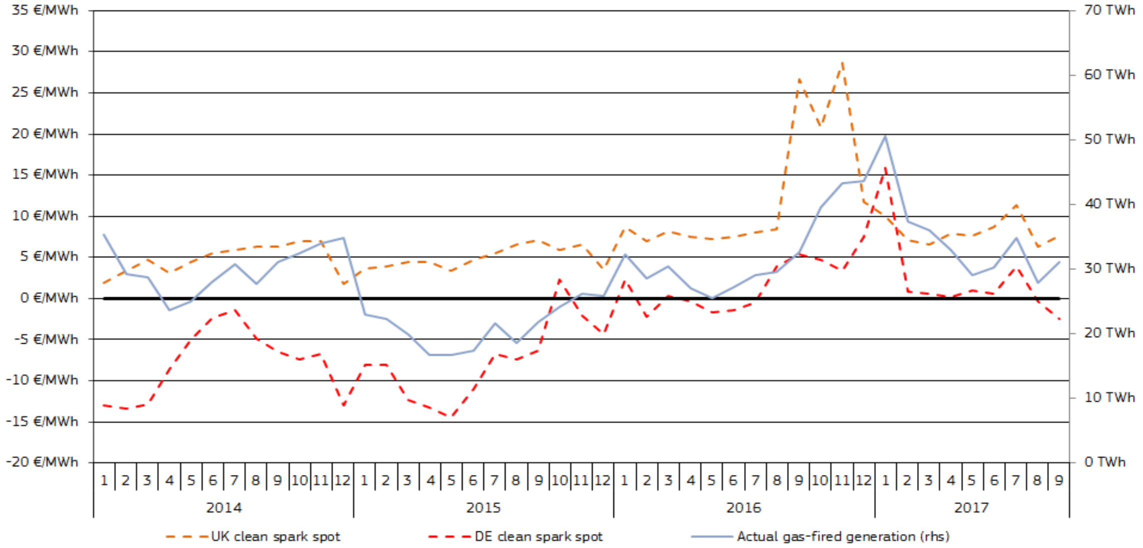
- Clean dark spreads, measuring the profitability (through reflecting the variable costs) of coal-fired generation fell as low as -10 €/MWh in July 2017 in the UK, showing the impact of increasing coal prices and that of the climate change levy, which latter significantly increased the costs of coal-fired generation in comparison to other sources, as Figure 10 shows. In Germany clean dark spreads were also below zero in Q3 2017 (between -2 and 0 €/MWh), however, coal-firing was still facing better profitability prospects in continental Europe than in the UK.

- In the third quarter of 2017 the monthly average coal consumption in electricity generation in the EU-28 was around 19.5 TWh, being similar to the same quarter of 2016 but significantly lower than in Q3 2014 or Q3 2015,

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

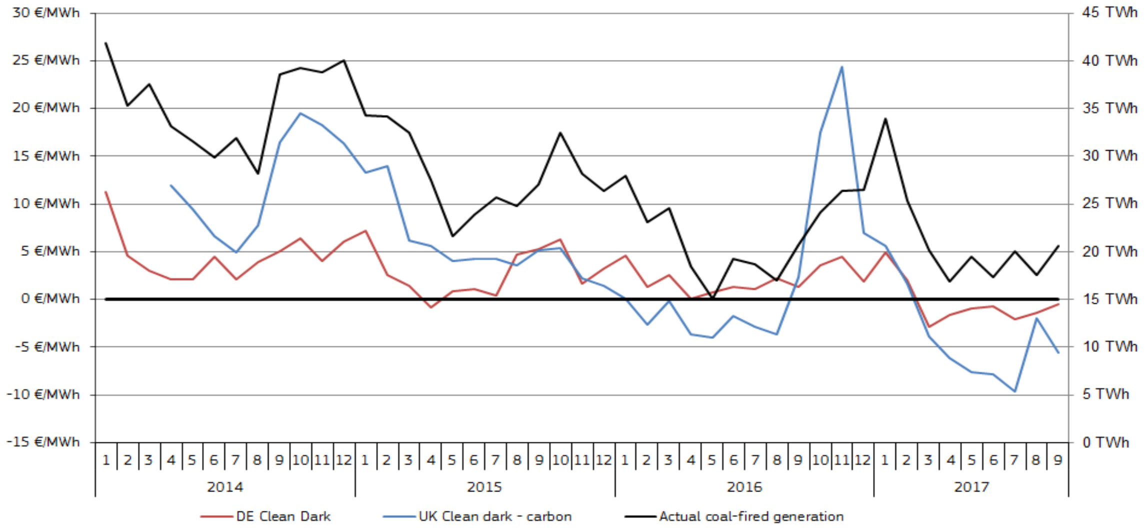
as Figure 10 shows. Even if being non-profitable, some fossil generation capacities must be kept in operation due to flexibility requirements of the electricity system and to the eventual non-availability of variable renewable sources or nuclear generation.

Figure 9 – 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 10 - 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 European wholesale electricity markets

2.1 Comparisons of wholesale electricity prices across European markets

- As the next map (Figure 11) shows, there were significant price differences in the wholesale electricity prices across the EU in the third quarter of 2017. More details on the drivers behind price changes in each market can be found in Chapter 3.

- The highest quarterly average wholesale electricity prices in the EU could be observed in Q3 2017 in Portugal, and Greece (both 52 €/MWh) and in Italy the quarterly average price was slightly below 52 €/MWh. At he same time the lowest quarterly wholesale averages could be found in Denmark and Sweden (both slightly below 34 €/MWh). Norway, being not an EU Member State, faced the lowest price in whole Europe in Q3 2017 (27 €/MWh on quarterly average), whereas the average price in Switzerland (35 €/MWh) was close to most of the prices in Central and Western European markets.

- In the third quarter of 2017 wholesale baseload electricity prices reached 38 €/MWh (European Power Benchmark) on average in Europe, which represented a modest increase (7%) in year-on-year comparison. Comparing with Q3 2016, in the third quarter of 2017 prices increased by the most in Romania (52%), Slovenia and Hungary (both 41%), whereas the United Kingdom was the only country in the EU where a price decrease could be observed (2.2%).

Figure 11 – *Comparison of average wholesale baseload electricity prices, third quarter of 2017*

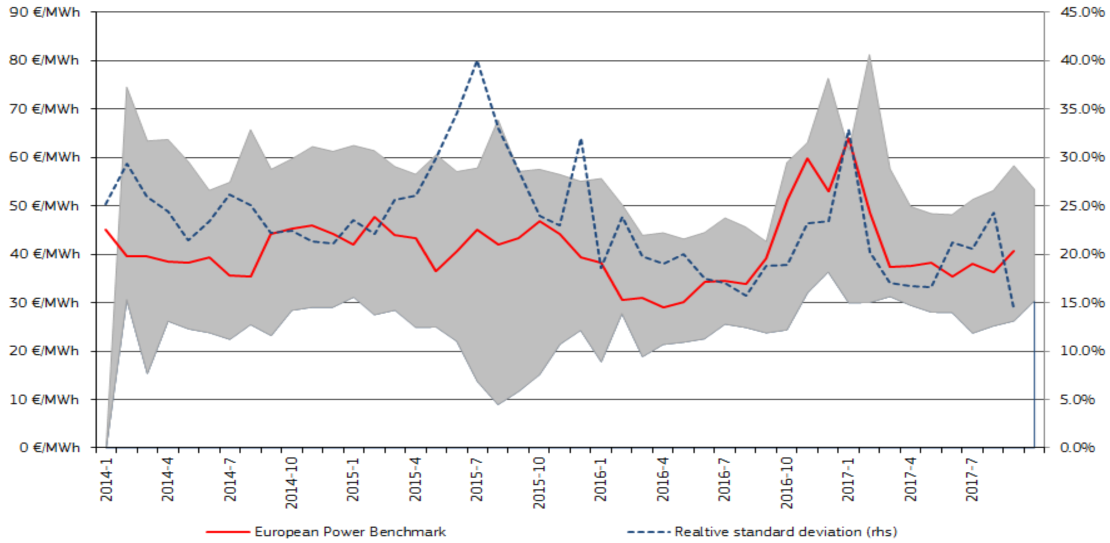
Source: European wholesale power exchanges

- In Q3 2017 wholesale day-ahead electricity prices increased in most of the European electricity regions. Wholesale prices in the Nordpoolspot[2] market and Central Western Europe[3] (CWE) were close to each other and they were below the European Power Benchmark (EPB). The UK has retained its price premium to North Western Europe. On the other hand in the Southern European markets (Spain, Portugal, Italy and Greece) and Central Eastern Europe[4] (CEE) prices were higher than the EPB.

- Figure 12 shows the European power benchmark index and as the two lines of boundary of the shaded area the lowest and the highest regional prices in Europe, as well as the relative standard deviation of the regional prices.

- Both the shaded area with minimum-maximum differentials and the relative standard deviation metric show that although there were some temporary divergences, wholesale electricity prices remained well-aligned in Q3 2017.

Figure 12 - *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)

2.2 Traded volumes on wholesale trading platforms and cross border electricity trade

- Figure 13 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.

- In September 2017, similarly to earlier years, the total monthly traded volume of electricity (1,322 TWh) was significantly up from the August traded volume (941 TWh), in parallel with the increasing electricity consumption, and it was similar to the volume measured in September 2016 (1,317 TWh). In Q3 2017 as a whole, the traded volume of electricity on the observed platforms amounted to 3,072 TWh, up from 2,869 TWh in Q2 2017 and increasing by 3.3% compared with Q3 2016, when the total traded volume was 2,974 TWh.

- Figure 14 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.

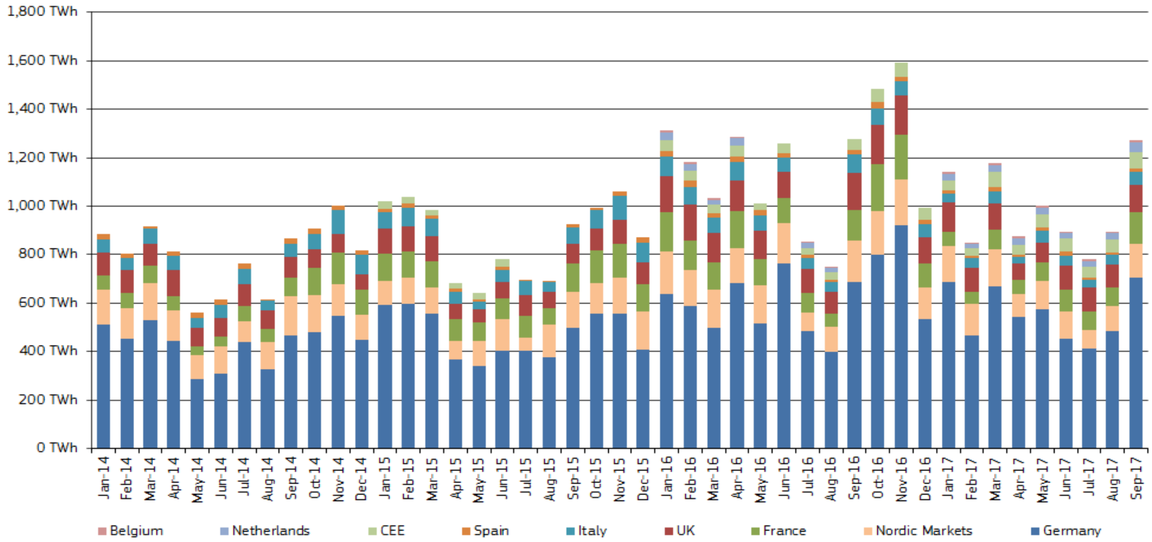
- In Q3 2017 in year-on-year comparison the total traded volume of electricity increased in Germany (by 2% or 35 TWh) , France (by 9% or 23 TWh) and Central and Eastern Europe (by 61% or 64 TWh) In contrast, the total traded volume of electricity decreased in the Nordic markets (by 11% or 37 TWh), in the UK (10% or 33 TWh), in Spain (by 16% or 7 TWh) and in Italy (24% or 39 TWh)

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

- Behind the increase of 3.3% in the overall traded volume of electricity there were different trends in different market segments. While OTC Bilateral contracts rose by 17%, exchange executed trade decreased by 15%, shifting the focus of trade from the exchange markets to the over-the-counter trade. In consequence, the share of OTC trade rose from 69% in Q3 2016 to 73% in Q3 2017.

