



European  
Commission

# Quarterly Report

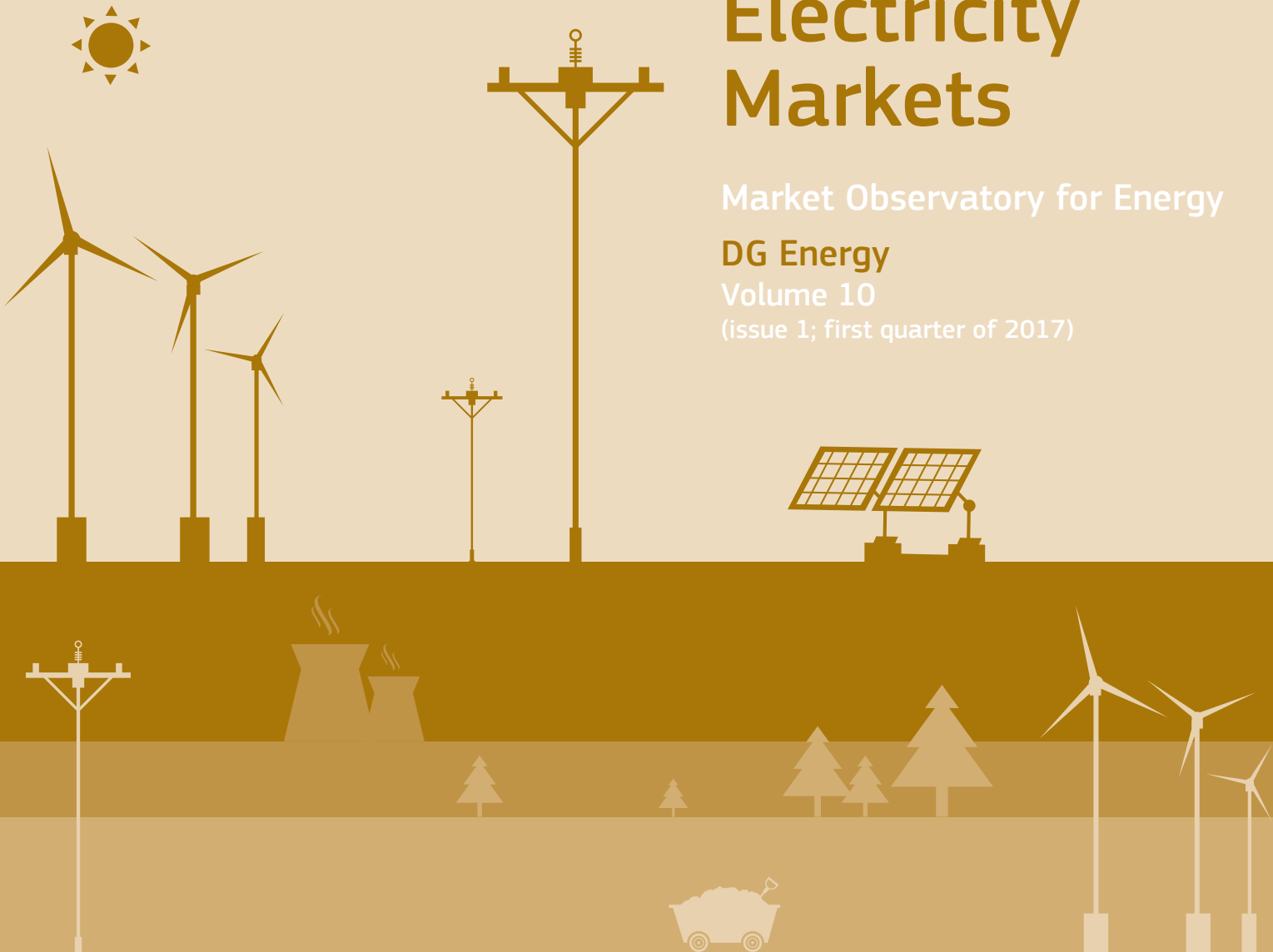
## on European Electricity Markets

Market Observatory for Energy

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# QUARTERLY REPORT ON EUROPEAN ELECTRICITY MARKETS

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## **HIGHLIGHTS OF THE REPORT**

- **In January 2017 short-lived periods of cold weather in most of Europe significantly increased the demand for electricity, resulting in high wholesale market prices. In February and March however, temperatures were higher than usual and wholesale electricity prices decreased.**
- **Such a cold spell was unprecedented since February 2012, resulting in daily average temperatures being on some days 10 degree Celsius below the long-term daily averages in many European countries.**
- **On the supply side ongoing safety tests in France and limited nuclear capacities in Germany, low wind and solar generation in most of Europe, low hydro availability because of the ongoing dry period and freezing temperatures have all added to the upward pressure on wholesale electricity prices.**
- **In consequence, natural gas consumption in power generation in the EU reached the highest level in the last seven years in January 2017.**
- **Although major electricity supply disruptions did not occur during the cold spell, several countries imposed export curtailments or explicit export bans, which were not the best solution and sometimes reflected the lack of cooperation in the internal electricity market.**
- **Bulgaria imposed the longest, twenty-seven day long electricity export ban that began on 13 January and lasted until the 8 February.**
- **Some parts of Europe, for example the Nordic markets and partly the British Isles were relatively spared from the cold weather and wholesale prices remained at moderate levels in January.**
- **In February 2017 the 2GW IFA interconnector between France and the UK resumed operation at full capacity, after months of maintenance works, enabling sufficient electricity flows between the two countries to avoid price spikes in the UK experienced at the end of 2016.**
- **The Central Western Europe power region, due to the low electricity generation and high wholesale prices, had the lowest net electricity export position in January 2017 in the last ten years.**

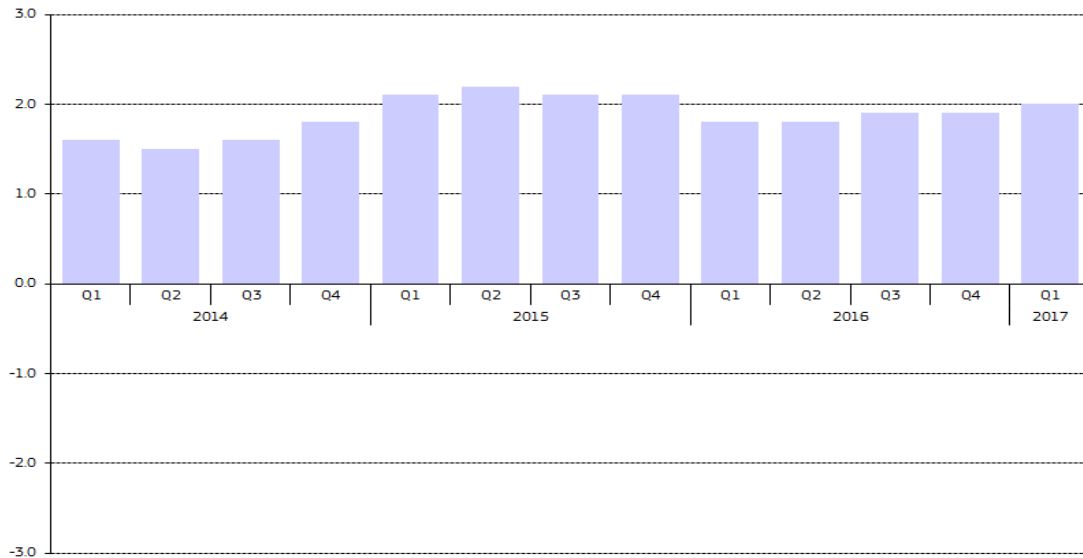
## EXECUTIVE SUMMARY

- **In January 2017 day-ahead baseload wholesale electricity prices rose to the highest level since February 2012, reaching 64 €/MWh in the EU on average.** This sharp increase was mainly due to the cold spell that impacted most of the European continent in this month, resulting in increasing heating-related electricity demand that also affected wholesale electricity prices. However, in parallel with the return of milder temperatures, wholesale prices started to decrease and in March 2017 they fell below 40 €/MWh on monthly average.
- In most of Central, Eastern and South-Eastern Europe there were several days in January 2017 **when average daily temperatures were 10 degree Celsius below the long-term daily averages.**
- Besides cold temperatures impacting the demand side of the wholesale electricity market, many **factors on the supply side** also supported high prices in January 2017. Ongoing nuclear safety test in France and an exceptional winter refuelling cycle in Germany, relating to the expiry of the nuclear fuel tax, **reduced the availability of nuclear capacities** in Central Western Europe.
- **Wind generation was also lower in January 2017 in many European markets** than in the same month of the previous year, and during wintertime solar generation became insignificant in the electricity generation mix in most of the EU countries. On top of this, the dry period of the last months of 2016 continued in the first quarter of 2017, pushing hydro reserve levels to several year lows, which also negatively impacted hydro generation.
- Low nuclear availability and dwindling renewable generation resulted in **increasing use of fossil fuels in the European energy mix at the beginning of 2017**, propelling the use of natural gas in power generation to the highest in more than seven years. Gas prices on most of the European hubs turned up amid cold temperatures, giving a support to wholesale electricity prices. Although coal prices started to decrease at the beginning of 2017, the increasing use of coal also added to electricity generation costs. Later in Q1 2017 as nuclear availability improved and renewable generation increased, the share of fossil fuels retreated in the electricity generation mix in many EU countries, providing for lower generation costs and wholesale market prices.
- **Curtailments in cross-border electricity flows or explicit export bans were imposed in a few EU Member States during the January cold spell.** In Bulgaria, where freezing temperatures resulted in the unavailability of hydro and lignite generation sources, a twenty-seven day long (from 13 January to 8 February) electricity export ban was imposed with the aim of protecting domestic consumers, especially in the residential sector. In Greece export curtailments were also imposed for shorter periods. Export bans were not the best solution for ensuring security of supply, as they also led to welfare losses for power generators, traders and consumers. The lack of cooperation between transmission system operators of neighbouring countries undermines the confidence in the internal electricity market.
- Some parts of Europe, mainly the Nordic countries and partly the British Isles, were relatively spared from the cold spell and significant price hikes did not occur in these wholesale electricity markets in January 2017. **At the beginning of March the 2GW IFA interconnector between the UK and France resumed operation at full capacity** after several months of maintenance works, enabling sufficient electricity flows between the two countries to avoid price hikes in the UK, which occurred several times at the end of 2016.
- **Retail electricity prices for household customers went up by 1.8%** between April 2016 and April 2017 in the European capital cities on average. In Nicosia and Madrid double-digit percentage increases could be observed, while in Riga and Vilnius retail electricity prices decreased by more than 10 percent. Changes in retail prices were mainly driven by energy costs, however, in some capital cities energy taxes or network costs also played an important role.

# 1 Electricity demand drivers

As Figure 1 shows, economic growth in the EU-28 remained strong in the first quarter of 2017, and GDP grew by 2.0% in year-on-year comparison, being slightly higher than the economic growth in Q4 2016 (1.9%).