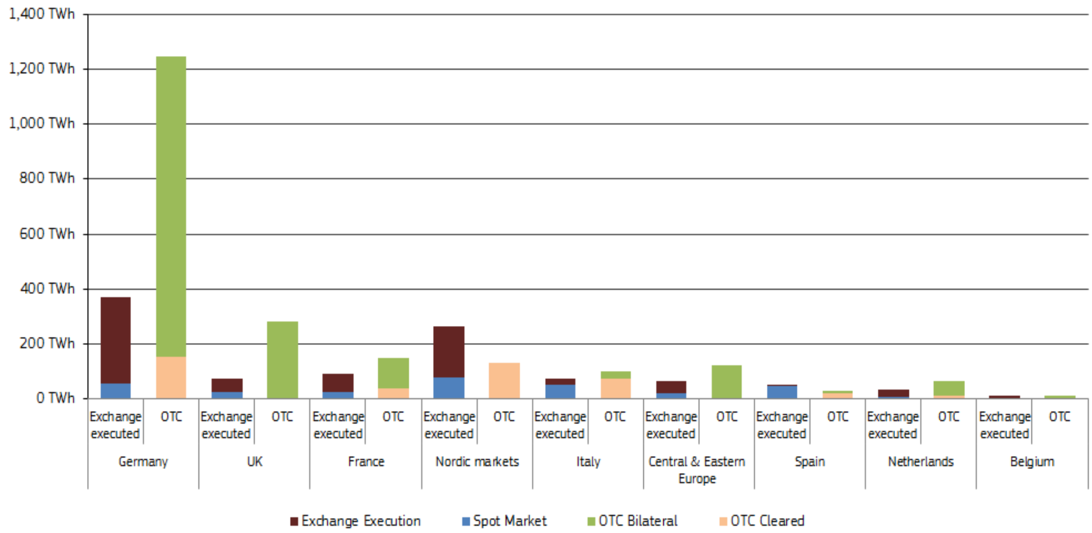
- Market liquidity can be measured by the so-called churn rates, providing information on the ratio of the total volume of power trade (including exchange executed and OTC markets) and electricity consumption in a given time period. Figure 15 shows the evolution of the quarterly regional churn rates between the beginning of 2014 until the second quarter of 2017. In Q2 2017 the decreasing trend of churn rates came to a halt and the churn rate of all observed markets rose slightly to 3.9 (from 3.8 observed in Q1 2017). However, churn rates did not change too much between the first and the second quarter of 2017 (e.g.: in Germany the churn rate decreased by 0.9 and reached 13.5, whereas in France it went up from 1.4 to 2.3). In the consequence of the further decrease in the churn rate, the UK became only the third most liquid market after the Nordic region (churn rates of 3.6 vs. 3.5).

Figure 13 – Monthly traded volume of electricity (incl. exchange executed and OTC) on the most liquid European markets



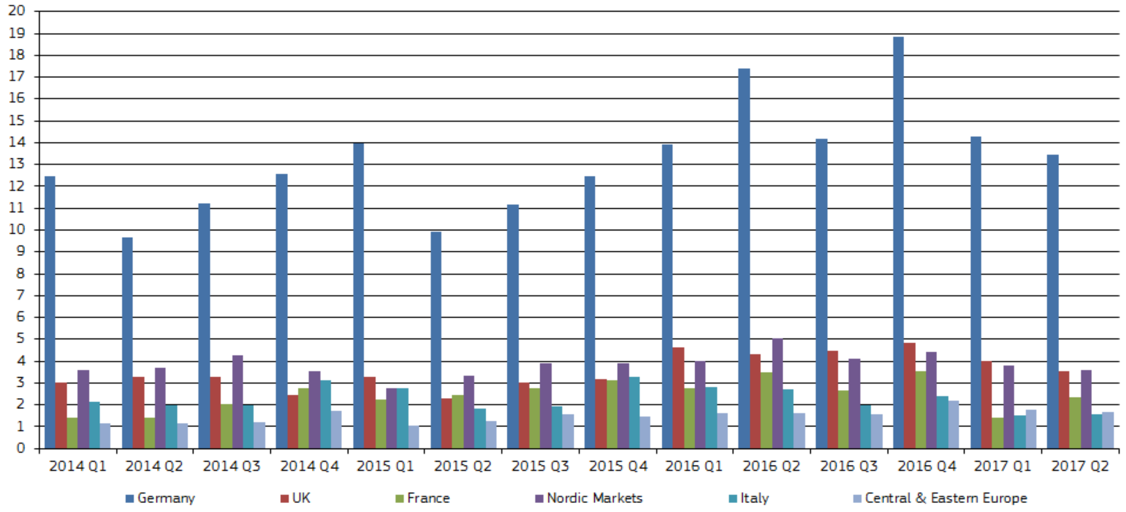
Source: Platts, wholesale power markets, Trayport, London Energy Brokers Association (LEBA) and DG ENER computations

Figure 14 - *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 15 *Quarterly churn rates on selected European wholesale electricity markets*

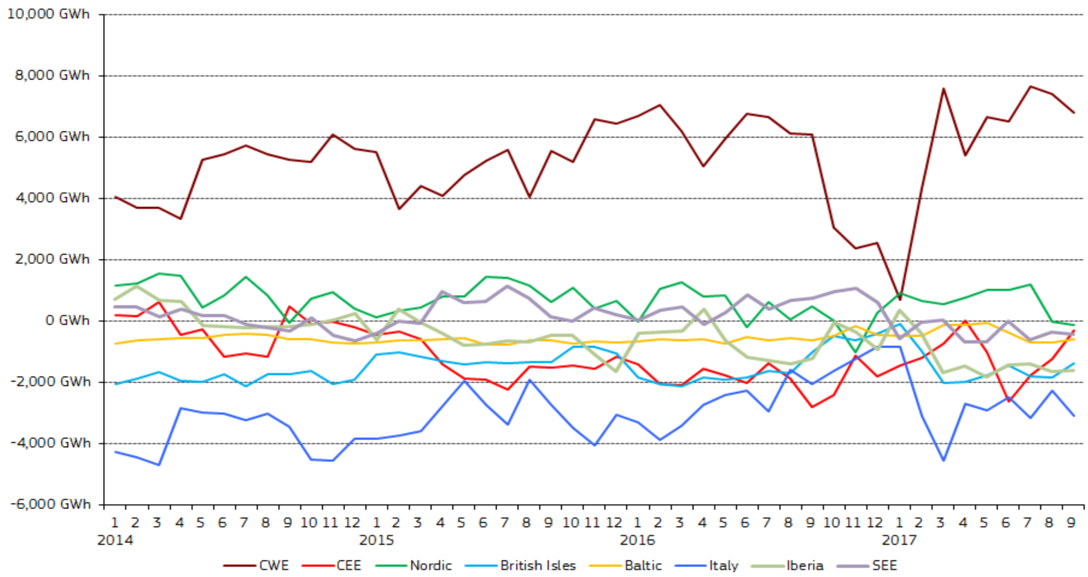


Source: Trayport, London Energy Brokers Association (LEBA), ENTSO-E and DG ENER computations

2.3 Cross-border trade of electricity

- As Figure 16 shows, in the third quarter of 2017 the Central Western Europe (CWE) power region reached its strongest net electricity exporter positon in the last few years, and it exported an amount of 7.3 TWh electricity on monthly average. During the three months of Q3 2017 electricity exports to Italy and the Iberian region picked up, relating to the significant price premium of these two regions to CWE markets.
- By the end of Q3 2017 the Nordic region was in a slight net importer position as there was not too much difference between the price level in the CWE and Nordic markets and the net electricity importer position of the CEE region also get closer to zero. In September 2017 all regions with the exception of the CWE were in net importer position.

Figure 16 – *EU cross border monthly physical flows by region*



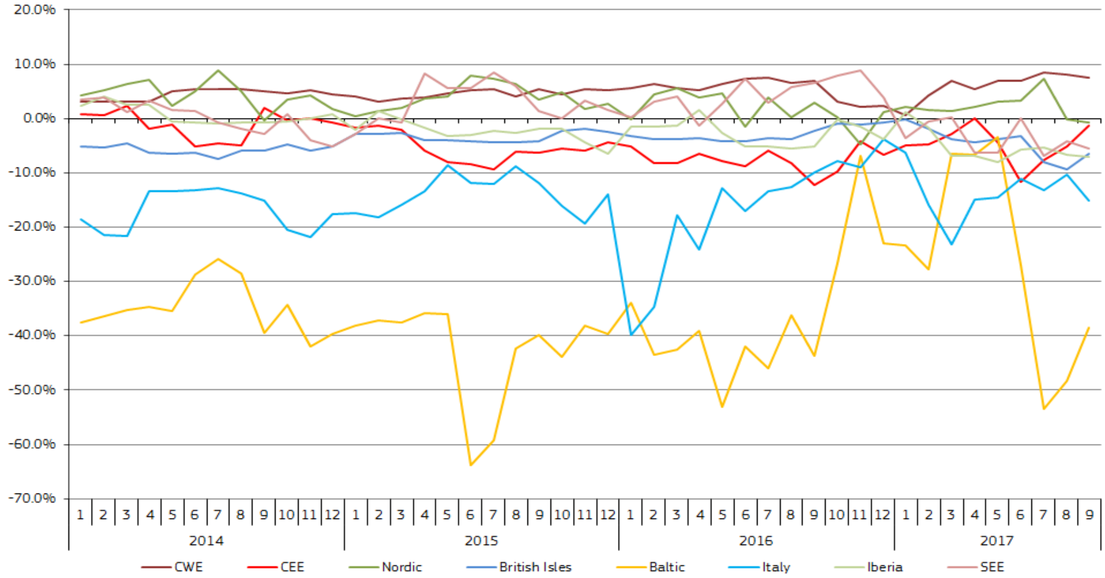
Source: ENTSO-E

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 17 shows the ratio of net electricity flow position to the domestic electricity generation in each region. In the third quarter of 2017 the net importer position compared to the domestic consumption got slightly closer to the equilibrium in the Baltic-states and the CEE region, which can be explained by decreasing import needs. In the case of the other regions there were no significant changes, and the net cross border position remained below, with the exception of Italy, than 10% of the total domestic electricity consumption in Q3 2017.

Figure 17 – *The ratio of the net electricity exporter position and the domestic generation in the regions*



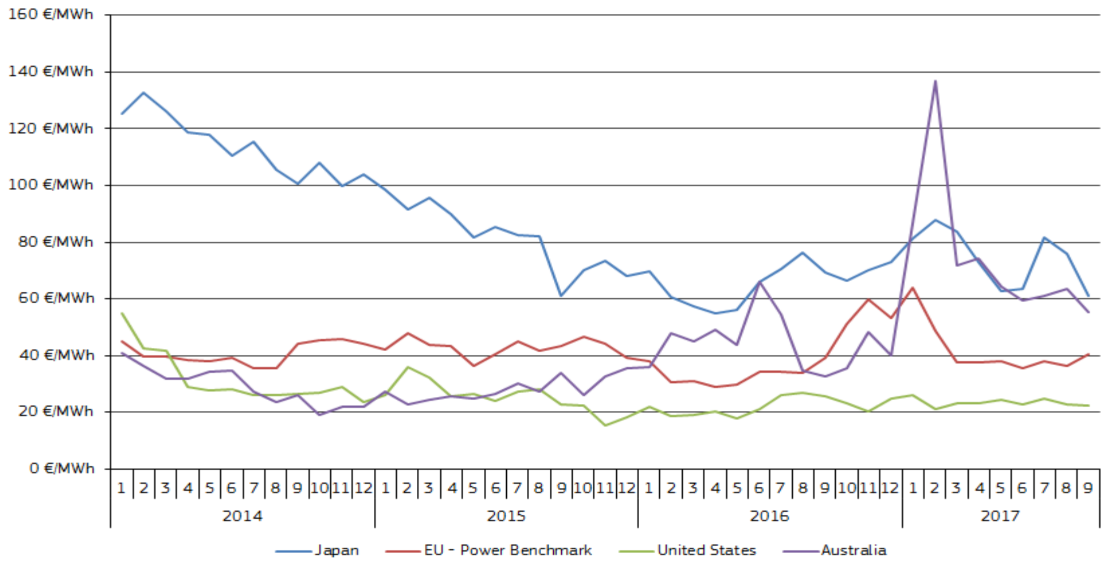
Source: ENTSO-E, own computations

2.4 Comparison of the EU wholesale electricity prices with international peers

- As Figure 18 shows, in the third quarter of 2017 the gap between wholesale electricity prices in Europe and the US widened again, as prices in Europe went up slightly, while in the US they moved to the opposite direction. As result, the monthly EU/US wholesale price ratio rose from 1.5 to 1.8 between June and September 2017. On quarterly average, in both Q2 and Q3 the EU/US price ratio was 1.6.

- Wholesale electricity prices in Japan showed a temporary upturn in July 2017, however, in August and September they fell back the level last seen mid-2016. In Australia wholesale prices continued their downward trend and in Q3 2017 they fell below the level of the Japanese contracts, though they were still high in long-term time series comparison.

Figure 18 – *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

3 Regional wholesale electricity markets

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

- In July and August 2017 wholesale baseload electricity prices in the CWE region fluctuated in a narrow range of 31-33 €/MWh on monthly average. In September 2017 the monthly average baseload price was slightly higher, reaching 36 €/MWh At the same time the regional average monthly peakload price rose from 33 €/MWh in August to 39 €/MWh in September 2017, as Figure 19 shows.

- The daily average regional day-ahead price varied between 22 €/MWh and 40 €/MWh during Q3 2017, however, the quarterly peak in France and Belgium reached 48 €/MWh, whereas in Germany on 30 July 2017 the daily average price fell to as low as 5 €/MWh (on this day and on some other Sundays – e.g.: on 20 August 2017 even negative prices could be observed during several hours). Figure 20 shows the daily average baseload contracts remained well-aligned during most of Q3 2017, however, during high renewable generation periods German prices were below the other peers in the region.