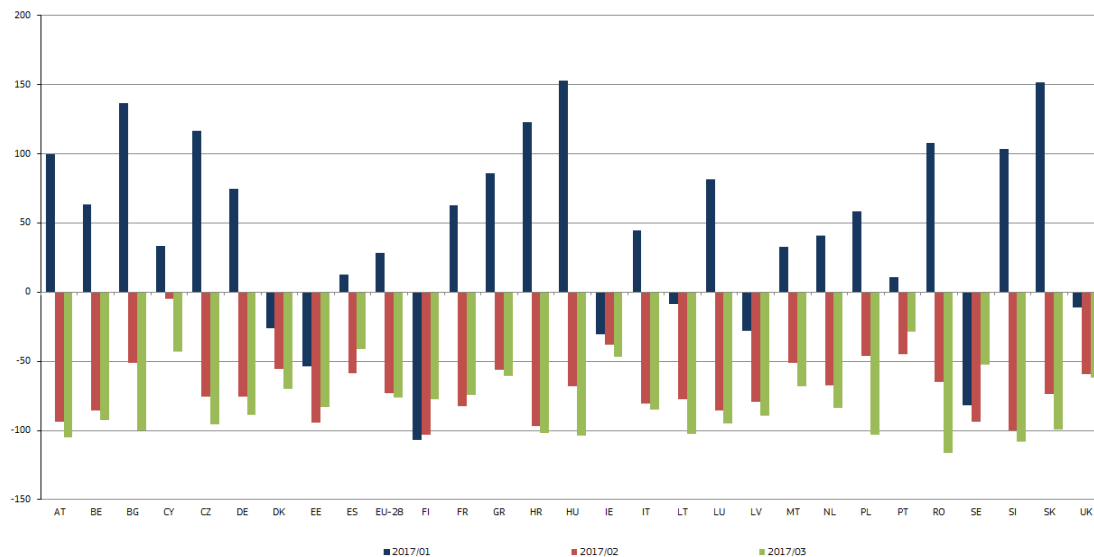
**Figure 1 – EU 28 GDP Q/Q-4 change (%)**



Source: Eurostat

- Figure 2 shows the monthly deviation of actual Heating Degree Days (HDDs) from the long term averages in January – March 2017 in the twenty-eight Member States of the EU. In the central and eastern/south-eastern part of the continent January 2017 was significantly colder than the long term average, as high-rising bars on the chart show. Although HDD represent monthly values, on some days the daily average temperatures reached the lowest in the last decades in some countries. More information on how the cold spell in January 2017 affected the wholesale electricity markets in each region can be found in in Chapter 4.
- In February and March 2017 the harsh winter weather was over and temperatures were generally higher than the seasonal average, contributing to lower heating related electricity demand and decreasing electricity prices on the wholesale markets.

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



Source: JRC.

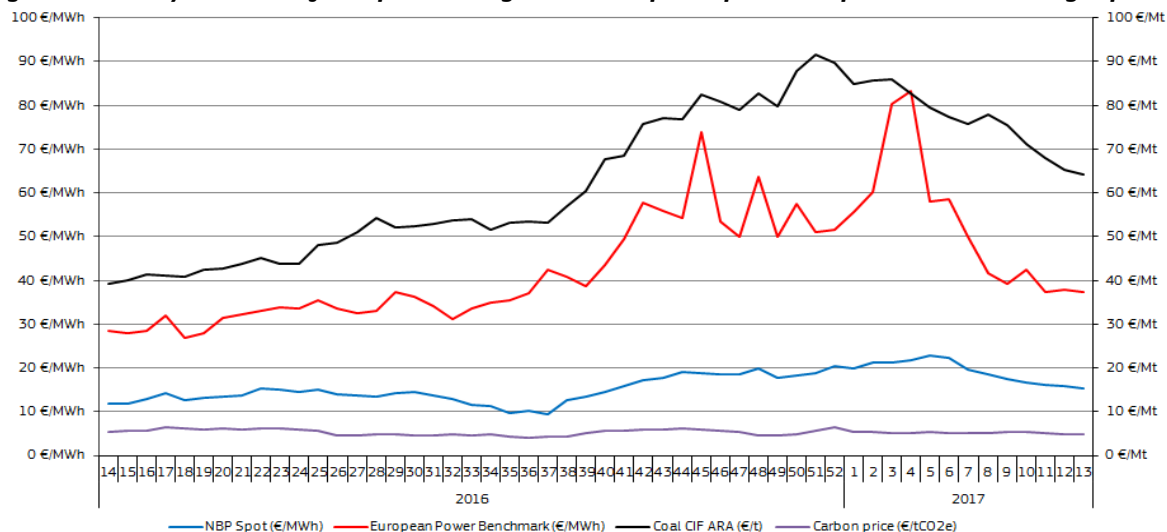
The colder is the weather, the higher is the number of HDDs

## 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, after undergoing a significant increase in the second half of 2016, started to decrease as of the beginning of the year and in parallel with the arrival of milder weather conditions in Europe as of February-March, they continued their downward trend until the end of Q1 2017. However, the low prices measured in the first quarter of 2016 did not return; and at the end of Q1 2017 the daily average coal price stood around 65 €/Mt, being similar to the price level of end of September 2016.
- Natural gas prices (represented by the most liquid hub prices in North-Western Europe) also showed a measurable increase during the first five weeks of 2017: the British NBP hub price rose from 19.6 €/MWh to 24 €/MWh between the first trading day of the year and 3 February 2017. This increase was mainly related to the cold weather, as low temperatures resulted in rising heating residential heating needs. Later in Q1 2017 in parallel with milder temperatures, gas prices started to decrease and finished the quarter at 15.7 €/MWh. European emission allowance contracts fluctuated in a narrow range of 4.5-6 €/tCO<sub>2</sub>e, not exerting significant influence on the electricity market.
- The price evolution of coal and gas resulted in increasing wholesale electricity prices on the European markets, as these two fuels typically set the marginal costs of electricity generation. Therefore, wholesale electricity prices were measurably impacted by higher gas prices in January, as receding renewable and hydro generation in many countries led to the increase in the use of coal and gas, resulting in rising electricity generation costs and wholesale market prices. Later, as gas prices went down and renewable generation picked up, wholesale electricity prices started to decrease. Cold spells in January not only impacted gas prices but the European wholesale electricity prices as well, showing a sharp increase in this period, as presented on Figure 3 below.

**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

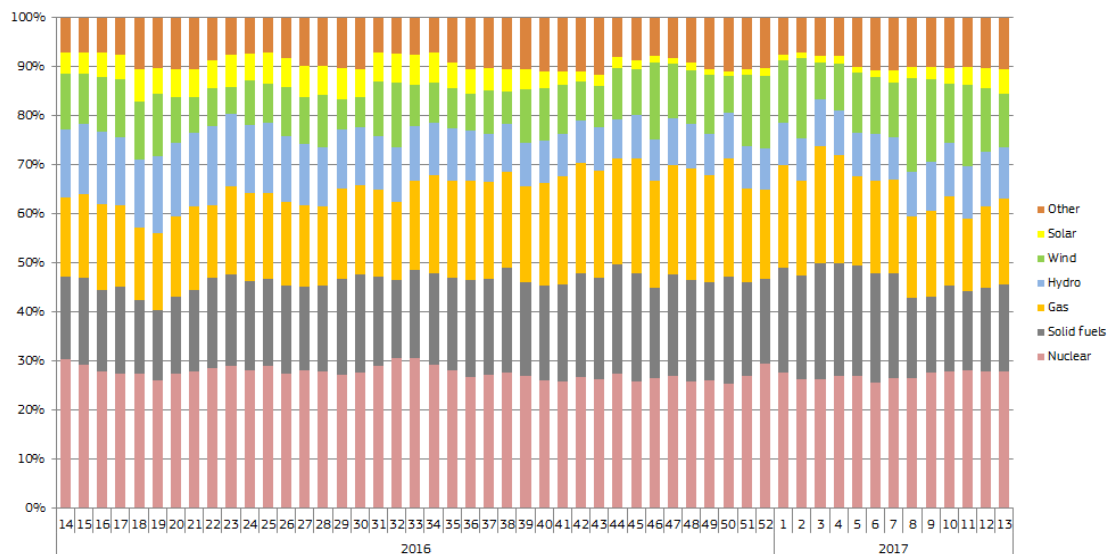
Coal CIF ARA: Principal coal import price benchmark in North Western Europe (in €/Mt)

NBP spot stands for the National Balancing Point (UK) gas spot price (in €/MWh)

Carbon price: EUA emission allowance spot price, in €/t

- The aforementioned shift between fossil fuels and renewables in the first quarter of 2017 can be followed on Figure 4, showing the weekly evolution of the electricity generation mix in the EU-28. As of the beginning of 2017 wind generation started to slowly increase and in parallel with the arrival of the spring period and longer daylight hours solar generation started to reappear in the EU electricity mix. At the same time the share of coal in the weekly generation mix started to decrease, showing that coal is replaceable if renewable sources are abundant.
- The first quarter of 2017 was drier than usual in many European countries, implying that the share of hydro generation was low in most of the electricity generation mixes in the EU countries. Low hydro availability in many markets might contribute to higher wholesale electricity prices, as the lack of hydro sources needs to be replaced by costlier generation sources. In January 2017 the share of fossil fuels amounted to 44% in the EU electricity generation mix, while in Q1 2017 this share was 38%.

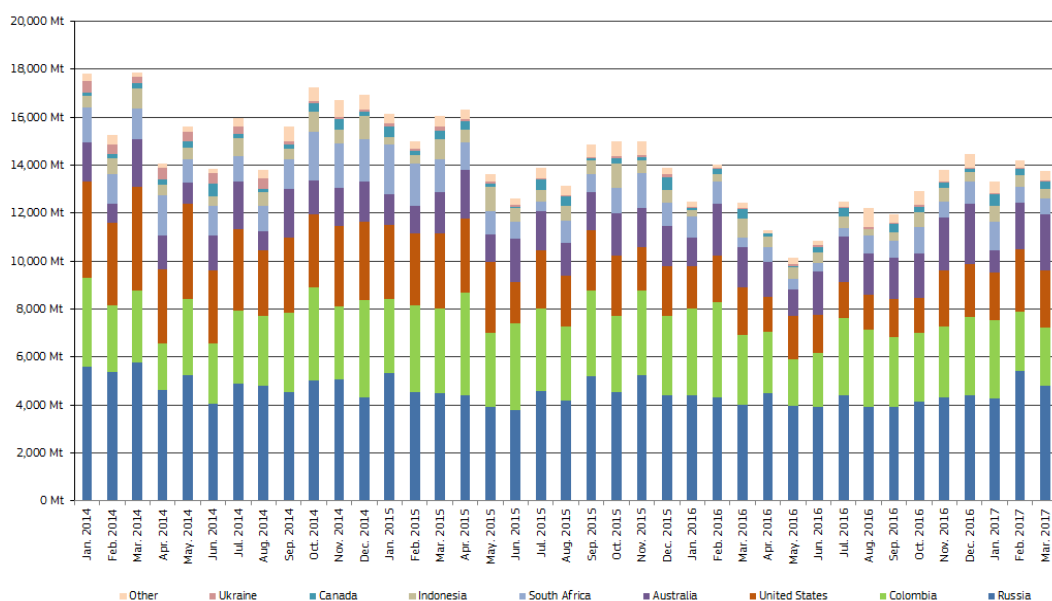
**Figure 4 – Weekly evolution of the electricity generation mix in the EU-28**



Source: ENTSO-E

- Figure 5 shows the major extra-EU coal import sources and the monthly amount of imported coal in the EU. In the first quarter of 2017 coal imports from extra-EU was 6% higher than imports in Q1 2016. This increase must have been related to the temporary rise in the use of coal in electricity generation<sup>1</sup> in the EU, bearing in mind that significant nuclear capacities were not available during this period and missing capacities were largely replaced by coal.
- In Q1 2017 the largest chunk of extra EU coal imports came from Russia, with a share of 34% in the total, followed by Colombia 21%). United States took back the third place in Q1 2017 as extra-EU import source, with a share of 16%, while Australia assured 13% of the total imports. South Africa had a share of 7% in the total extra-EU coal imports, while the share of Canada, Indonesia and Ukraine remained below 3% each.
- In Q1 2017 the estimated EU import bill of hard coal from extra-EU sources amounted to €4.7 billion, while in the same period of the 2016 the extra-EU import bill was €2.3 billion, showing the impact of significantly higher coal prices and increasing amount of imported coal in year-on-year comparison.