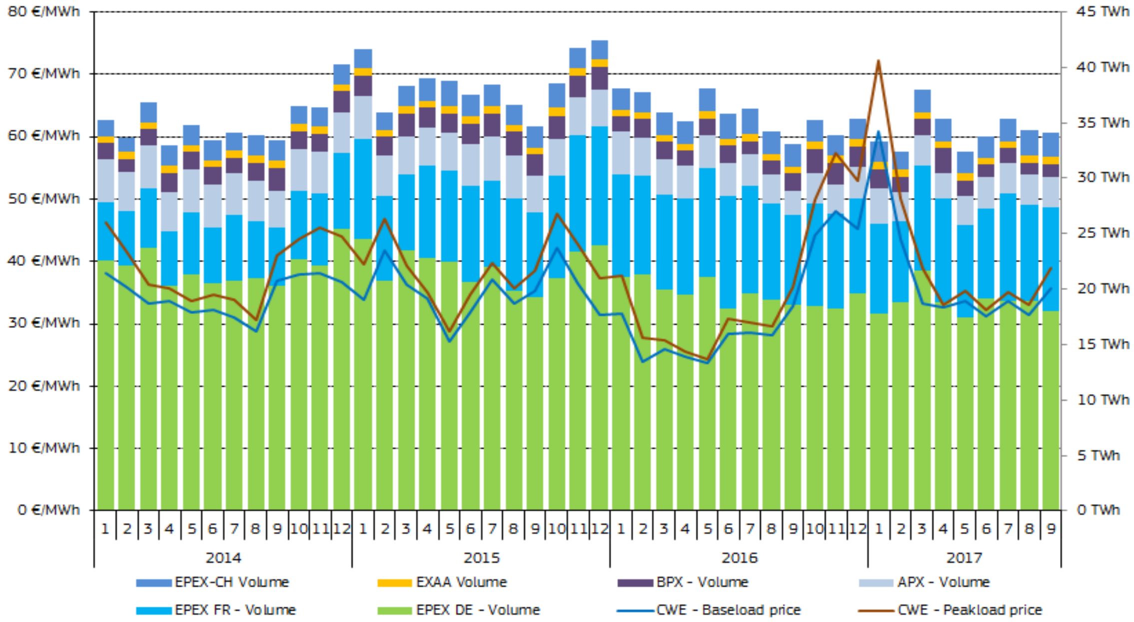
- On the demand side of the market the lack of temparatures being permanently higher than the long term seasonal average resulted in limited demand for cooling in the CWE region in July and August 2017. In the second half of September 2017 however, temperatures fell several degrees below the usual values and this increased heating related demand for electrcity,especially in France. In September demand for electricity usually increases on the back for rising lighting needs (the daylight period gets shorter) and on increasing demand from industry after the end of the summer holiday period.

- On the supply side of the market, both coal and gas prices showed a gradual increase in the third quarter of 2017, resulting in rising electricity generation costs. However, wind and solar generation in the CWE region showed significant year-on-year increases in Q3 2017, contributing to mitigating the impact of increasing fossil fuel generation costs. Hydro reservoir levels in Austria, Switzerland and France continued to increase, following the usual seasonal pattern, and in Q3 2017 hydro generation was up in the region, both compared to the previous quarter and to the same quarter of 2016.

- Moreorver, nuclear availability and generation in France (see Figure 21), in contrast to the first half of 2017, improved significantly, and was higher in Q3 2017 (week 27-39 on the chart) than in the same quarter of 2016. In Germany the Brokdorf nuclear power plant, having 1.4 GW nameplate capaicty, returned to the grid at the end of July and in August practically all reactors of the country's nuclear fleet were operational Good nuclear avilability in both Germany and France contributed to low wholesale electricity prices in the CWE region in August 2017. However, in September announcements on the expected temporary shut down of the Tricastin nuclear reactor in

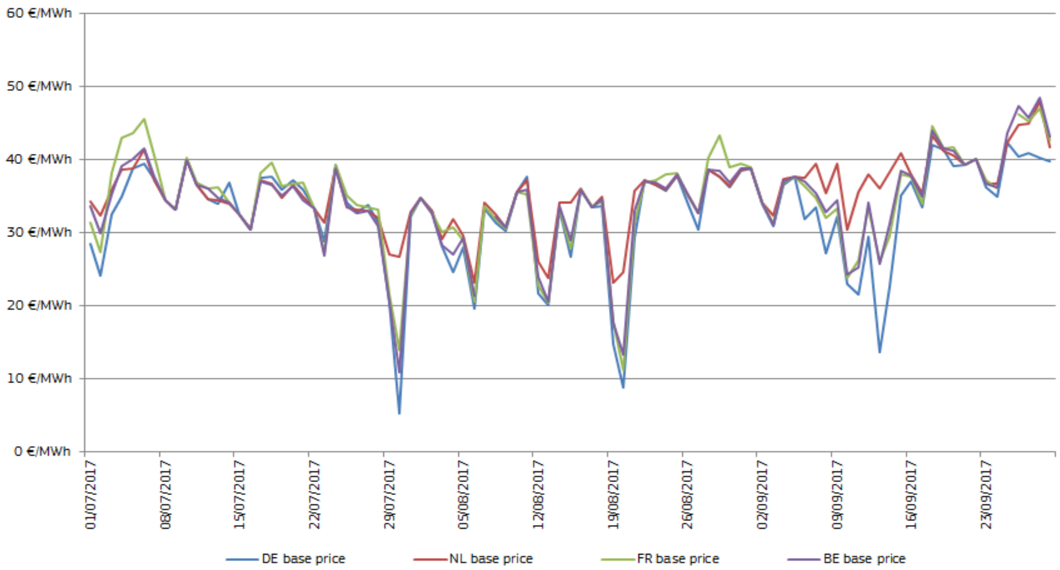
France sparked some fears on nuclear availability in France, resulting in an upward pressure on wholesale electricity prices.

Figure 19 - *Monthly exchange traded volumes of day-ahead contracts and monthly average prices in Central Western Europe*



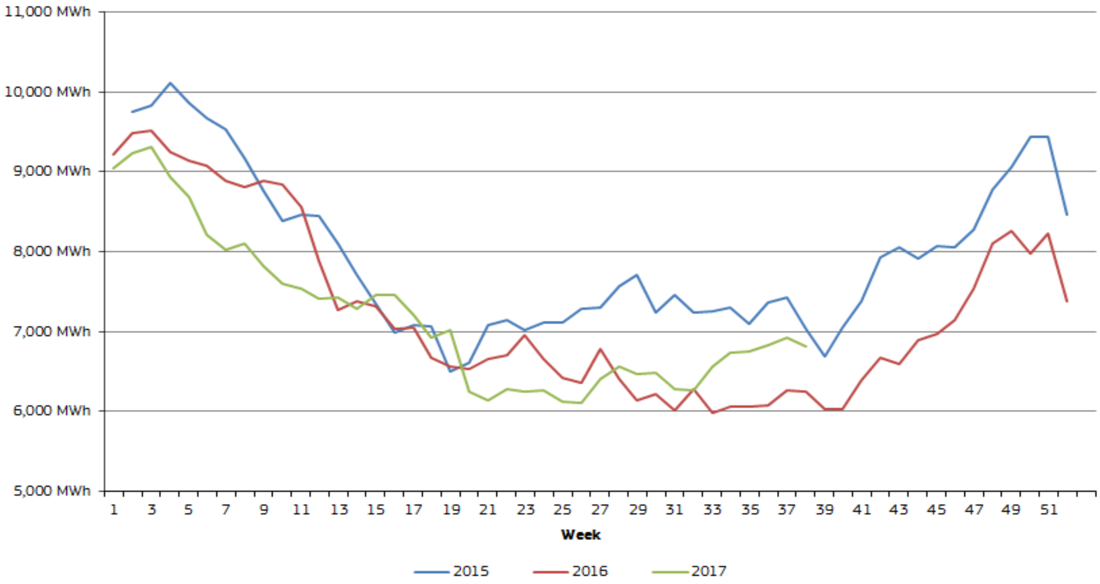
Source: Platts, EPEX

Figure 20 – *Daily average wholesale power prices in the CWE region*



Source: Platts.

Figure 21 – *The weekly amount of generated nuclear electricity in France*

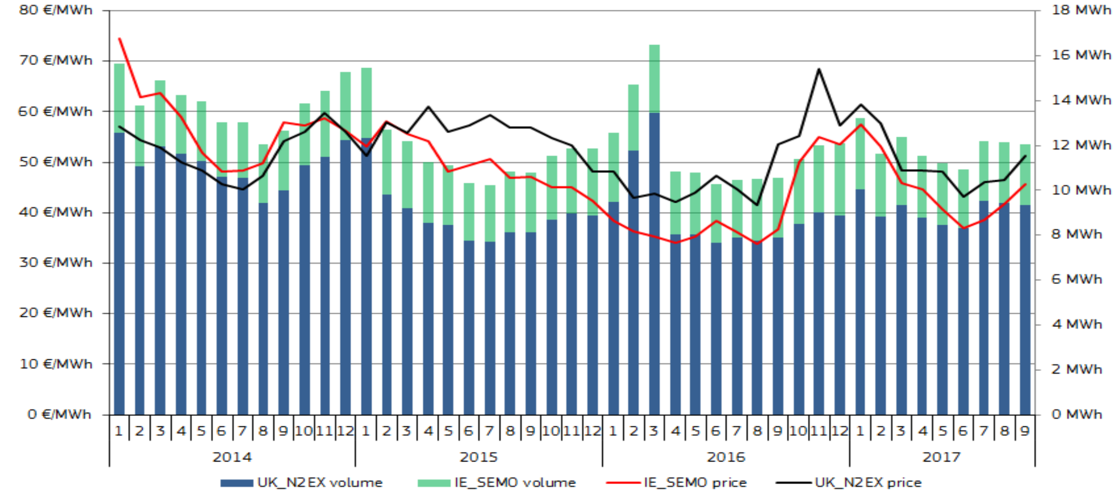


Source: ENTSO-E

3.2 British Isles (UK, Ireland)

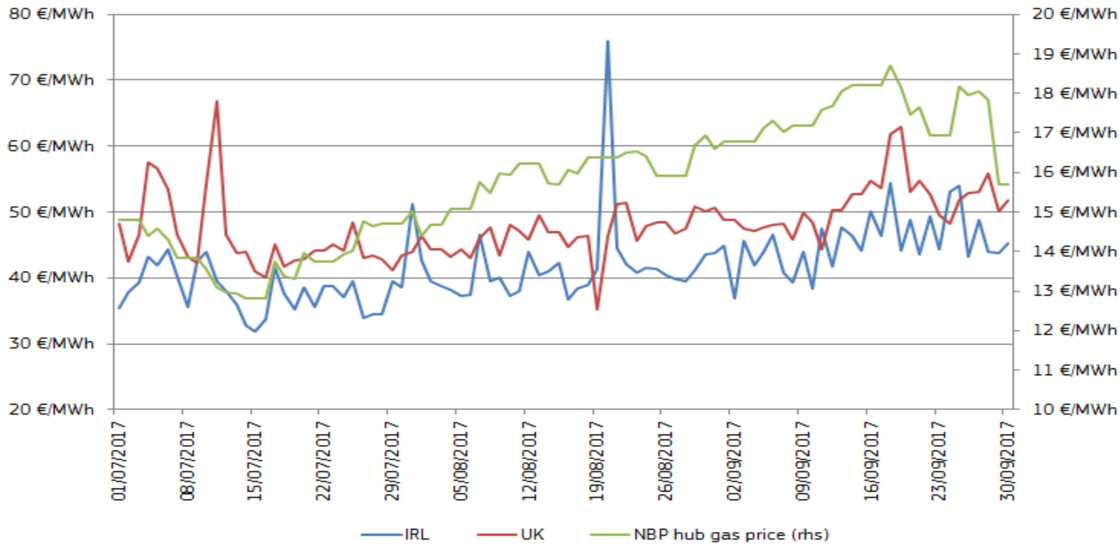
- Wholesale baseload electricity prices both in the UK and Ireland showed a measurable increase in the third quarter of the year: while in June 2017 the monthly average baseload price was 37 €/MWh in the Ireland and 43 €/MWh in the UK, by September 2017 they respectively rose to 46 €/MWh and 51 €/MWh, as Figure 22 shows.
- During most of Q3 2017 (see Figure 23), daily average wholesale electricity prices in the UK and Irish markets moved in parallel with increasing natural gas prices as in this period the UK market was relatively undersupplied by natural gas, partly owing to low LNG imports. In mid-June 2017 the price of natural gas on the NBP hub in the UK was less than 13 €/MWh, while at the end of September it was close to 18 €/MWh.
- The impact of increasing natural gas prices on the cost of electricity generation in the UK was partially mitigated by increasing share of wind and solar generation. The year-on-year change in the UK domestic electricity generation mix between the third quarter of 2016 and 2017 can be followed on Figure 24. While wind had a share of 10.3% in Q3 2016, its share rose to 13.5% in the third quarter of 2017, however, in some periods (e.g.: week 37 of 2017 the share of wind in the electricity mix was almost 20%). At the same time the share of gas was 42% in Q3 2017, being 5 per cent lower than in the same quarter of 2016.
- At the end of August 2017 the France-UK electricity interconnector, having 2 GW capacity, experienced a forced outage, and as of mid-September it was set to run at half capacity (1 GW) for scheduled maintenance for a three week long period, reducing the available electricity imports from continental Europe. Furthermore, in mid-September the other interconnector with the continent (the Brit-Ned link) was also set to operate at half capacity, further reducing electricity import availabilities to the UK.
- In the consequence of reduced interconnector capacities with the European continent and dwindling wind generation, on 18-19 September 2017 the daily average wholesale electricity price in the UK rose to as high as 63 €/MWh, being the highest in ten weeks' time. Tight supply margins, in the case of reduced availability of baseload generation technologies or import capacities can result in high price volatility, in parallel with increasing share of variable sources in electricity generation in a given market.

Figure 22 – *Monthly electricity exchange traded volumes and average day-ahead wholesale baseload prices in the UK and Ireland*



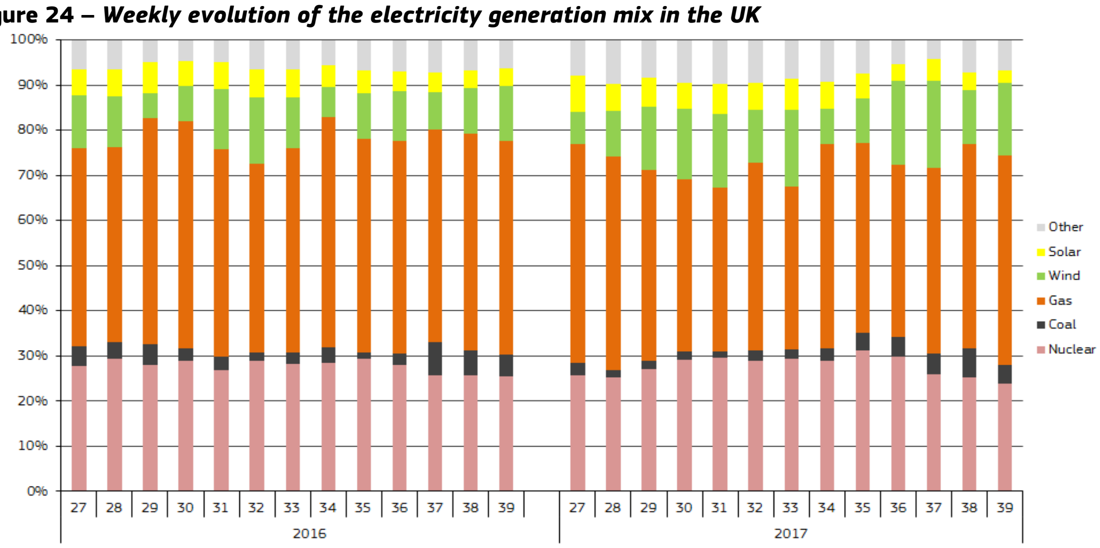
Source: Nordpool N2EX, SEMO

Figure 23 – *Daily average baseload electricity prices in the UK and Ireland*



Source: Nordpool N2EX SEMO

Figure 24 – *Weekly evolution of the electricity generation mix in the UK*

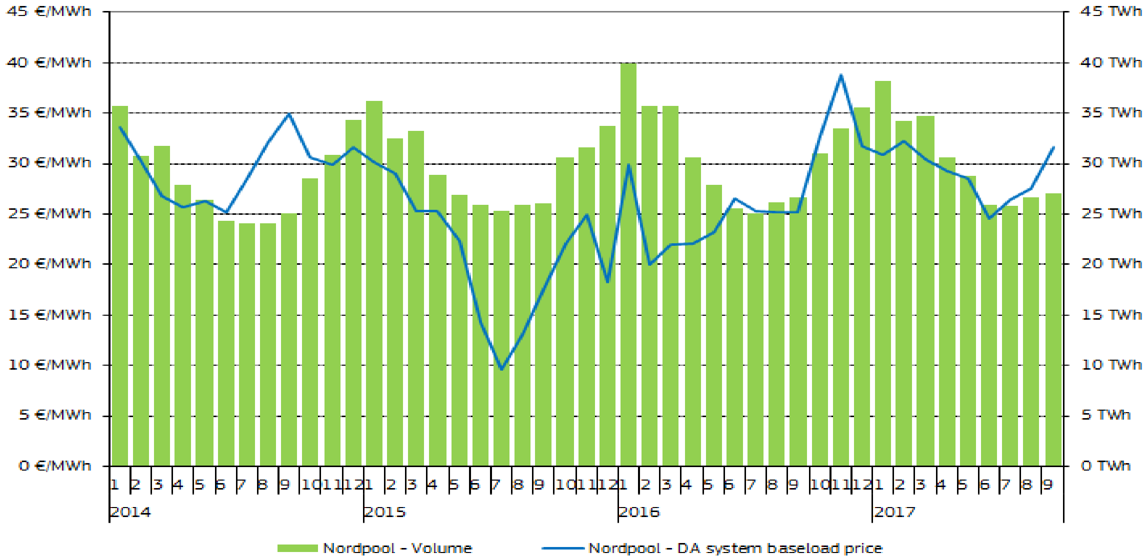


Source: ENTSO-E

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

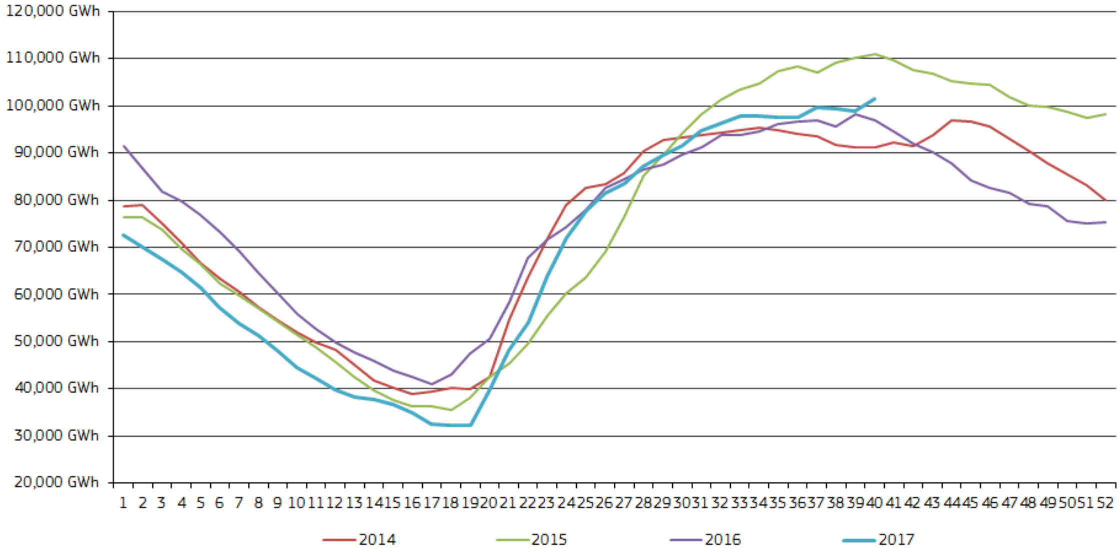
- As Figure 25 shows, in the third quarter of 2017 the monthly average wholesale system electricity price in the Nordpoolspot market slightly decreased (from 24 €/MWh to 32 €/MWh between June and September 2017). The monthly average of September 2017 was the highest September price since 2014.
- In the first half of 2017 hydro availability in the Nordic region was lower than in 2014-2016. However, during most of Q3 2017 the combined hydro reservoir level of Norway, Sweden and Finland were higher than in 2014 and 2016 and it was close to the levels of 2015, as it can be followed on Figure 26.
- However, some conventional generation technologies in the region, mainly nuclear, had lower share than in the same period of the previous year, that resulted in higher import needs from Russia to Finland and to the Baltic states, and higher wholesale electricity prices across in the Eastern part of the Nordic region.
- Different market prices in the Nordic region can also be followed on Figure 27, showing that daily price volatility in the Baltic countries and Finland is higher than in Norway, Sweden and Denmark, in spite of improvements in the regional interconnector capacities over the last few years. Increasing price volatility can be observed during the periods of increasing electricity demand and hence increasing imports from outside the Nordic region, normally during winter periods and summer heat waves.

Figure 25 – *Monthly electricity exchange traded volumes of and the average day-ahead wholesale prices in Northern Europe*



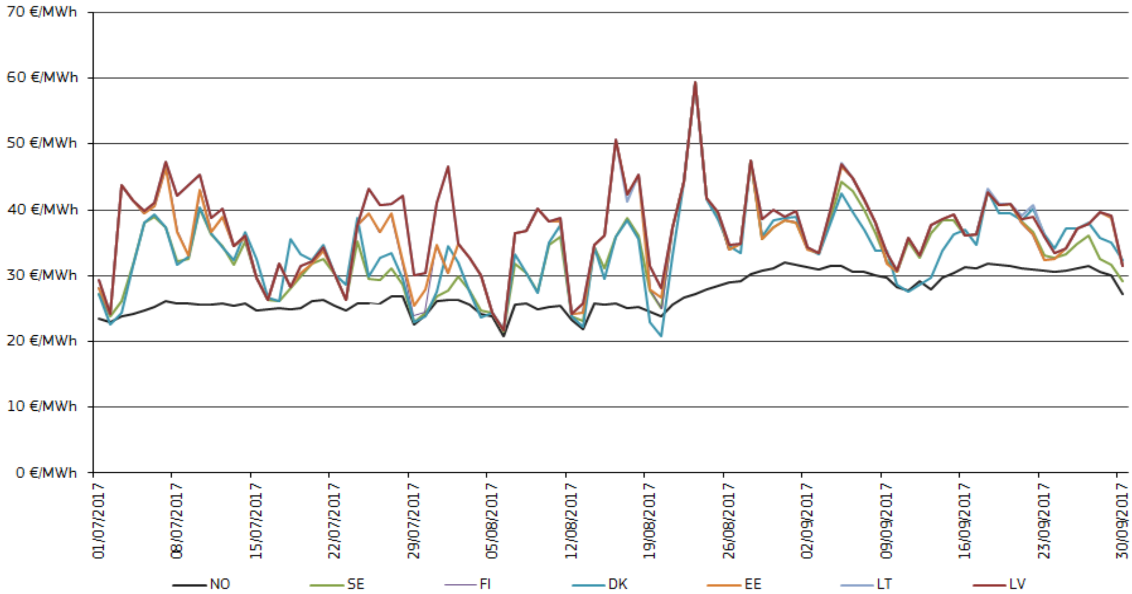
Source: Nordpool spot market

Figure 26 –*Weekly combined hydro reservoir levels (Norway, Sweden and Finland) in the Nordic region in different years*



Source: Nordpool spot market

Figure 27 – *Daily average market prices in the Nordic region*



Source: Nordpool spot market

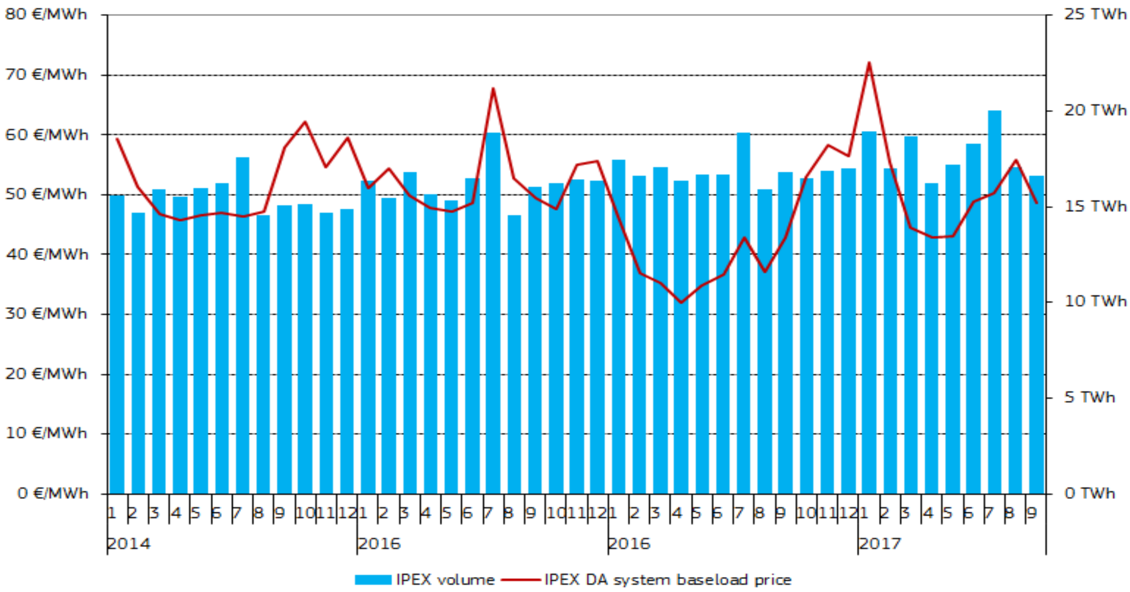
3.4 Apennine Peninsula (Italy)

- The Italian wholesale baseload electricity price, as Figure 28 shows, continued its upward trend in July and August 2017, reaching in the latter month 56 €/MWh on average, which was the highest since February 2017. In September however, the monthly average price fell back to 48 €/MWh.
- On the demand side, daily average temperatures in July and August 2017 were higher than the long term daily averages during most of the time in Italy, resulting in an increase in domestic needs for cooling, which also exerted an upward pressure on wholesale electricity market prices. In September however, daily temperatures were more or less in line with the long term seasonal values, resulting in the lack of upward pressure on wholesale electricity prices, which might have contributed to decreasing market prices.
- On the supply side important factors, such as increasing natural gas prices, being an important driver of wholesale electricity price in Italy, should be mentioned. Moreover, the quarterly share of natural gas increased in the Italian

power generation mix (from 24% to 27% between the second and the third quarter of 2017), while the share of hydro decreased at the same time (19% to 16%), leaving more room for costlier fossil fuel generation sources that ensured an upward price support for Italian wholesale electricity prices.