**Figure 5 – The most important Extra-EU coal import sources and monthly imported quantity in the EU-28**



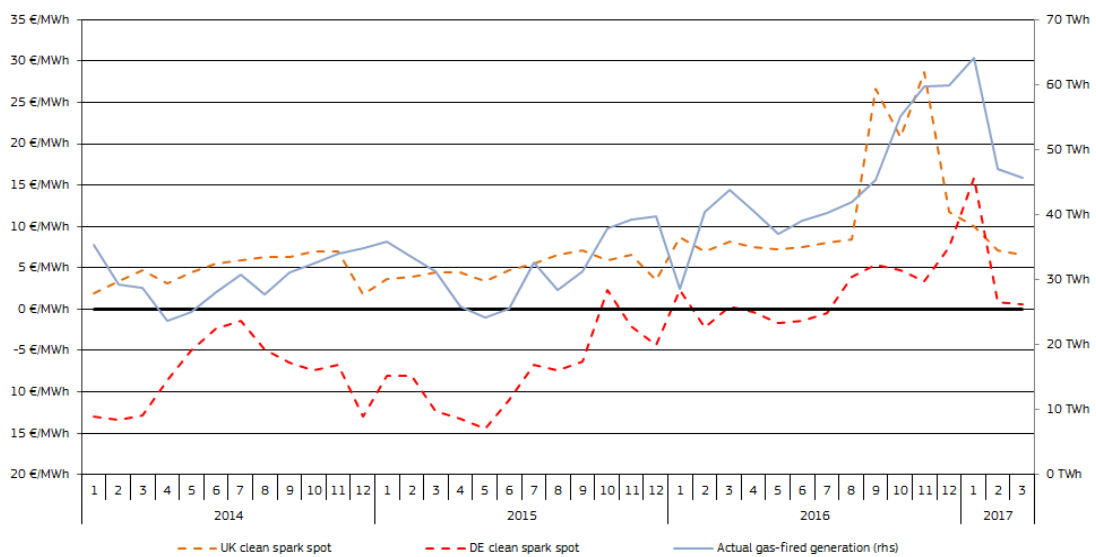
Source: Eurostat, COMEXT database

<sup>1</sup> It is worth noting that in this breakdown of the foreign trade statistics information on steam and coking coal shipments are not available



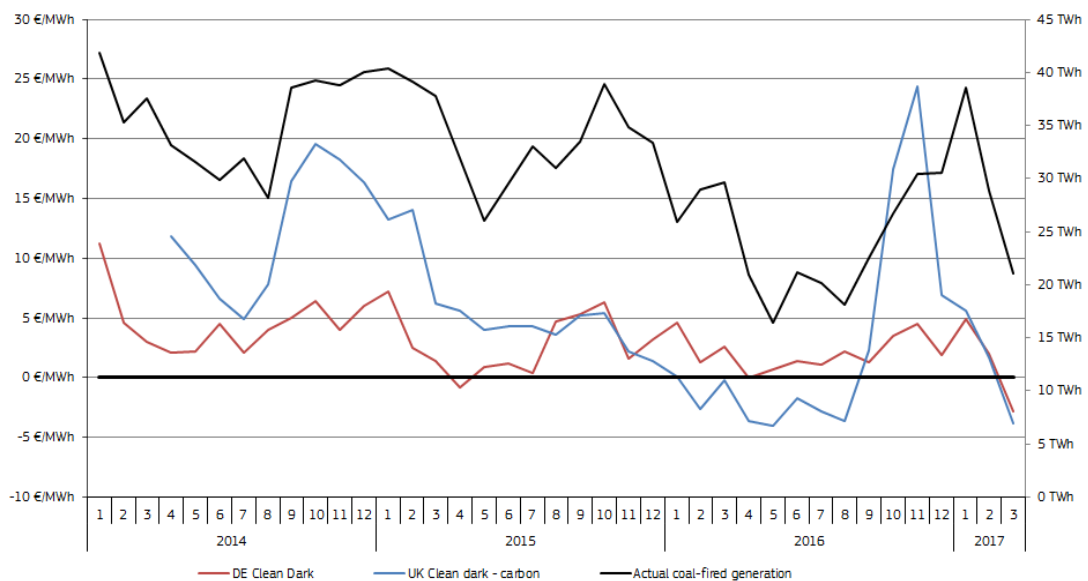
- At the beginning of the first quarter of 2017, in parallel with high electricity prices which outperformed the increase in natural gas prices, clean spark spreads increased significantly (see Figure 6), which, in combination with rising gas consumption in power generation, resulted in improving profitability for electricity generators. In January 2017 the total electricity generated from gas amounted to 65 TWh in the EU, which was the highest since the beginning of available time series (January 2010). As in February and March wholesale electricity prices started to decrease, clean spark spreads in both the UK and Germany went down, in the latter country they fell close to zero by the end of Q1 2017. Wholesale electricity prices are more flexible downwards than gas prices and in the periods of abundant renewable generation low electricity prices result in decreasing profitability of gas, leading to its crowding-out from the generation mix.
- The use of coal also rose significantly at the beginning of 2017, reaching in January a monthly consumption last seen in 2015. However, the profitability of coal fired generation (see Figure 7), owing to high coal prices, and in the UK to the climate change levy as well, was lower than that of natural gas. In parallel with decreasing wholesale electricity prices as of February 2017, clean dark spreads fell below zero, both in the UK and Germany.

**Figure 6 – Evolution of clean spark spreads in selected markets and electricity generation from natural gas in the EU**



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

**Figure 7 – Evolution of clean dark spreads in selected markets 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 8) 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.
- In the first quarter of 2017 wholesale baseload electricity prices reached 50.3 €/MWh on quarterly average, which was 8% lower compared to Q4 2016, in spite of the five-year high monthly average prices in many EU countries measured in January 2017. Compared to the first quarter of 2016, in Q1 2017 wholesale electricity prices in the EU were up by 51% on average, as in the base period, in Q1 2016, prices were on several years' low and in Q1 2017 high prices were impacted by the cold spell in January in many countries.
- The highest quarterly average wholesale electricity prices could be observed in Q1 2017 in Spain (60 €/MWh), Greece (59 €/MWh) and Hungary (58 €/MWh), while the lowest quarterly averages were seen in Denmark (31 €/MWh, Sweden (32 €/MWh), Finland and Estonia (33 €/MWh in both countries).
- Comparing with Q1 2016, in the first quarter of 2017 prices increased by the most in Spain (by 89%), and Portugal and Hungary (by 83% in both countries). There were only two countries (Lithuania and Latvia) where year-on-year decreases could be observed in Q1 2017 (by 6% and 7%, respectively).

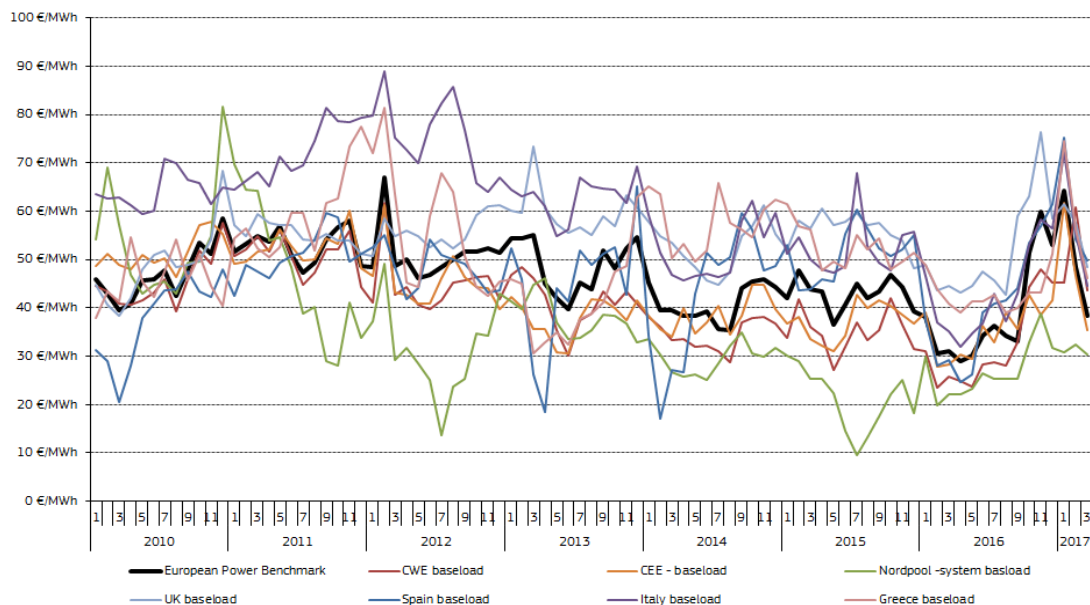
Figure 8 – Comparison of average wholesale baseload electricity prices, first quarter of 2017



Source: European wholesale power exchanges

- Figure 9 shows the evolution of the monthly average baseload wholesale electricity prices in the main power regions in the EU since 2010. As it was already mentioned, on quarterly average wholesale electricity prices decreased at EU level, however, in January 2017 the EU average wholesale electricity price reached the highest since February 2012.
- In Q1 2017 the highest prices could be observed on the Spanish, Italian and Greek markets. Prices in Spain and Italy were highly influenced by Central Western Europe<sup>2</sup>, where nuclear outages in France resulted in decreasing exports to these two countries. In Greece the lack of sufficient electricity imports and increasing demand amid of the cold spell played an important role in driving up the wholesale electricity price.
- In spite of high prices in France, the average price in Central Western Europe remained below the European benchmark. Some markets in Central Eastern Europe<sup>3</sup> were heavily impacted by the cold weather and decreasing generation and import capacities, which resulted in high prices. The UK market, being the highest priced in earlier quarters in all Europe, was less impacted by price hikes, as the weather was milder than in continental Europe and the interconnector with France resumed full capacity operation, enabling higher amount of power flows. In the Nordpoolspot<sup>4</sup> market, though hydro generation was lower than in the last few years, temperatures were higher than usual in all Q1 2017, limiting the demand for electricity.
- The price spike in January 2017 resulted in an increasing difference between the cheapest and the most expensive wholesale electricity markets in Europe, as Figure 10 shows. As the European benchmark and the regional prices started to decrease, the metrics on price differential and the standard deviation also showed the re-convergence of different regional market prices.