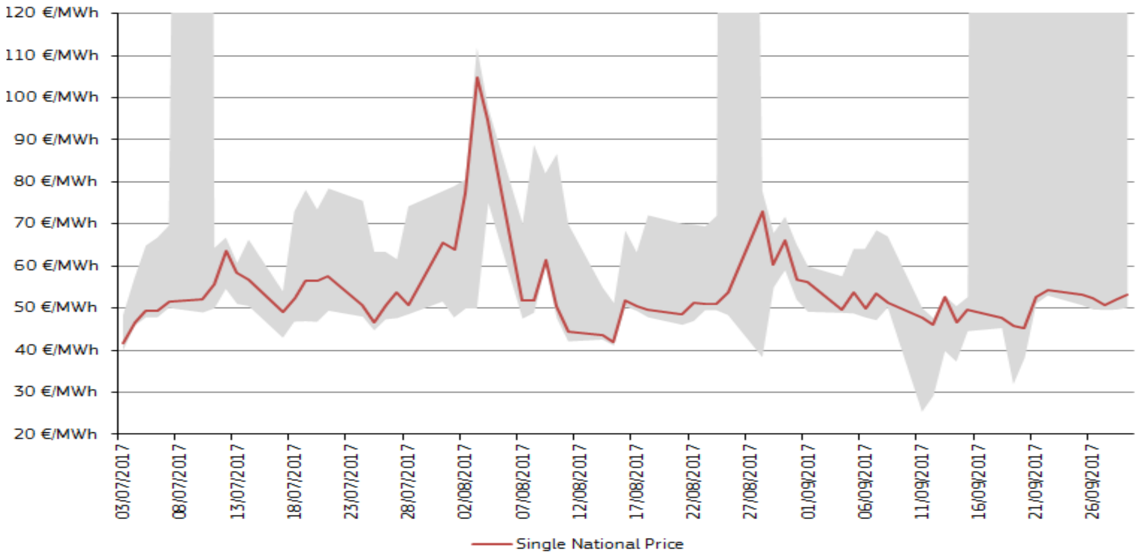
- Figure 29, shows the daily evolution of the national average price and area prices in the Italian market. The biggest price spike could be observed during the early August heat wave, when on 3-4 August 2017 there were several hours with the national average wholesale electricity price being above 100 €/MWh. In the Corsica region, having limited interconnection capacities[5] with mainland Italy, prices reached 3,000 €/MWh on several trading days in September 2017.

Figure 28 - *Monthly electricity exchange traded volumes and average day-ahead wholesale prices in Italy*



Source: GME (IPEX)

Figure 29 – *Daily average wholesale electricity prices in the Italian market, within the range of different area prices*



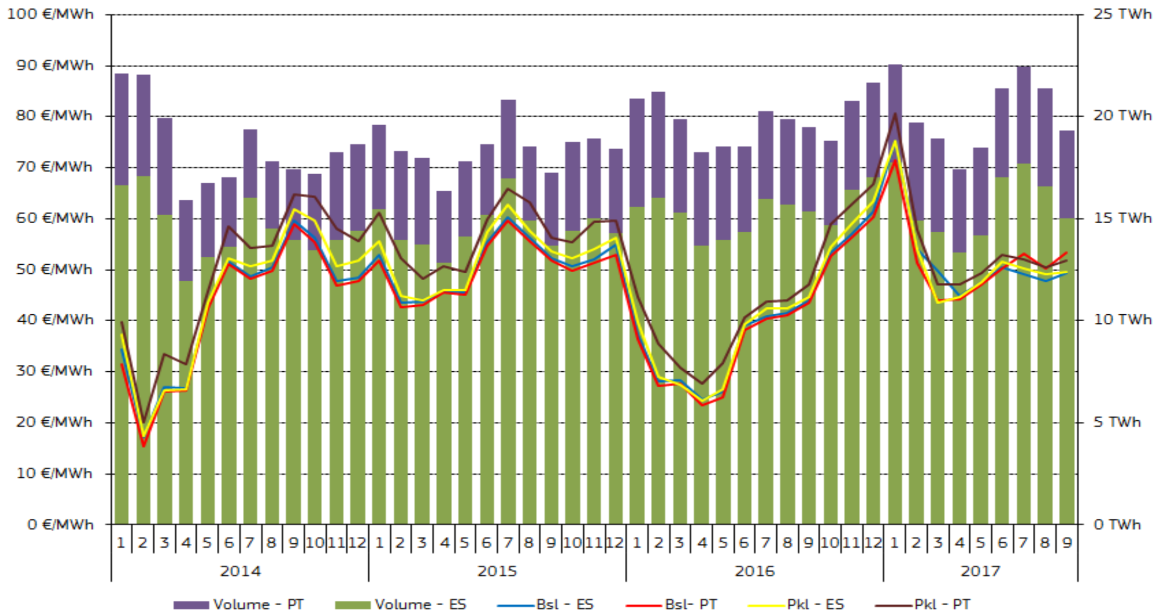
Source: GME (IPEX) – Shaded area reaching out towards the top of the chart implies that in some regions the local price reached 3000 €/MWh

[5] The Clean Energy for EU Islands initiative aims at reducing the energy imports dependency of islands by making better use of their own renewable energy sources and embracing more modern and innovative energy systems. This will help reduce energy costs and at the same time improve air quality and lower greenhouse gas emissions : https://ec.europa.eu/energy/en/news/clean-energy-eu-islands-launched-malta

3.5 Iberian Peninsula (Spain and Portugal)

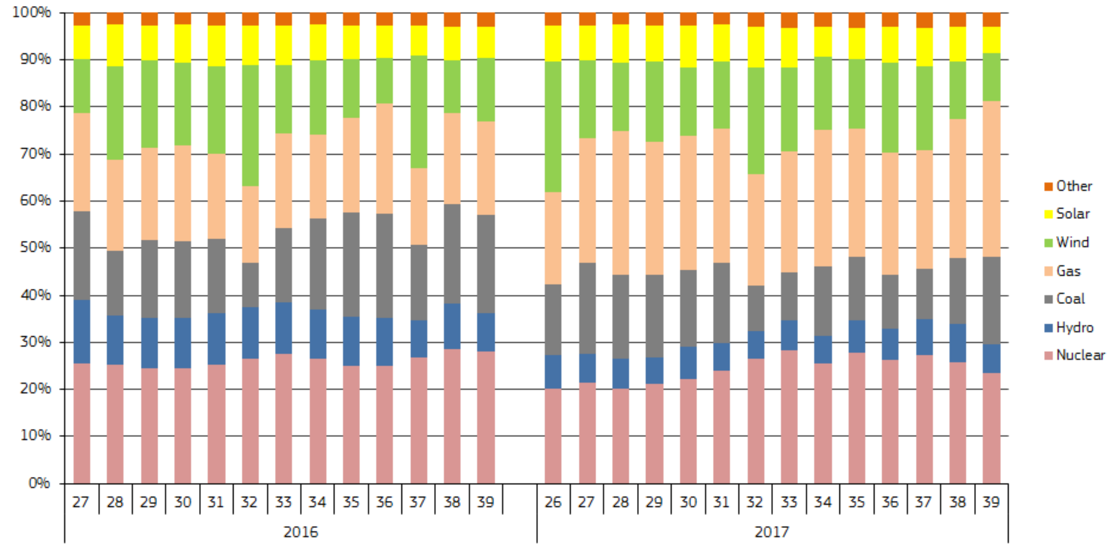
- In the third quarter of 2017 the monthly average wholesale baseload contracts in Spain and Portugal showed a high degree of stability: the Spanish baseload contract fluctuated in a range of 47-49 €/MWh, while the Portuguese baseload varied between 51 €/MWh and 53 €/MWh. The monthly peakload averages were between 49 €/MWh and 50 €/MWh in Spain, while in Portugal they were in a narrow range of 50-52 €/MWh - see Figure 30.
- Contrary to many summer periods in earlier years, in July and August 2017 temperatures in Spain and Portugal did not significantly exceed the long term values, putting a lid on residential demand for cooling, which also contributed to the stability of wholesale electricity prices in the Iberian region.
- Figure 31 shows the evolution of the weekly electricity generation mix in Spain, comparing the third quarter of 2017 with the same quarter of 2016. It seems that the share of wind at the beginning of Q3 2017 was higher than a year before, helping in keeping electricity generation costs under control. However, the share of hydro in in Q3 2017 was lower than a year before (10% vs. 6%), whereas the share of nuclear also slightly decreased, leaving a higher share for costlier fossil fuel generation.
- Within fossil fuels, there was a significant shift from coal to gas: whereas in Q3 2017 in year-on-year comparison the share of gas in the Spanish electricity mix went up from 19% to 27%, at the same time the share of coal decreased from 20% to 16%. This was the consequence of the increase in coal prices between these periods, making gas-fired generation more competitive.
- In the second half of September 2017 electricity imports in the Iberian-peninsula decreased as the capacity on the interconnector with France was reduced to 1 GW due to planned maintenance works. In itself this measure did not result in significant change in market prices, as the price premium of the Spanish wholesale electricity market to France remained in a range of 10-20 €/MWh in this period. However, the variable nature of wind power generation amid restricted electricity imports made the wholesale electricity prices more volatile on the short run.

Figure 30 - *Monthly electricity exchange traded volumes and average day-ahead prices in the Iberian Peninsula*



Source: Platts, OMEL

Figure 31 – *Weekly evolution of the electricity generation mix in Spain, comparing the third quarter of 2016 and 2017*



Source: ENTSO-E

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

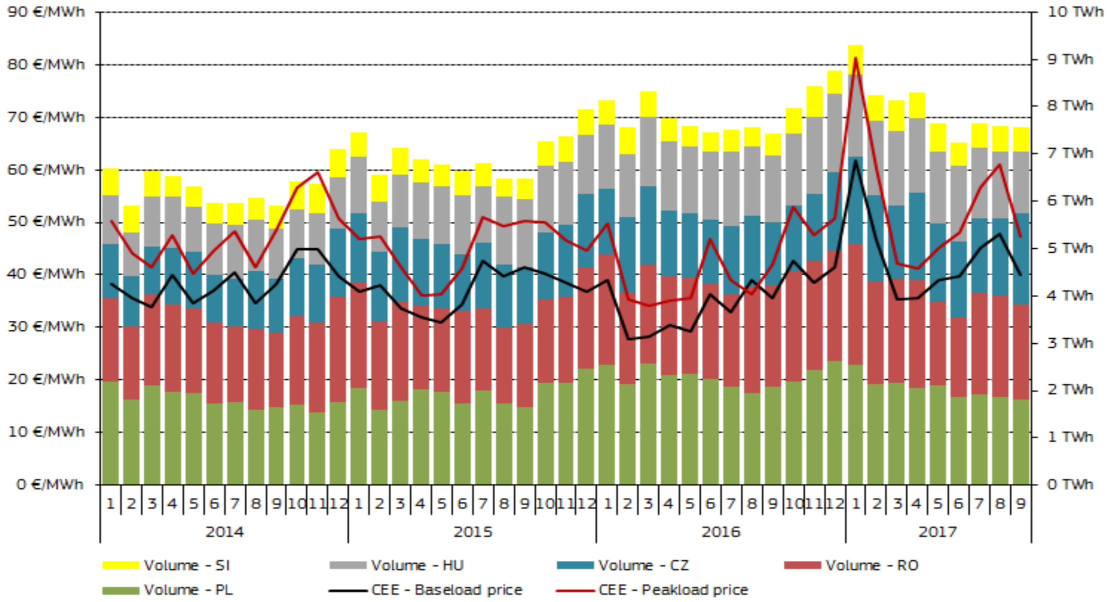
- The regional monthly average price in Central and Eastern Europe (CEE) reached the highest in August 2017 since the February of this year: in this month the average baseload was 48 €/MWh, while the peakload increased to 61 €/MWh. In September 2017 both baseload and peakload averages fell back close to their values measured in June 2017 (respectively 40 €/MWh and 47 €/MWh), as Figure 32 shows.

- In July and August 2017 there were many trading days when daily average temperatures in most of the regional countries were several degrees higher than the long term daily average; as it can be followed on Figure 33. During the early days of August (especially on the 3rd and 4th), temperatures were particularly high in the countries of the CEE region, and this impacted many of the regional wholesale prices, as it can also be followed on Figure 34.

- However, wholesale electricity prices in Hungary, Romania and Slovakia were more impacted by the heatwave as prices in the Czech Republic and Poland. Czech and Slovak prices, normally closely aligned to each other, showed significant differences on several trading days during the third quarter of 2017. The southern part of the CEE region depends on hydro-based electricity imports from the Balkans, and during dry and hot periods imports are limited. At the same time the northern part (Czech Republic, Poland) has better access to competitive electricity imports from Western Europe.