**Figure 9 - Comparisons of the European benchmark and the monthly baseload prices in regional electricity markets**



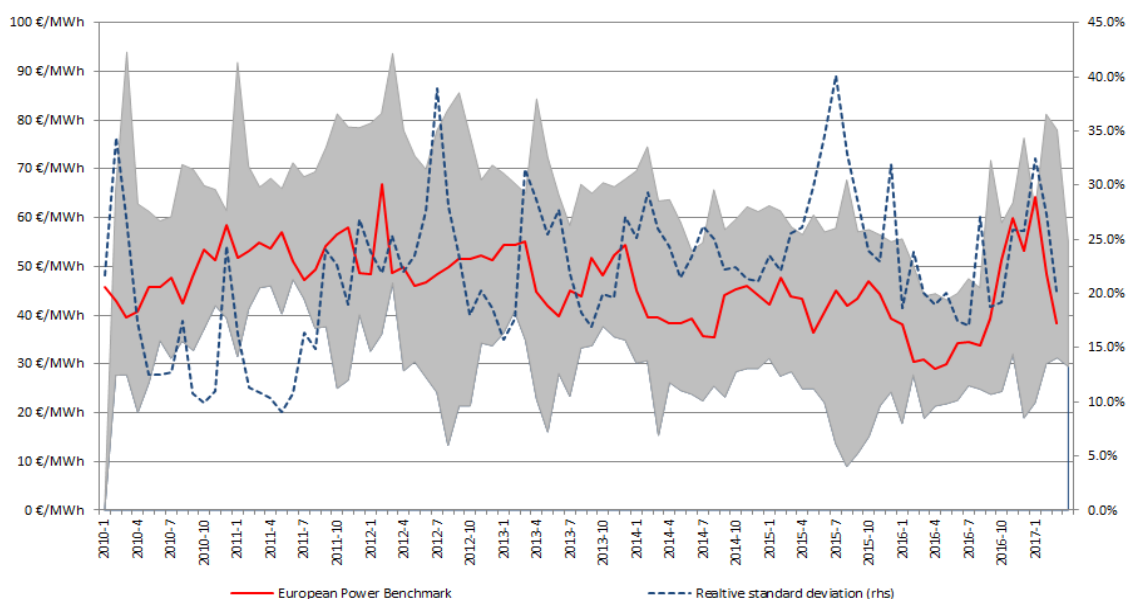
Source: Platts, European power exchanges – As of January 2017 Platts PEP has been replaced by a calculated EU average (European Power Benchmark)

<sup>2</sup> Central Western Europe includes Austria, Belgium, France, Germany, the Netherlands and Switzerland

<sup>3</sup> Central Eastern Europe includes Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia

<sup>4</sup> Nordpoolspot includes Denmark, Estonia, Finland, Latvia, Lithuania, Norway and Sweden

**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**



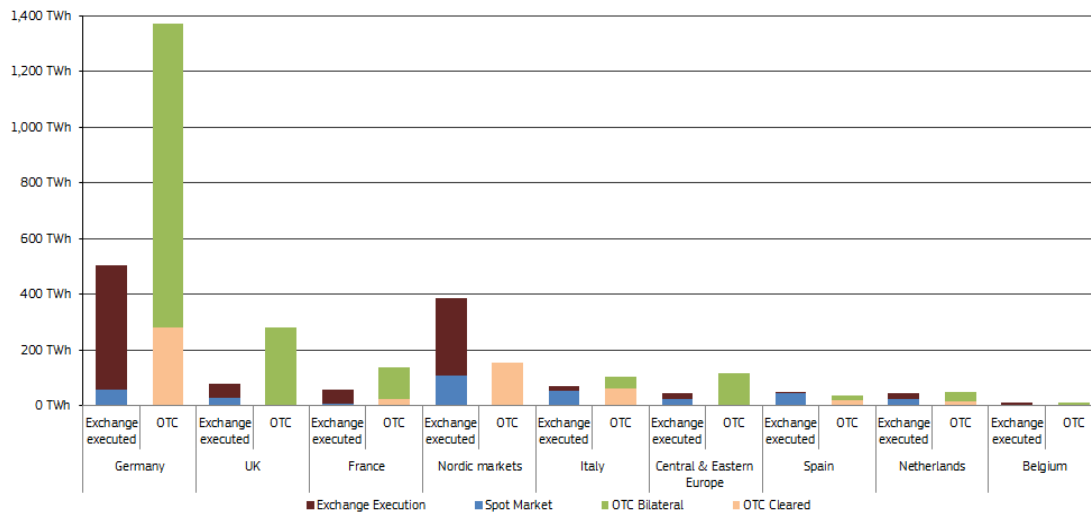
Source: Platts, European power exchanges – As of January 2017 Platts PEP has been replaced by a calculated EU average (European Power Benchmark)

### 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

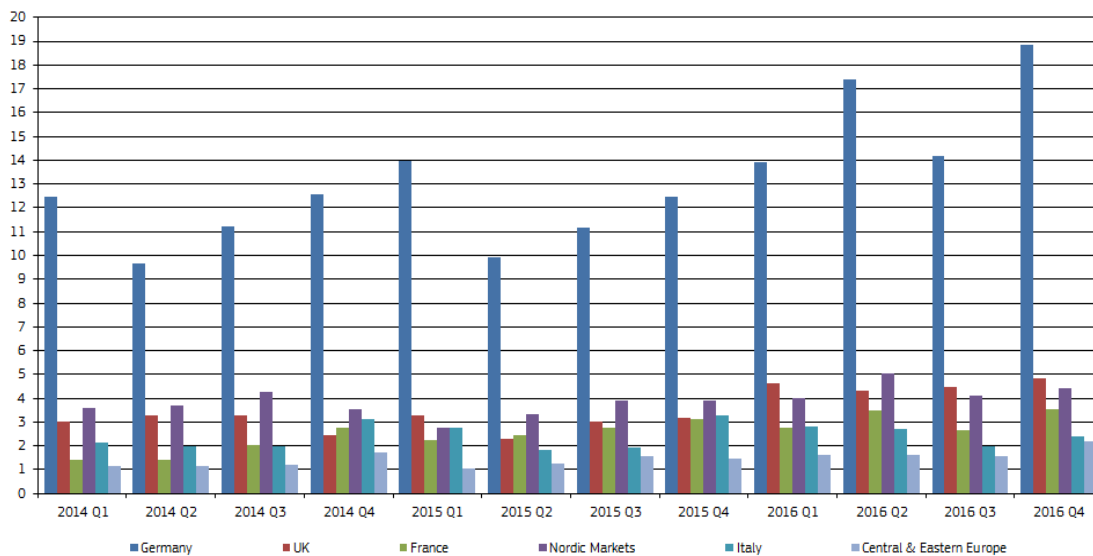
- Figure 11 shows the comparison of volumes in different market segments in electricity trading on the most liquid electricity trading platforms in the EU. In order to show the significance of spot and forward traded volumes on organised trading platforms, as well as bilateral trade and cleared trade 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 first quarter of 2017 in most of the observed markets, with the exception of Germany and the Central Eastern Europe market, where traded volumes grew by 5.7% (98 TWh) and 11% (24 TWh), respectively. The biggest decreases could be observed in France (52%), Italy (44%) and Spain (35%). In absolute terms, the total traded volume of electricity amounted to 3,166 TWh in Q1 2017 in the observed markets in Europe (on Figure 11), which was by 10% (358 TWh) lower than in Q1 2016.
- The year-on-year change in the OTC traded volume evolved similarly in these markets, however, in Germany it slightly decreased in spite of the overall increase. Looking at the numbers showing the evolution of the traded volume of electricity compared to the previous quarter (Q4 2016), in the first quarter of 2017 all observed markets on Figure 11 showed significant decreases (ranging from 14% to 60%).
- 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 12 shows the evolution of the quarterly regional churn rates between the beginning of 2014 until the fourth quarter of 2016. In the fourth quarter of 2016 all observed markets showed similar (or slightly increasing) churn rates as in Q3 2016, with the exception of Germany, where the quarterly churn rate rose to record high (close to 19).. However, if churn rates are compared to those in Q4 2015, the trading liquidity increased in all markets, with the exception of Italy. In Q4 2016 the most liquid markets in Europe were Germany, followed by the UK (with a churn rate of 4.8), the Nordic markets (4.4) and France (3.6). The average estimated churn rate on all observed European markets was 4.7 in Q4 2016.

**Figure 11 - 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 own computations

**Figure 12 Quarterly churn rates on selected European wholesale electricity markets**



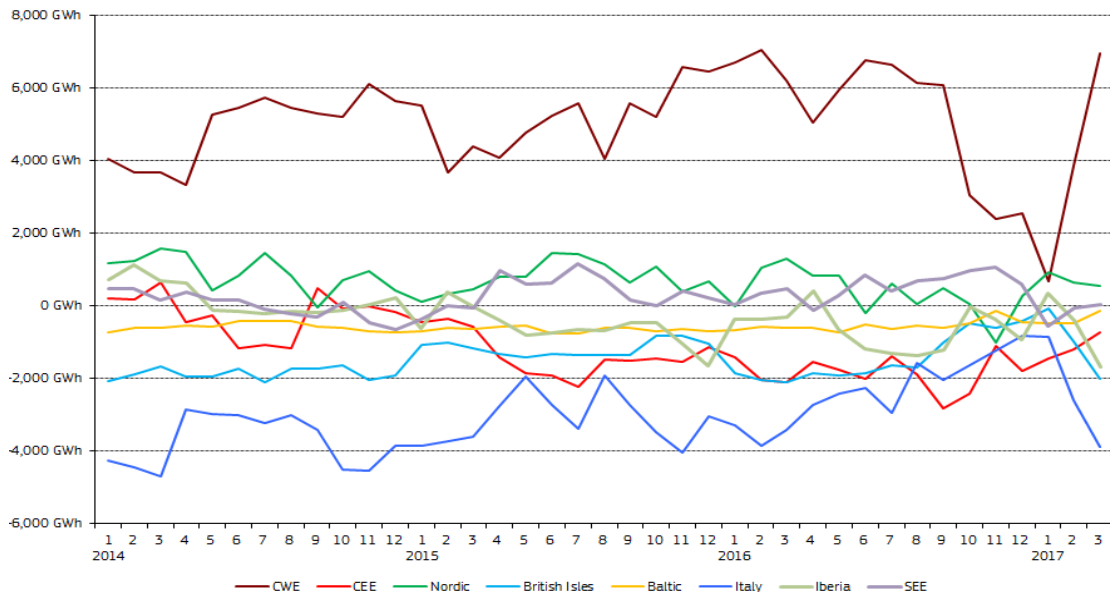
Source: Trayport, London Energy Brokers Association (LEBA), ENTSO-E and own computations

### 3.2 Cross border trade of electricity

- As Figure 13 shows, in the first quarter of 2017 the Central Western Europe (CWE) power region retained its net electricity exporter position. However due to lower than usual electricity generation in January 2017, owing to ongoing nuclear reactor safety tests, low renewable generation and hydro availability, the CWE region could not export as much electricity as in the previous quarters, resulting in the lowest net exporter position in the last ten years. As later in Q1 2017 this low generation period with high markets prices was over, the electricity export of the region picked up again.
- The Nordic region, due to lower than usual domestic hydro generation (see Figure 23), could not profit from the significant price premium of the markets in Central Western and Eastern Europe, consequently, its net exporter position remained close to the zero after being in the negative range in some months of Q4 2016.
- In Italy net imports at the beginning of the year shrunk to low levels, as curtailments in the exports and high market prices in France made electricity imports in Italy uncompetitive compared to domestic electricity generation. As soon as prices in the CWE region started to decrease, electricity exports to Italy ramped up and in March 2017 the country's net importer position reached 4,000 GWh.