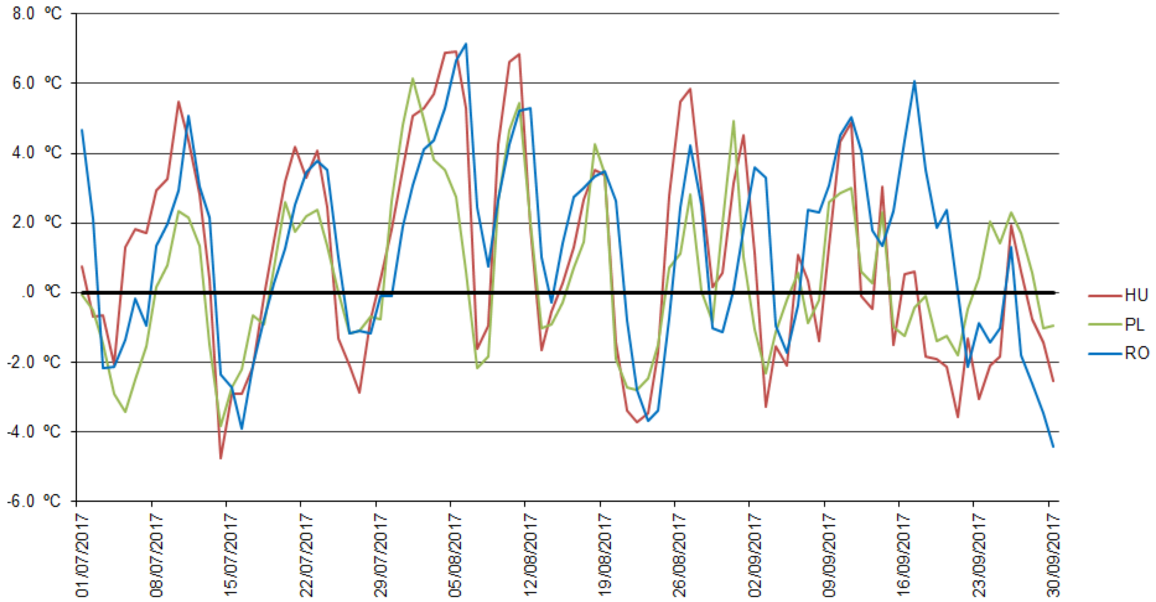
- During almost all of Q3 2017 wholesale electricity prices were the highest in Romania in the whole CEE region, primary owing to lower than usual hydro and nuclear electricity generation in the country, even making the traditionally electricity supplier country in the whole CEE region net importer of power in some periods. In Hungary one of the four nuclear reactors (with a nameplate capacity of 500 MW) was still offline for maintenance works, adding to the country's electricity import needs amid high consumption during hot summer period in August 2017. As of the second half of September 2017, as the summer hot weather was over and hydro availability improved, prices across the CEE region recoupled and price divergences practically disappeared.

Figure 32 - *Monthly electricity exchange traded volumes and average day-ahead prices in Central Eastern Europe*



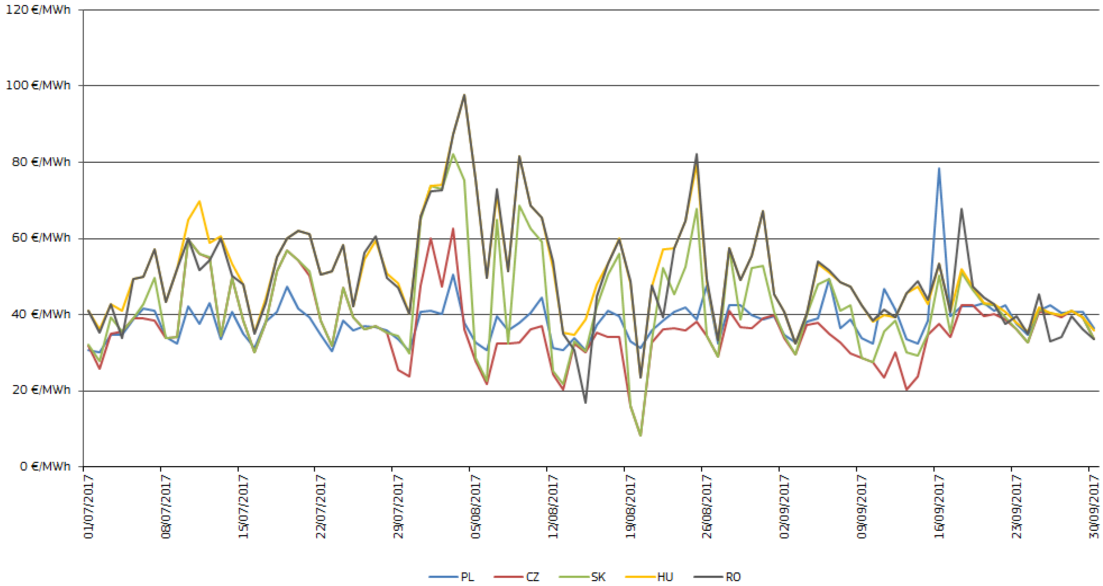
Source: Regional power exchanges, Central and Eastern Europe (CEE)

Figure 33 – *Difference between the actual daily average temperature and the long term average (1975 – 2016)*



Source: JRC, DG ENER own computations

Figure 34 – *Daily average wholesale power prices in the CEE region*



Source: Platts, CEE Regional power exchanges

3.7 South Eastern Europe (Greece and Bulgaria)

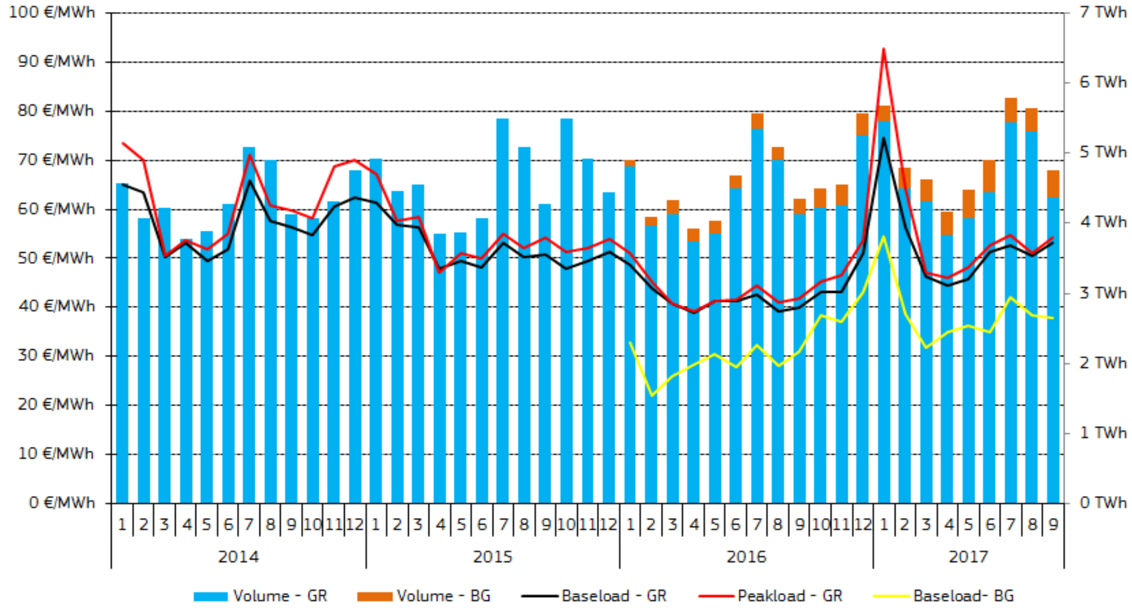
- Wholesale electricity prices in Greece were relatively stable during the third quarter of 2017, as it can be followed on Figure 35. The monthly average baseload price fluctuated in a narrow range of 51 €/MWh and 53 €/MWh between July and September 2017, while at the same time peakload contracts varied between 51 €/MWh and 55 €/MWh. In Bulgaria the monthly average baseload price remained stable in a narrow range of 38-42 €/MWh during Q3 2017.

- Similalry to other southern countries in Europe, temperatures were generally higher in July and August 2017 compared to the long term daily averages. However, in Greece and Bularia extra power demand stemming from residential cooling did not result in wholesale price spikes, though in Serbia there were some trading days with prices above 80 €/MWh.

- Looking at the daily average price contracts (see Figure 36), Greek prices fluctuated between 42 €/MWh and 60 €/MWh during Q3 2017, and were less volatile compared to the Romanian and Serbian prices, being more affected by changes in hydro availability in the Balkans. Bulgarian prices were also relatively stable, ranging between 25 €/MWh and 60 €/MWh, though hydro availability in the country was generally lower throughout Q3 2017 than in the same quarter of the previous two years.

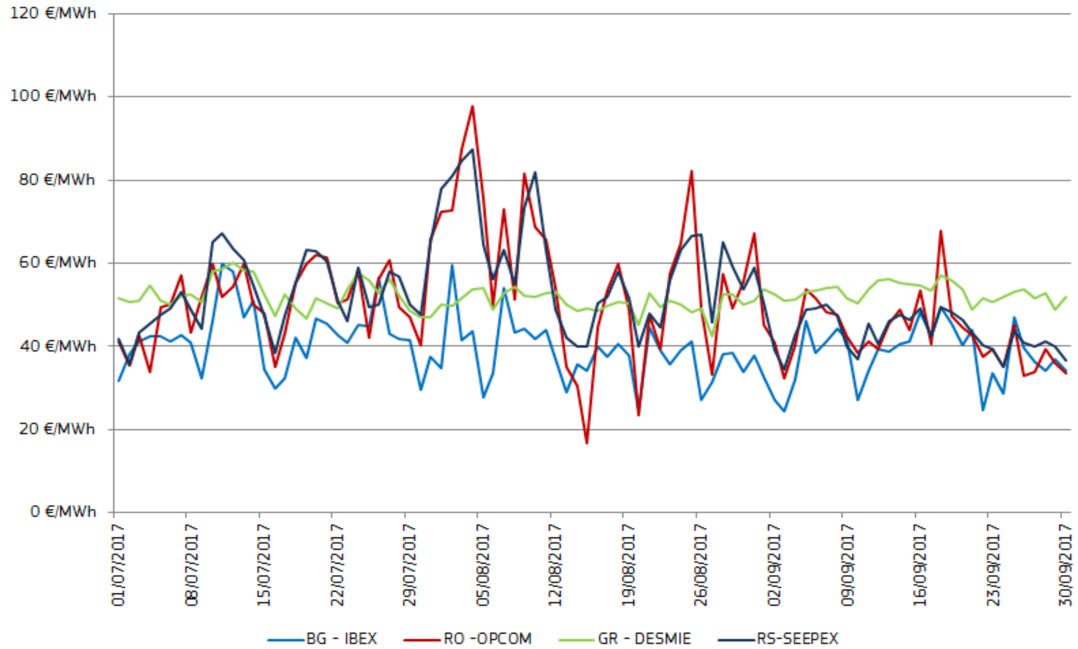
- On the supply side, the share of hydro in Q3 2017 in the Greek electricity generation mix decreased compared to the same quarter of 2016. At the same time the share of wind and solar remained practically the same. In contrast, the share of costlier fossil fuels, namely gas and lignite, increased in Q3 2017 in year-on-year comparison; however, increasing imports from neighbouring countries offered a competitive alternative to higher domestic generation costs. In Bulgaria lower hydro availability was compensated by increasing electricity generation based on cheap domestic lignite, helping in keeping the generation costs and wholesale electricity prices under control.

Figure 35 - *Monthly traded volumes and prices in Greece and Bulgaria*



Source: LAGIE, IBEX

Figure 36 – Comparison of daily average day-ahead prices in Bulgaria, Greece, Romania and Serbia



Source: IBEX, LAGIE, OPCOM, SEEPEX

4 Retail electricity prices in the EU

4.1 Retail electricity prices in the EU Member States

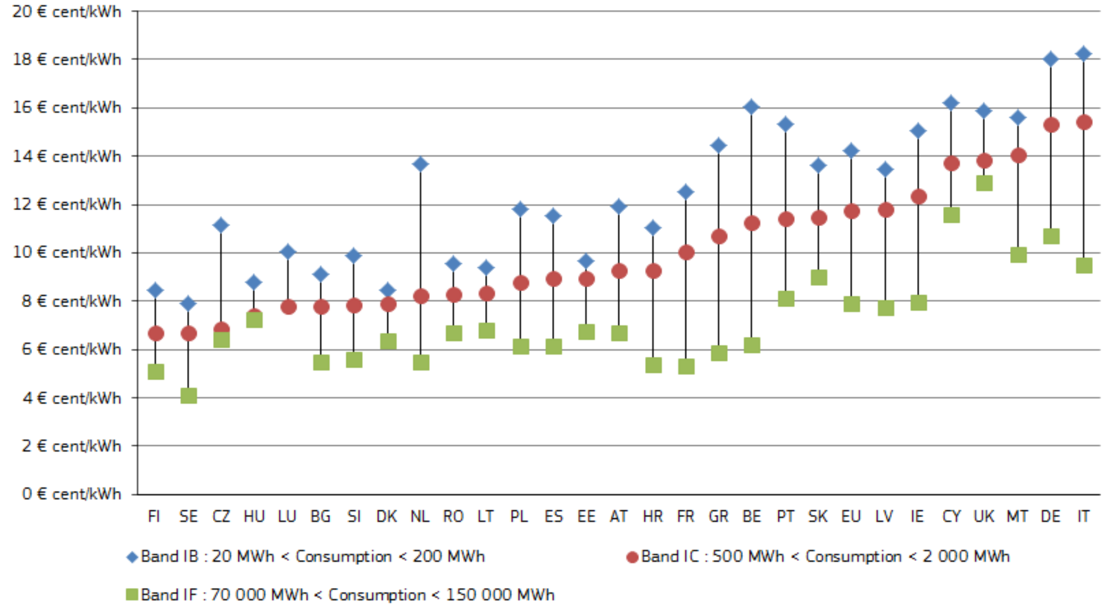
- Figure 37 and Figure 38 show the monthly estimated retail electricity prices in September 2017 in the 28 EU Member States for industrial customers and households for three different levels of annual electricity consumption (Eurostat bands I_B, I_C and I_F for the industrial customers and bands D_B 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 September 2017 Italy was the most expensive country (with a price of 18.2 Eurocent/kWh), while Sweden was the cheapest (7.9 Eurocent/kWh). At the same time in the case of households with low annual consumption retail electricity prices were the lowest in Bulgaria (9.9 Eurocent/kWh), while households had to pay the most in Germany (34.0 Eurocent/kWh).