- The net electricity flow position of the UK was close to the equilibrium, but after the France-UK interconnector resumed full capacity operation and the decrease in the CWE market prices the country became net importer again. The net position of the Iberian-peninsula evolved similarly in Q1 2017.

**Figure 13 – EU cross border monthly physical flows by region**



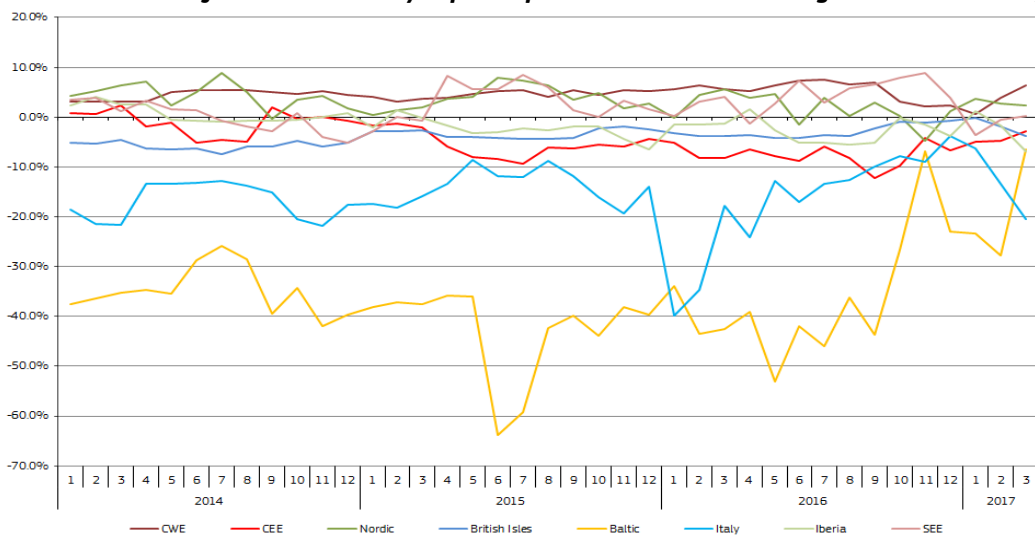
Source: ENTSO-E

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

- It is also important to analyse the ratio of net electricity flow position to the domestic electricity generation in each region, as by comparing absolute interregional electricity flows the difference between the magnitudes of regional electricity production is hidden and the same amount of electricity imports and exports might have different impacts on the local markets in different regions.
- As Figure 14 shows the role of imports compared to domestic generation had of particular importance in the Baltic-states over the last few years; whereas imports also had dominant position in assuring electricity supply in Italy. In all other regions the net electricity position (import or export) fluctuated in a narrow range of 10% of the total domestic generation.

**Figure 14 – 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)

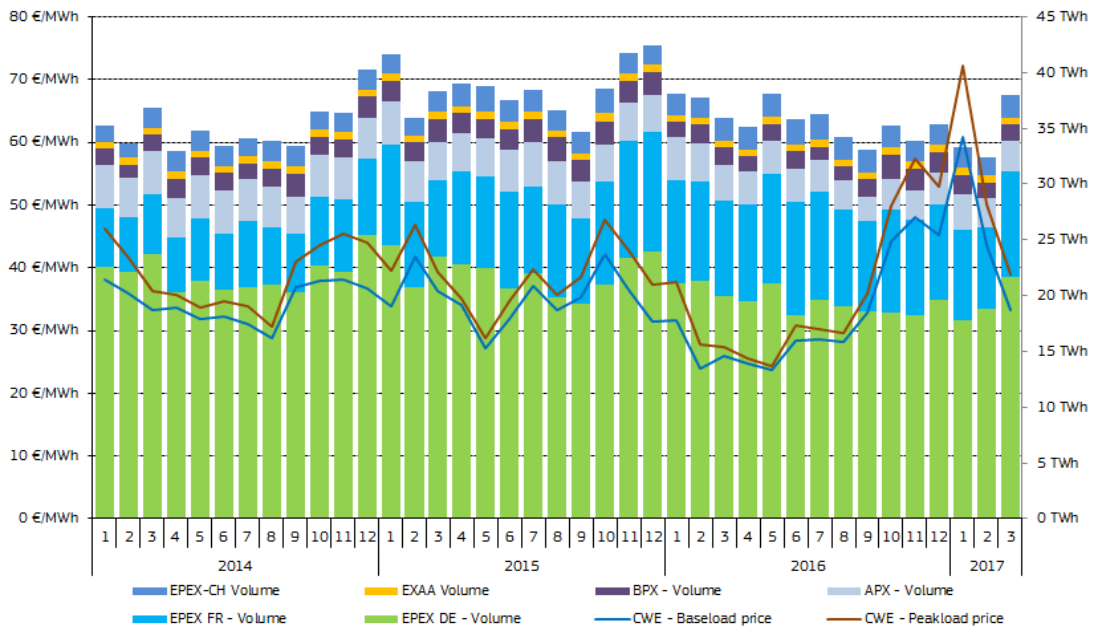
- In January 2017 wholesale baseload electricity prices in the CWE region showed a significant increase and reached 61 €/MWh on average, which was the highest since February 2012. At the same time the regional average monthly peakload reached 72 €/MWh, which was also the highest in the last five years. After the peak measured in January, prices started to decrease and by March 2017 both the average monthly baseload and peakload contracts fell significantly, reaching respectively 33 €/MWh and 39 €/MWh as Figure 15 shows. The daily average regional day-ahead price reached its peak on 25 January 2017 (77 €/MWh) in the first quarter of 2017, however, on this day on some national markets in the CWE region (e.g.: Belgium, France) the daily average price rose above 120 €/MWh.
- As Figure 16 shows, there were clear signs of temporary divergence between different markets in the CWE region during the first part of Q1 2017: while prices in France and Belgium were very volatile and reached high values compared to earlier quarters, at the same time, though also turning up sharply, prices in Germany and the Netherlands remained in lower ranges. As of mid-February the significant French-Belgian price premium to the other two markets started to disappear and prices generally took a downward direction in the CWE region. By the end of Q1 2017 prices re-converged across the regional markets.
- On the demand side of the market it is important to mention the extremely low temperatures across the countries of the CWE region in the first four weeks of January 2017. As Figure 17 shows, between 17 and 20 January the daily average temperatures in Germany, France and Belgium were lower by 8 degree Celsius compared to the long term average local temperatures for those days. Low temperatures significantly impacted the need for electricity in domestic heating over this period in France, leading to high wholesale electricity market prices. After the end of the cold, temperatures across the CWE region were higher than normal during most of the time in February-March 2017; contributing to lower electricity demand and to lower market prices.
- On the supply side many different factors have contributed to high wholesale electricity prices in January 2017. In Germany four out of the remaining eight nuclear reactors were impacted by the winter refuelling stops, sparked by the expiry of the nuclear fuel tax at the end of the previous year<sup>5</sup>. In France, as Figure 18 shows, the nuclear electricity generation had been significantly lower than usual since the second half of 2016, owing safety tests<sup>6</sup> that still continued at the beginning of 2017. However, some reactors were put back in operation in February and France switched back to electricity exporter position in the same month (3.7 TWh net exports after 0.9 TWh net imports in January 2017). In Germany the outage in nuclear capacities continued until the end of Q1 2017, being longer than expected regarding the reduced nuclear availability.
- Although coal prices gradually started to decrease in January 2017 and later in Q1 2017 they fell significantly, natural gas prices in most of the European markets reacted with rises on the cold spell. Due to lower-than-usual nuclear availability and receding renewable generation at the beginning of 2017, the share of coal and natural gas in the regional power generation increased, implying higher electricity generation costs that led to higher wholesale electricity market prices in the CWE region. In January 2017 the output of fossil fuel based electricity generation rose to five year high in Germany.
- Wind power generation decreased by 15-20% across the region in January 2017 compared to the same month of the previous year, and as during wintertime solar power could not assure significant production sources, the share of renewables, similarly to nuclear, also decreased, providing for the aforementioned costlier fossil fuel sources. As an extension of the dry period during the last few months of 2016, hydro levels in Austria, Switzerland and France were also lower than usual, resulting in low hydro power generation. Although both wind and solar generation picked up in February-March 2017, providing for cheap generation sources and lower wholesale prices, hydro reserves remained low during the whole Q1 2017 across the CWE region.
- In spite of having harsh wintry weather conditions and occasional price spikes in the CWE region, electricity supply disruptions and restrictions of power flows did not occur during the January 2017 cold spell. However, France has curtailed the export capacities to Spain in peak hours between 14 and 20 January 2017 in order to 'remain within safety limits' and they also increased import capacities from Switzerland and Spain to cope with increasing demand for electricity. It is important to note that this curtailment did not significantly impact electricity flows as during this period electricity mainly flowed from Spain to France.

<sup>5</sup> See more here: <https://www.platts.com/latest-news/electric-power/london/german-nuclear-outages-to-stretch-deeper-into-21473631>

<sup>6</sup> Nuclear capacity availability was impacted by the ongoing safety test. See Quarterly report on European Electricity Markets, Vol. 9, issue 4. [https://ec.europa.eu/energy/sites/ener/files/documents/quarterly\\_report\\_on\\_european\\_electricity\\_markets\\_q4\\_2016.pdf](https://ec.europa.eu/energy/sites/ener/files/documents/quarterly_report_on_european_electricity_markets_q4_2016.pdf)

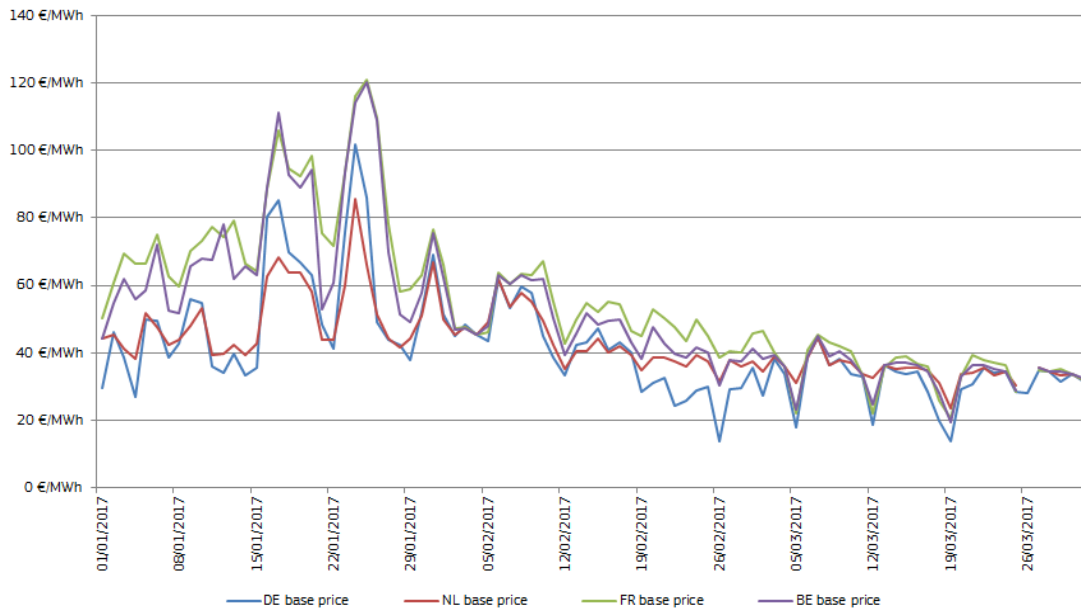


**Figure 15 - Monthly traded volumes and prices in Central Western Europe**



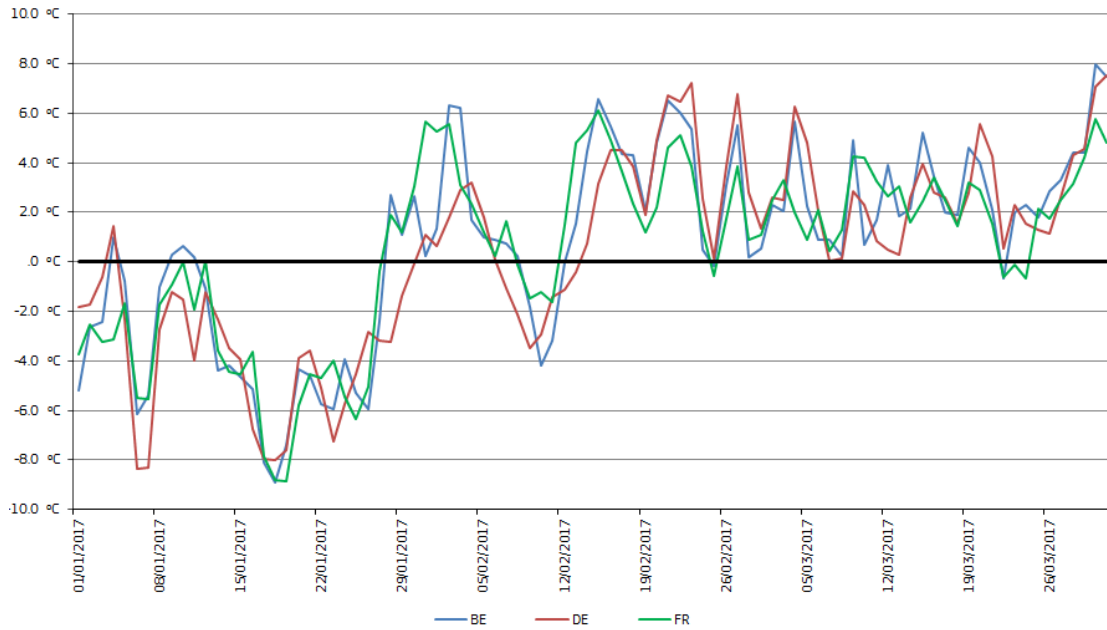
Source: Platts, EPEX

**Figure 16 - Daily average wholesale power prices in the CWE region**



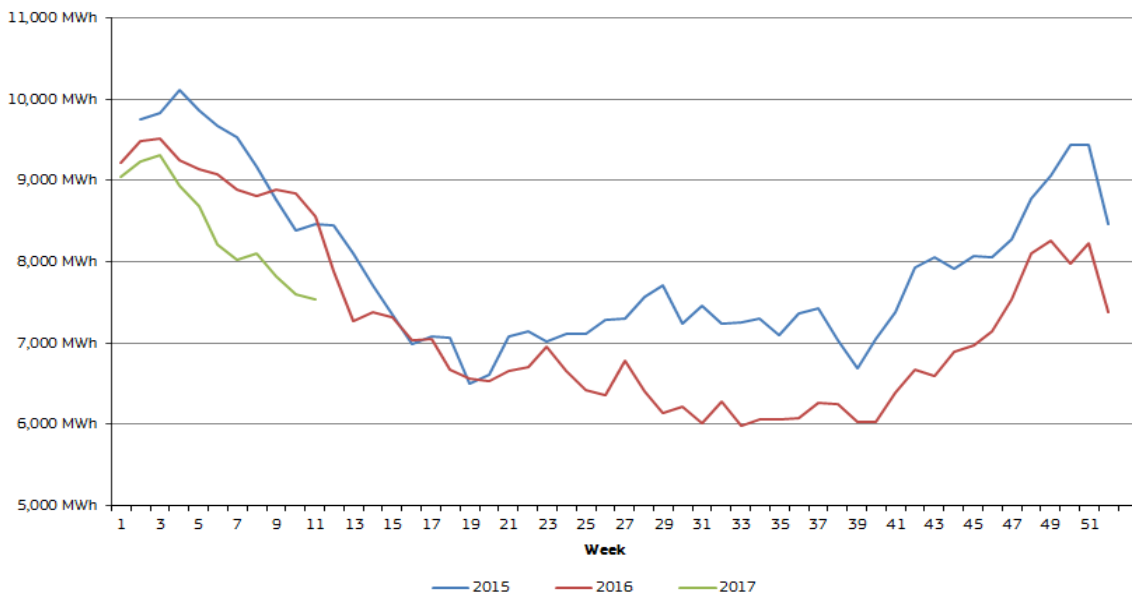
Source: Platts.

**Figure 17 – Deviation of the daily average temperature from the average of the period of 1975-2016**



Source: JRC, DG ENER

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



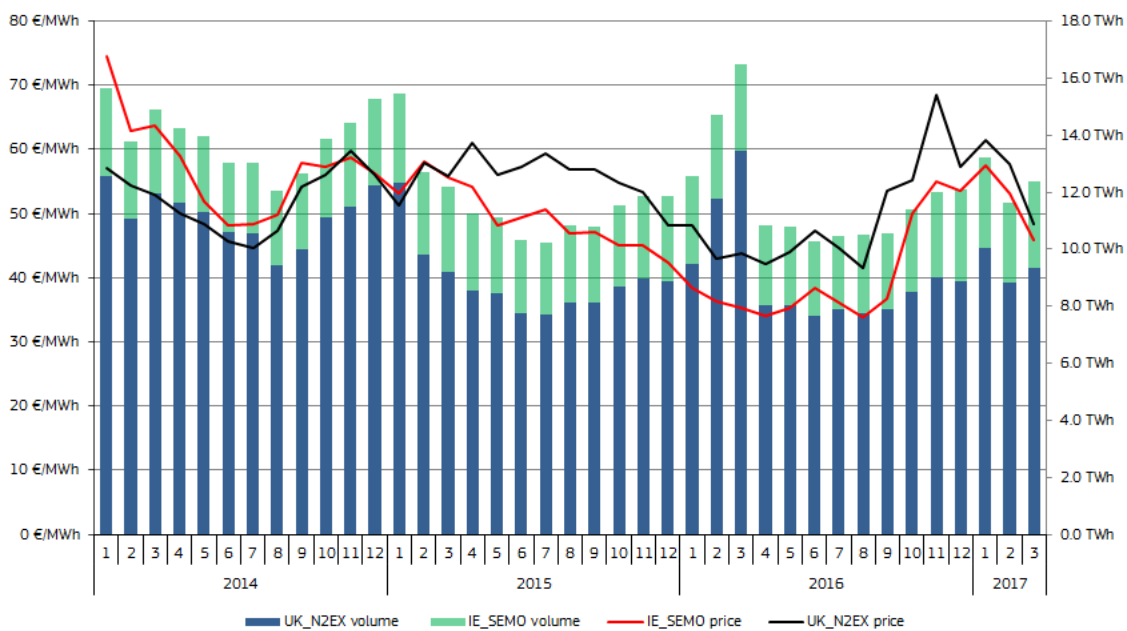
Source: ENTSO-E

## 4.2 British Isles (UK, Ireland)

- Although day-ahead wholesale baseload electricity prices rose both in the UK and Ireland and respectively reached 58 €/MWh in 61 €/MWh in January 2017 on monthly average, the sharp upturn, which could be observed in many continental markets, did not occur at all, as Figure 19 shows. By March 2017 the monthly average baseload price went down and reached 46 €/MWh and 48 €/MWh, respectively.
- However, in the third week of January the daily average price rose above 70 €/MWh on some trading days in both markets, as Figure 20 shows. As of beginning of February until the end of March 2017 the daily average price in both markets followed a downward trend, and price spikes registered in January did not occur again in the UK in the remaining part of the first quarter of 2017 (though in Ireland prices showed temporary upturns).

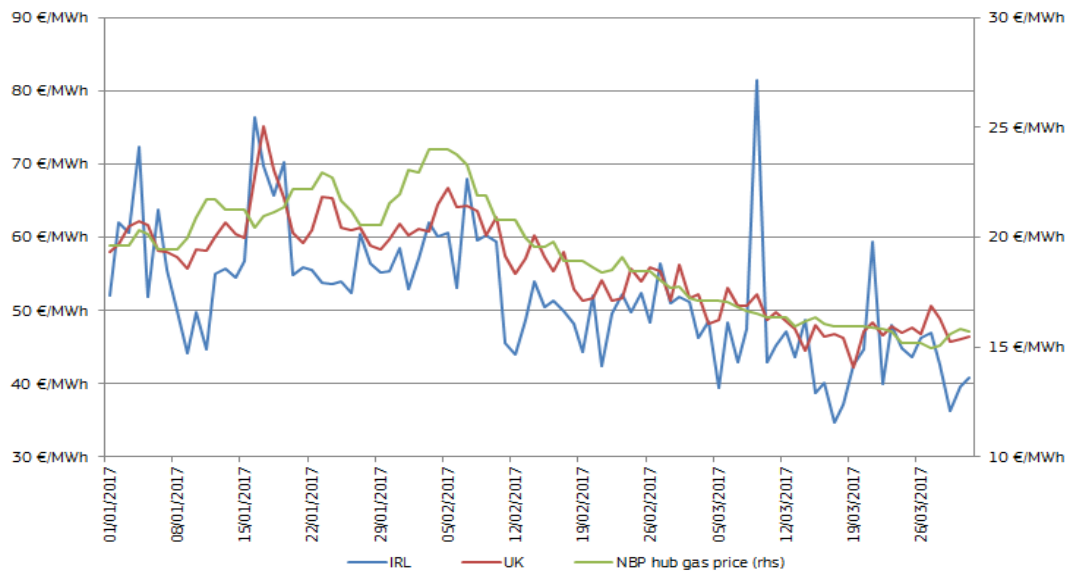
- In contrast to many countries in continental Europe, average daily temperatures in the UK and Ireland remained in line with the long term average (or were even higher) in January 2017. In February and March the weather was generally milder than usual, resulting in the lack of upward pressure on natural gas prices and on wholesale electricity prices.
- Interestingly, the highest wholesale electricity prices both in the UK and Ireland could be observed in the third week of January, which did not coincide with the highest natural gas prices in Q1 2017. This also shows that natural gas prices, though still setting marginal wholesale electricity prices in both countries, have less strong influence on the overall wholesale market than earlier, as the share of renewable generation (mainly wind) has been increasing over the last few years in both countries.
- Figure 21 shows the weekly evolution of the electricity generation mix in the UK in the second half of 2016 and in Q1 2017. The share of coal-fired generation in the UK electricity mix went down substantially compared to its importance few years ago; in parallel with increasing carbon tax and the decommissioning of coal-fired capacities over the last few years in the UK. Furthermore, higher penetration of wind energy seems to be an additional factor in crowding out coal from the British energy mix. Otherwise saying, instead having the traditional coal-gas competition, recently coal is more and more competing with wind and its share is significant only in case when wind generation is low (and/or gas prices are relatively high). In Q1 2017 the share of wind in the UK electricity generation mix was higher than the share of coal (14% vs. 11.5%). In Ireland the wind is even more important; in March 2017 it was the country's principal electricity generation source (with a monthly average share of 31%).
- In January 2017 the average UK wholesale electricity price discount to the French market was 17 €/MWh, which discount could be observed for the last time in February 2012. In the first month of 2017 the UK was net electricity exporter to France, and the net export of power amounted to 432 GWh. In February and March 2017, the UK became net electricity importer again, as high continental prices started to decrease. As in early March the 2 GW IFA (UK-France) electricity interconnector resumed operation at full capacity (since November 2016 it operated on limited capacity), power imports to the UK ramped up.