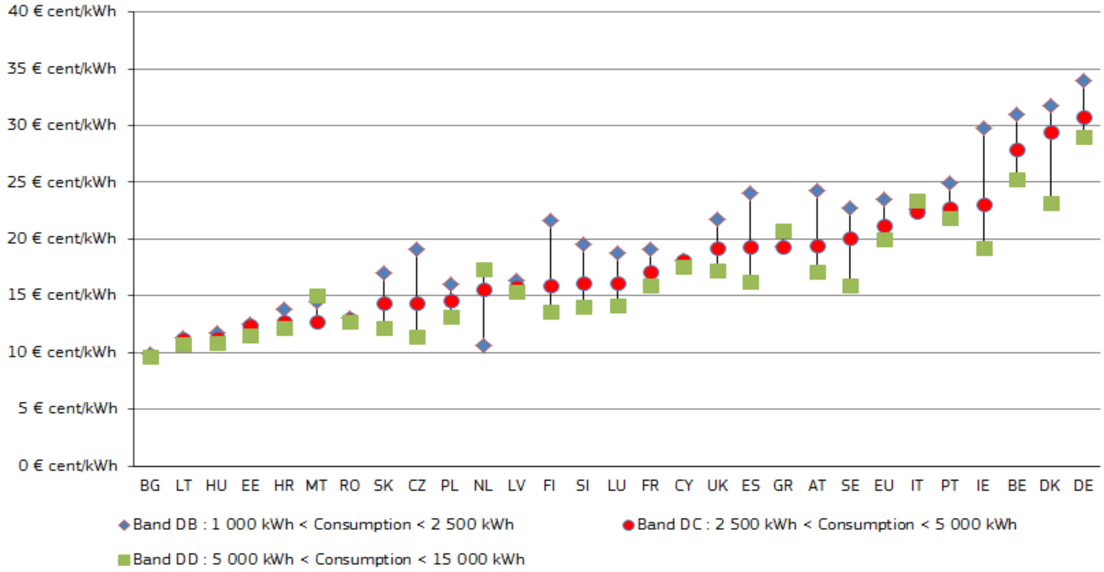
- In the case of industrial customers, having medium level annual electricity consumption (Band I_C), the monthly ratio of the highest and the lowest price in the EU was 2.3 (6.7 Eurocent/kWh in Finland and Sweden, 15.4 Eurocent/kWh in Italy), while in the case of large industrial customers it was 3.1 (4.1 Eurocent/kWh in Sweden, 12.9 Eurocent/kWh in the United Kingdom) in September 2017. In the same month, in the case of households with medium level annual consumption (Band D_C) the highest-lowest price ratio was 3.1 (9.8 Eurocent/kWh in Bulgaria, 30.8 Eurocent/kWh in Germany).

Figure 37 – *Estimated industrial retail electricity prices, September 2017 –without VAT and recoverable taxes and levies*



Source: Eurostat, DG ENER

Figure 38 - *Estimated household retail electricity prices, September 2017 –all taxes included*

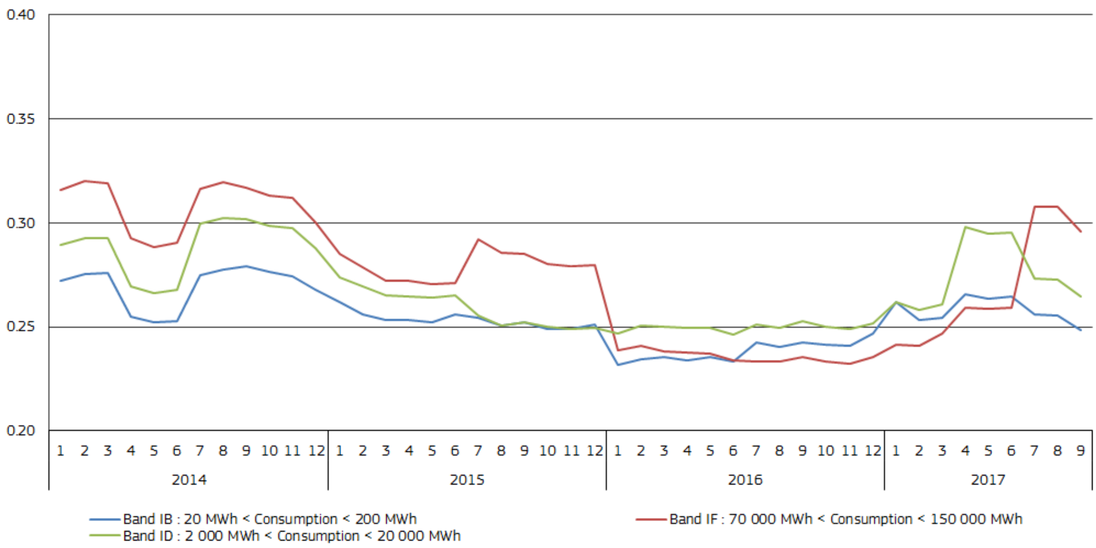


Source: Eurostat, DG ENER

- Figure 39 and Figure 40 show the different behaviour of industrial and household retail price convergence across the EU, using relative standard deviation of retail electricity prices as metric. In the case of industrial customers there had been a convergence in retail electricity prices over the last few years, and the relative standard deviation mostly decreased over time. After a temporary increase in price divergence across Europe in the second quarter of 2017, the relative standard deviation of industrial electricity prices resumed decreasing in Q3 2017, so retail prices started to re-converge, especially in the case of industrial customers with medium level of annual consumption.

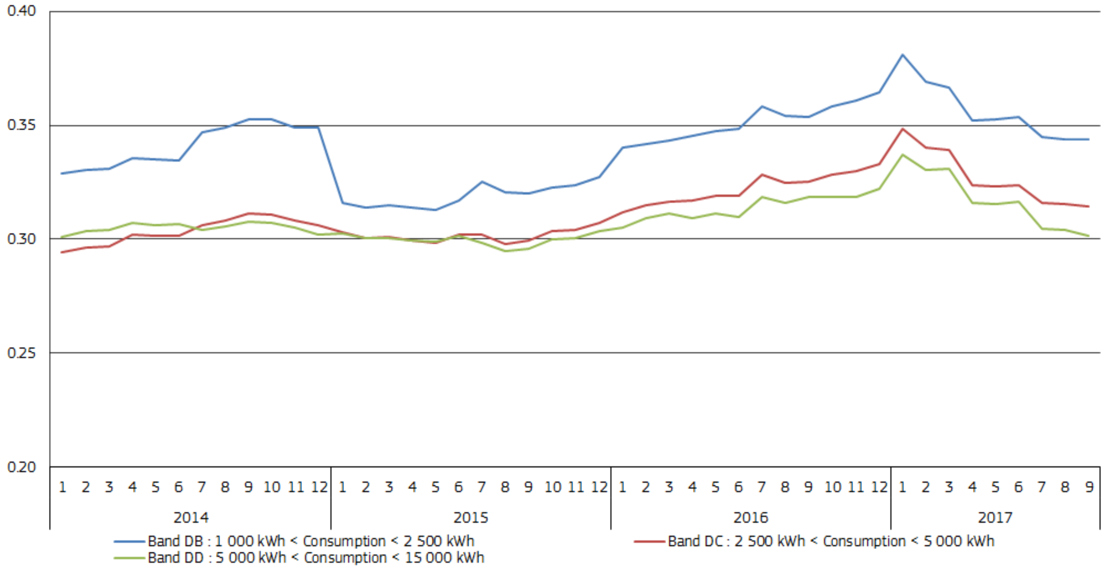
- Retail electricity prices paid by household customers, after showing the signs of price divergence in most of 2016, started to re-converge as of the beginning of 2017, which trend kept on continuing in the third quarter of 2017. However, in the case of household customers the role of price regulation and non-market elements (network costs, taxes and policy levies) in the final retail price is still more important than in the case of industrial customers, policy changes in different countries can always result in .price divergence across the EU.

Figure 39 – ***Relative standard deviation of retail electricity prices in the EU Member States in three industrial customer consumption groups***



Source: Eurostat, DG ENER

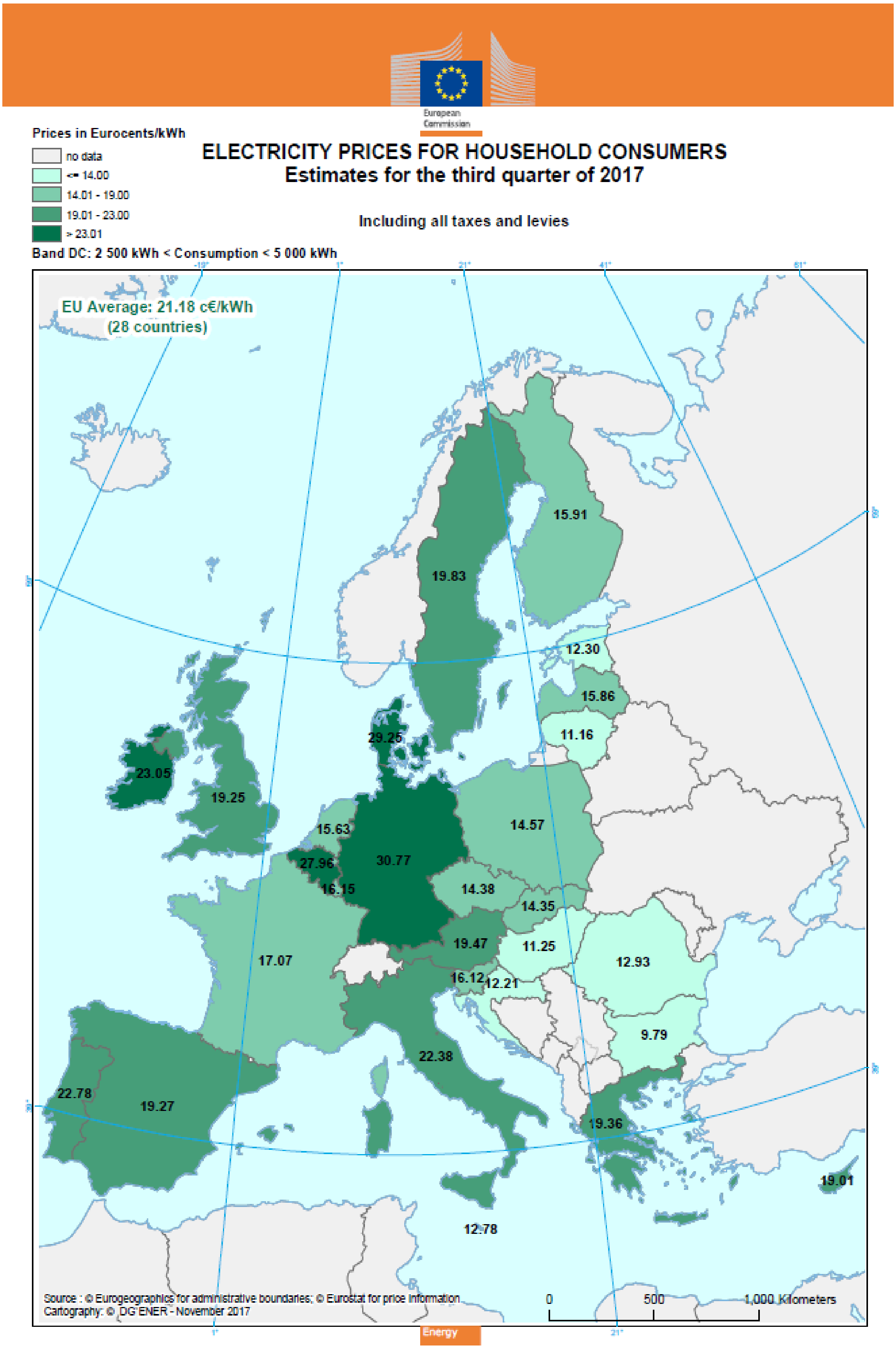
Figure 40 - ***Relative standard deviation of retail electricity prices in the EU Member States in three household customer consumption groups***