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



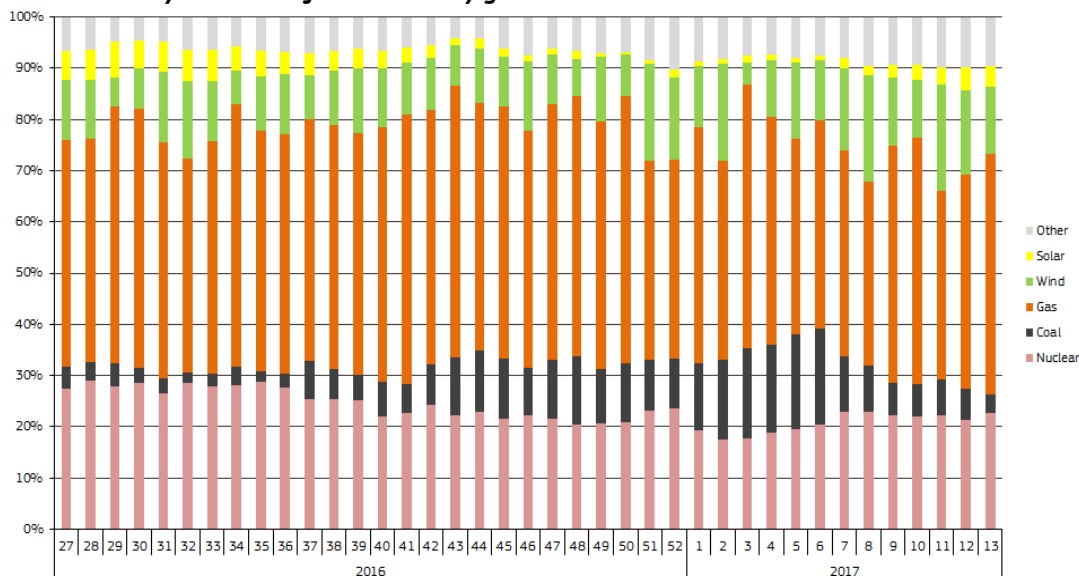
Source: Nordpool N2EX, SEMO

**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**

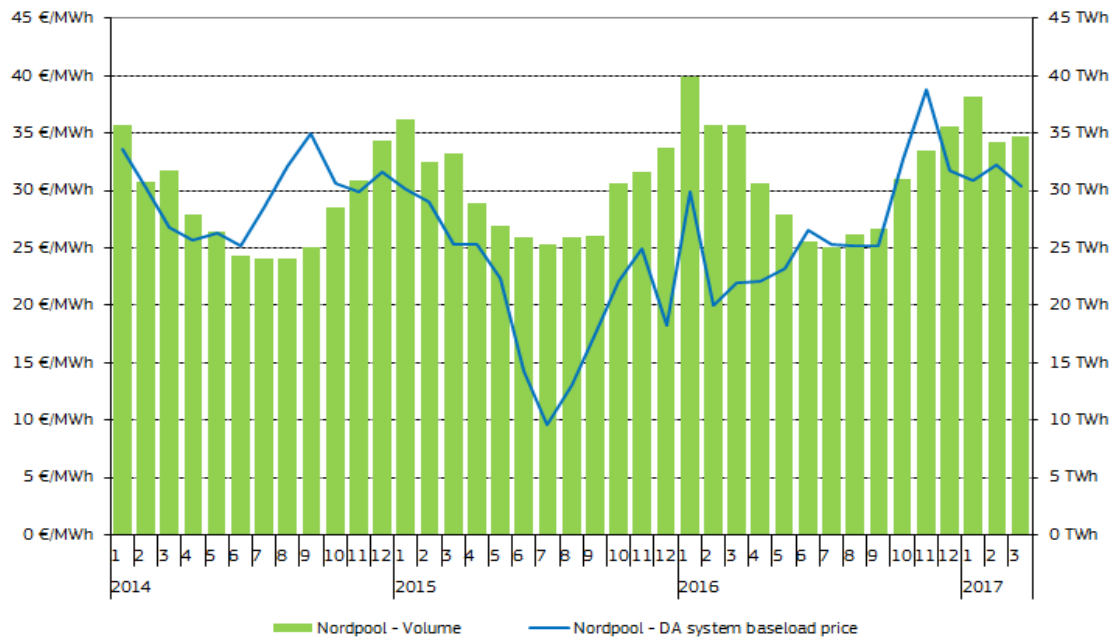


Source: ENTSO-E

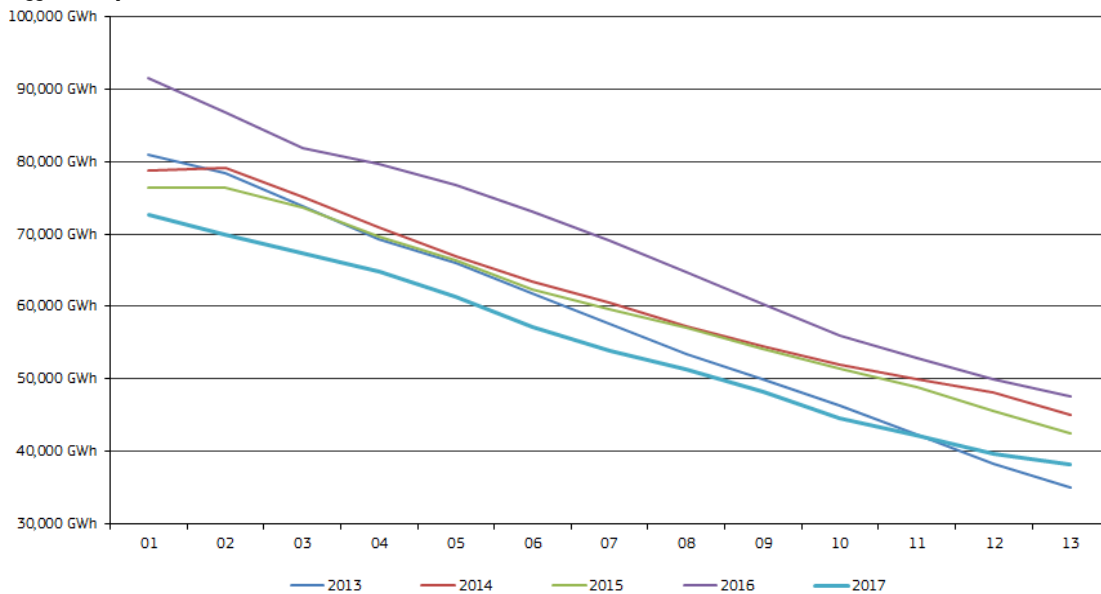
### 4.3 Northern Europe (Denmark, Estonia, Finland, Latvia, Lithuania, Norway, Sweden)

- As Figure 22 shows, in January 2017 the monthly average wholesale system electricity price in the Nordpoolspot market did not show the signs of huge increase in demand for electricity, as it even managed to decrease compared to December 2016, providing for a unique exception compared to other regional European markets where sharp price increases could be observed in this period. The monthly average Nordpool system price remained around 31-32 €/MWh in the whole Q1 2017.
- In contrast to the Central and Eastern parts of the continent the weather was generally milder in January 2017 throughout the whole Nordic region; and in February and March higher-than-normal temperatures continued to characterise the regional weather. This resulted in lower-than-usual heating needs, putting a lid on wholesale electricity prices in the regional markets.
- On the other hand, hydro availability in the Nordic region remained the lowest in the last five years during almost all of the first quarter of 2017, as Figure 23 shows. The level of hydro availability traditionally has an important role in shaping the wholesale market price in the Nordic region. Low hydro generation did not enable the Nordic region to profit from high prices in Central Europe, so the net exporter position did not improve in January 2017.

**Figure 22 - Monthly traded volumes and prices in Northern Europe**



**Figure 23 –Weekly combined hydro reservoir levels (Norway, Sweden and Finland) in the Nordic region in different years**



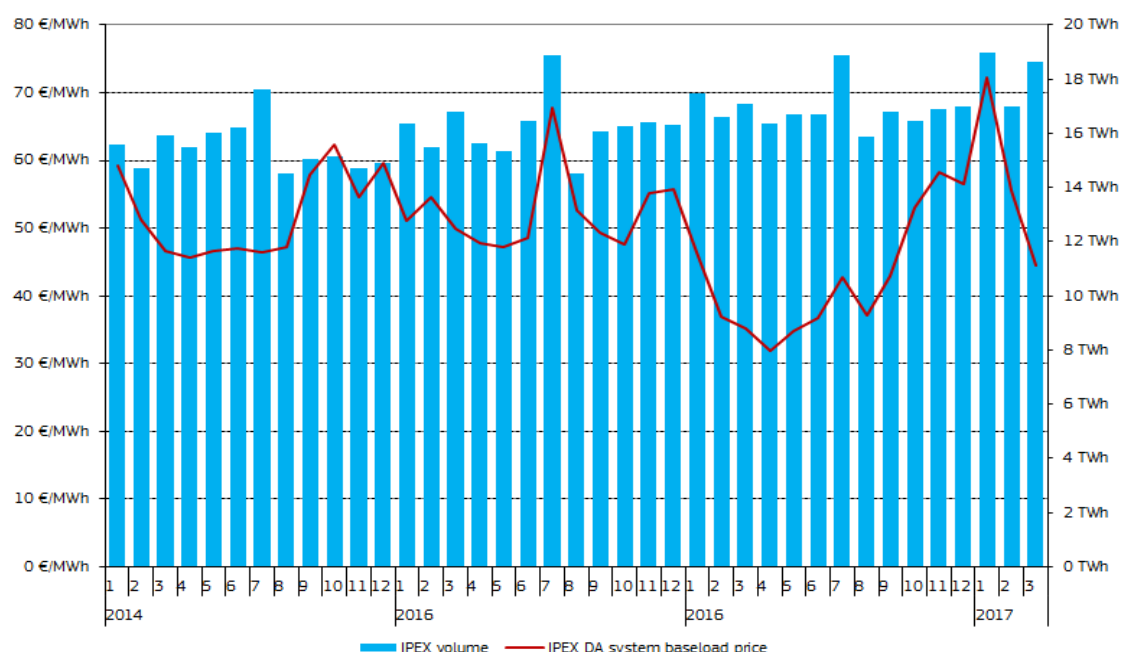
#### 4.4 Apennine Peninsula (Italy)

- The Italian monthly average wholesale baseload price followed the same pattern as prices in many European markets: from December 2016 to January 2017 a huge increase could be observed (from 56 €/MWh to 72 €/MWh), while in February, as the cold snap was over and the weather turned milder, the monthly average price started to decrease and in March it reached 44 €/MWh. Looking at the daily average price, the peak in Q1 2017 could be observed on 25 January (102 €/MWh – being the highest since 23 July 2015).
- In Italy the monthly average temperature in January 2017 was 2.8 degree Celsius lower than the January monthly average of the period between 1975 and 2016. Lower-than-normal temperatures resulted in high natural gas prices

in the Italian PSV hub (on 11 January the daily average hub price reached 40 €/MWh, being the highest since 7 February 2012).