Source: Eurostat, DG ENER

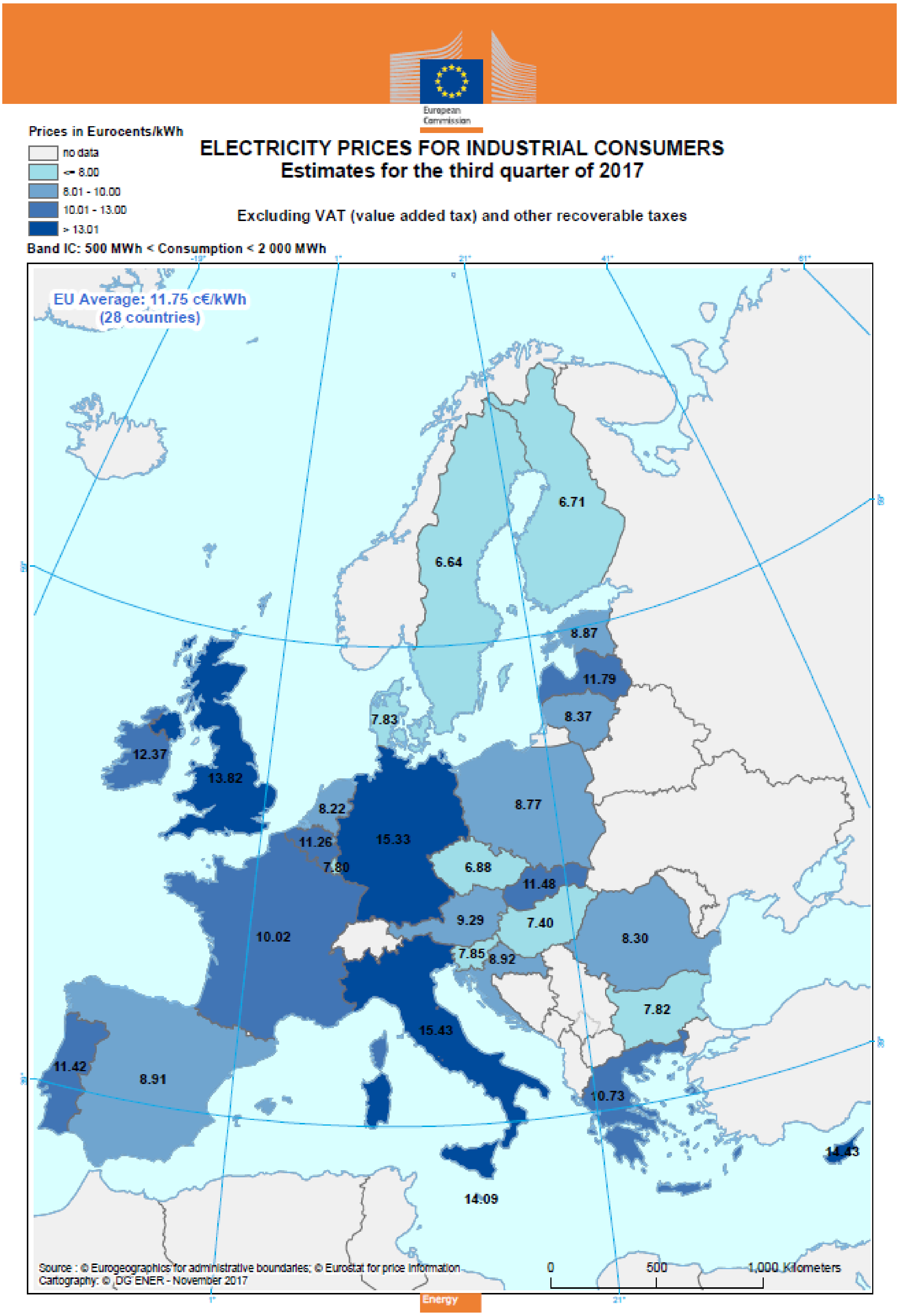
- The two maps (Figure 43 and Figure 44) show the estimated quarterly average retail electricity prices paid by households and industrial customers, having medium level of annual electricity consumption, in the third quarter of 2017.

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

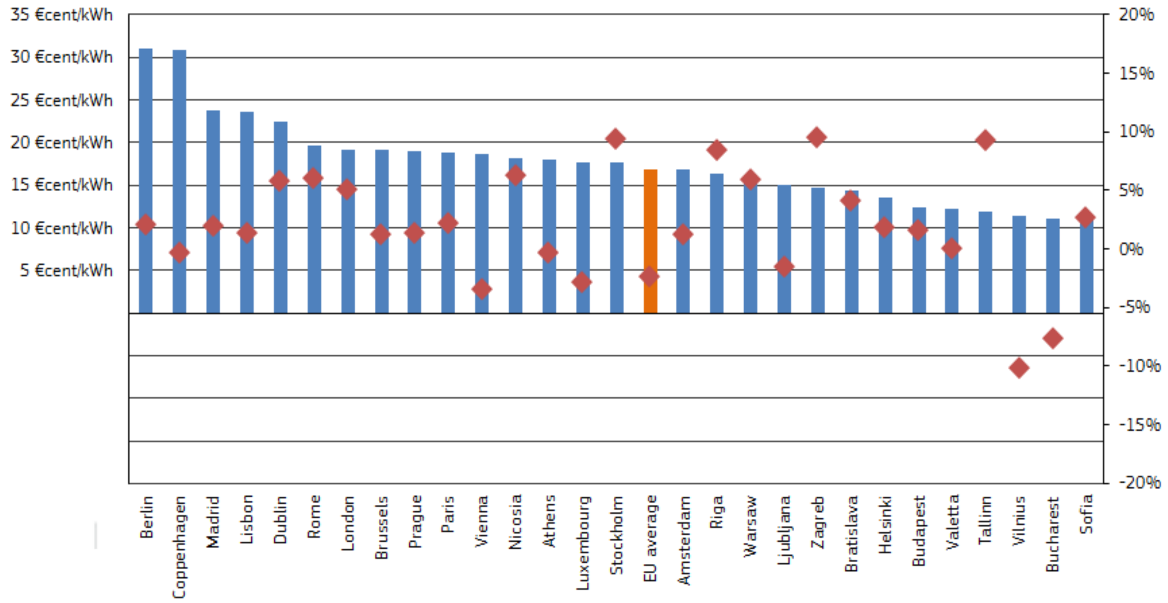


Source : Data computed from Eurostat half-yearly retail electricity prices and consumper price indices

4.2 Retail electricity prices in the EU capital cities

- Figure 43 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 September 2017 the highest retail electricity prices paid by households could be observed in Berlin and Copenhagen (both 31 Eurocent/kWh and 30.9 Eurocent/kWh, respectively), while the cheapest capitals in the EU were Sofia and Bucharest (10.9 Eurocent/kWh, and 11.0 Eurocent/kWh, respectively). Compared with September 2016, the highest price increases could be observed in Zagreb (9.5%), Stockholm (9.4%) and Tallinn (9.2%). Retail electricity prices decreased the most in Vilnius (10.2%) and in Bucharest (7.6%).
- Figure 44 shows the change in household retail electricity prices between September 2016 and September 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. Energy supply costs went up the most in Nicosia and Rome (respectively by 1.6 Eurocent/kWh and 1.3 Eurocent/kWh), and they decreased measurably in London (0.9 Eurocent/kWh) and Vilnius (0.8 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 the decreases in transmission and distribution costs in these two cities[6]. To a lesser extent, this was the case in Rome as well, where energy taxes went down by 1 Eurocent/kWh but distribution costs went up by 0.7 Eurocent/kWh.
- Transmission and distribution costs had the biggest downward impact on the final retail prices in Nicosia (1.3 Eurocent/kWh), while in Riga and London they resulted in the increase of final prices (1.2 Eurocent/kWh and 0.9 Eurocent/kWh, respectively).

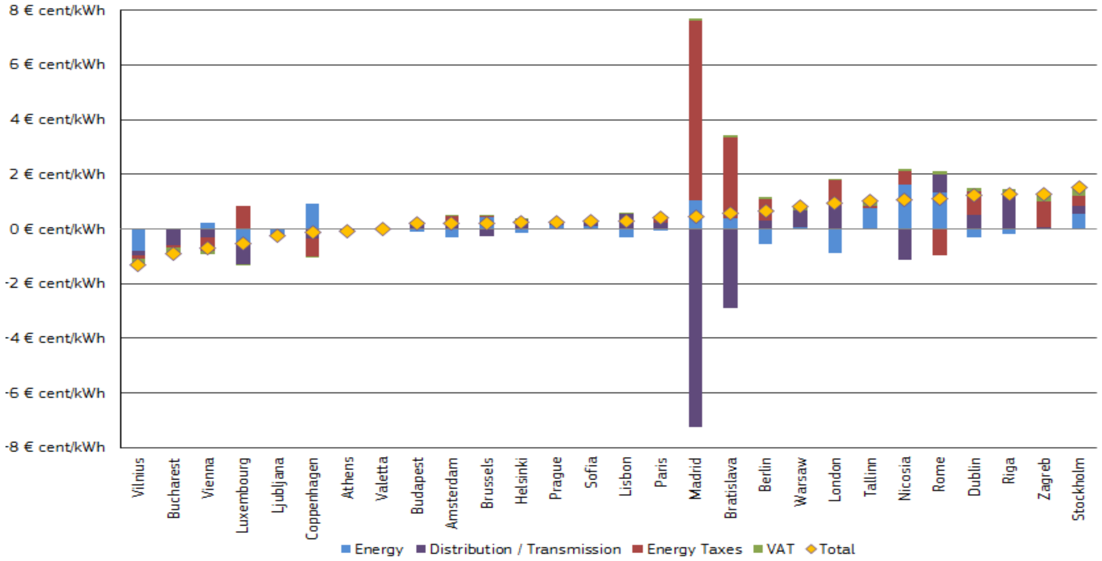
Figure 43 – *The Household Energy Price Index (HEPI) in the European capital cities - Electricity prices in September 2017, and changes in household electricity prices compared to September 2016*



Source: Vaasaett

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

Figure 44 – *Change in electricity prices and their cost components in the European capital cities, between September 2016 and September 2017, in* Eurocent/kWh



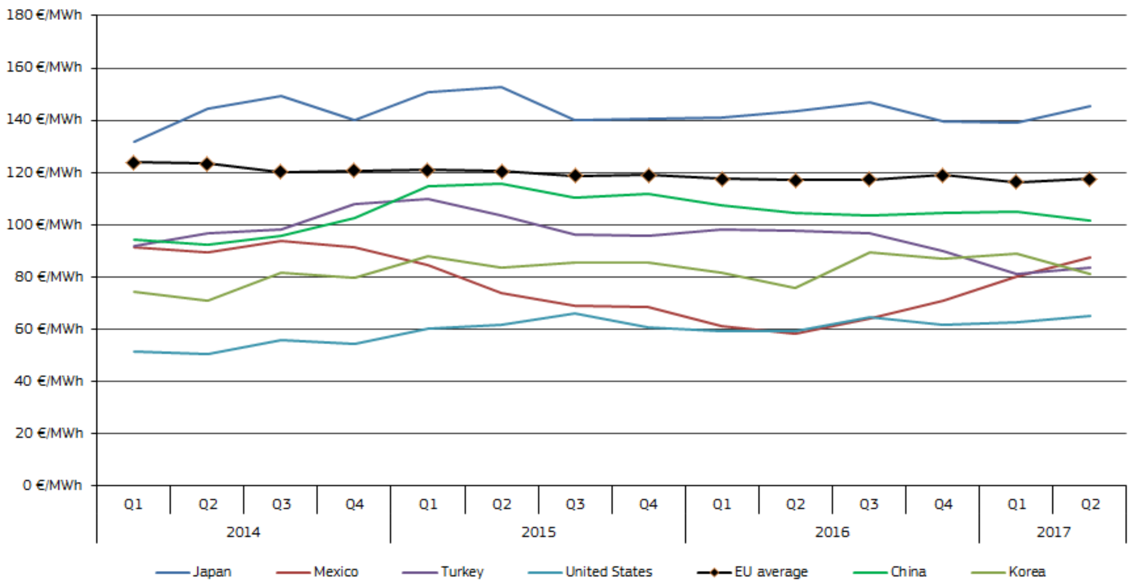
Source: Vaasaett

4.3 International comparison of retail electricity prices

- Retail electricity prices paid by industrial customers in the EU are relatively high, if compared with industrial electricity prices in the main trading partners of Europe, as the next chart (Figure 45) shows. Differences between wholesale electricity prices in the EU and the US are perfectly reflected in differences between EU and US retail electricity prices paid by industrial customers. In the case of Japan the difference in wholesale prices with the EU was bigger than in the case of retail industrial electricity prices in the last few quarters.

- Retail electricity prices in China were 5-10% lower than in the EU during the last three years. In the case of Turkey the price discount to the EU increased in 2016-2017, primarily owing to the depreciation of the Turkish lira. In Korea the retail electricity price was cheaper by one third over the last three-four years, while in Mexico the price gap with the EU somewhat closed in 2016-2017, though industrial electricity was still 25% cheaper in Q2 2017in the country as in the EU on average.

Figure 45 – *Retail electricity prices paid by industrial customers in the EU and its main trading partners*



Source: Eurostat, IEA, CEIC, DG ENER estimations

5 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.

Long-term average for HDD and CDD comparisons: In the case of both cooling and heating degree days, actual temperature conditions are expressed as the deviation from the long-term temperature values (average of 1975-2016) in a given period.

Monthly estimated retail electricity prices: Twice-yearly Eurostat retail electricity price data and the electricity component of the monthly Harmonised Index for Consumer Prices (HICP) for each EU Member States to estimate monthly electricity retail prices for each consumption band.

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). 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.

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.