- As the share of natural gas significantly increased in the Italian power generation at the beginning of 2017 (in January the share of gas grew to 55%, in parallel with receding hydro and wind generation), this also gave a boost to electricity generation costs and wholesale electricity prices on the Italian market. In February and March 2017 renewable generation increased and gas-fired generation receded in the power mix, assuring cheaper generation costs.
- During winter periods the share of electricity imports in the Italian consumption increases compared to the other periods of the year. As in January 2017 all markets in Central Europe faced high wholesale electricity prices, this also impacted import purchase costs of electricity in Italy. As import costs were not so competitive compared to domestic generation as in the similar period of earlier years, Italy's net importer position (860 GWh) was much smaller than in the month of January of the preceding years. Later, as import prices decreased, electricity inflows from Central Europe picked up again and in March the net importer position of Italy reached 3,900 GWh.
- During the cold spell in January the flow of electricity between different regions of Italy was hampered by heavy snowfalls and unplanned outages on 380kV transmission lines between the North and the South of the country, resulting in reserve risks and an operational security issue in the Northern regions, in the consequence of which hourly curtailments on export capacities to France were imposed on 18-19 January 2017.

**Figure 24 - Monthly traded volumes and prices in Italy**



Source: GME (IPEX)

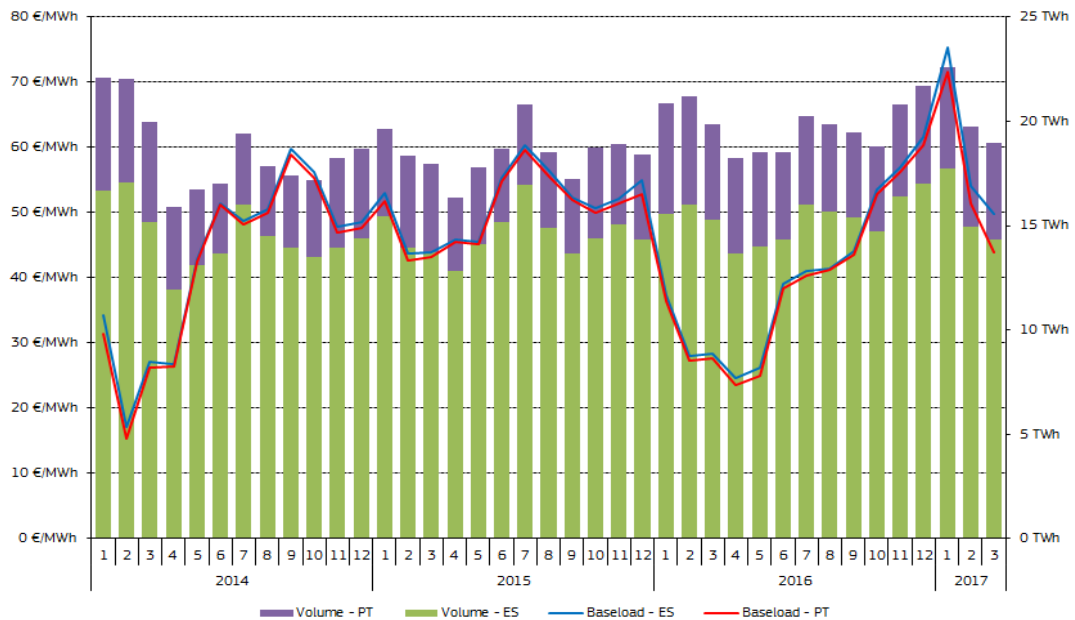
#### 4.5 Iberian Peninsula (Spain and Portugal)

- In January 2017 the monthly average wholesale baseload contracts in Spain and Portugal underwent a significant increase compared to the previous month: in Spain the monthly average price rose from 62 €/MWh to 75 €/MWh, while in Portugal it went up from 60 €/MWh to 72 €/MWh, as Figure 25 shows. After the sharp upturn in January, the wholesale electricity price contracts started to decrease both in Spain and Portugal and by March 2017 they respectively fell back to 50 €/MWh and 44 €/MWh.
- However, in comparison to the countries of the neighbouring Central Western Europe region, in Spain and Portugal temperatures in January were not significantly lower than the long-term values, implying that high electricity prices were not related to unusually high local heating-related demand. Instead, high prices were the consequence of higher domestic generation costs and decreasing imports from the CWE region.
- As Figure 26 shows, during the first few weeks of 2017 the share of fossil fuels temporarily increased in the electricity generation mix, as hydro generation was low, owing to the ongoing dry weather and lower-than-usual hydro reserve levels, and to wind and solar generation being lower than in the same period of the previous year. Later in Q1

2017 wind generation started to pick up and hydro generation also increased, resulting in lower electricity generation costs as the share of coal and gas decreased.

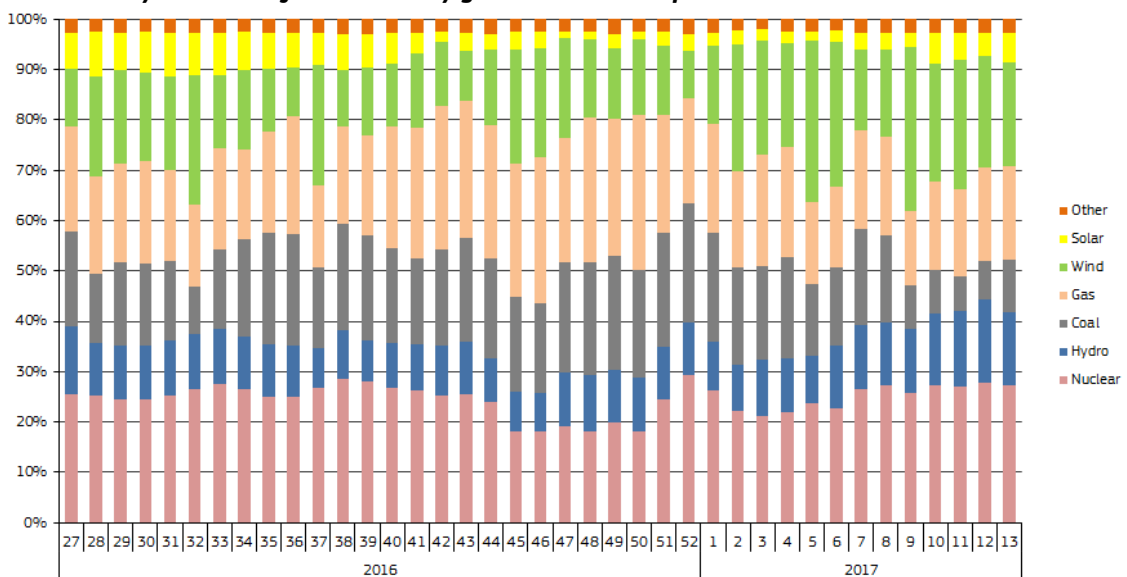
- High wholesale electricity prices in France and the short-lived export capacity curtailments towards Spain resulted in a net electricity exporter position of Spain to France in January, however, in February and March the country resumed its usual net electricity importer position, as it can be followed on Figure 27. In March 2017 the whole Iberian region imported more electricity (by 2,000 GWh) than its total electricity exports in the same month.

**Figure 25 - Monthly traded volumes and prices in the Iberian Peninsula**



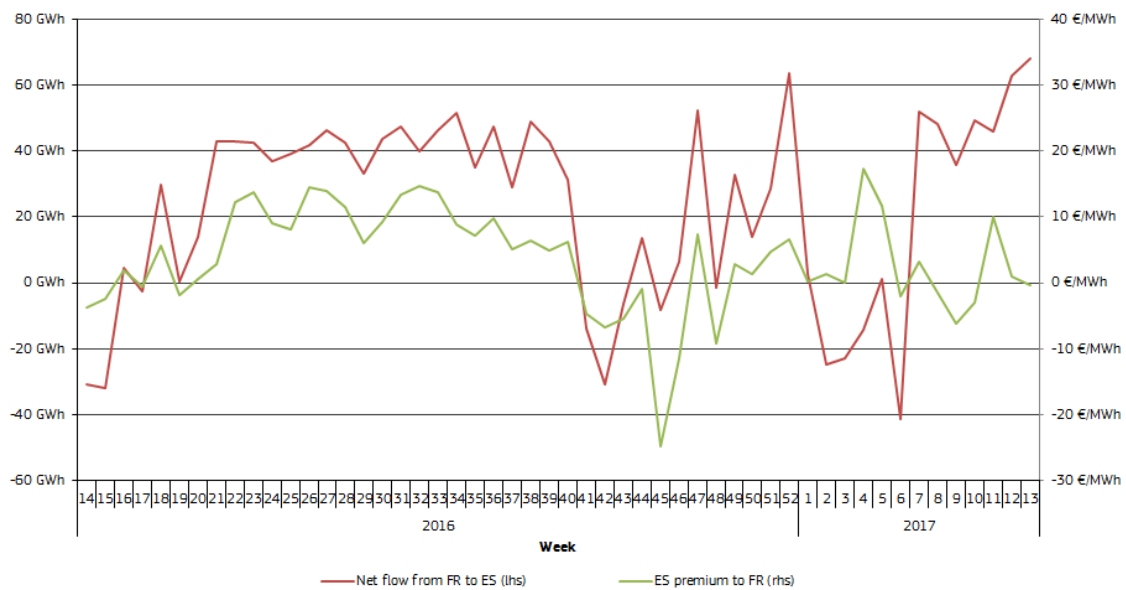
Source: Platts, OMEL

**Figure 26 - Weekly evolution of the electricity generation mix in Spain**



Source: ENTSO-E

**Figure 27 – Weekly average Spanish electricity price premium over France and weekly net electricity flows between the two countries**



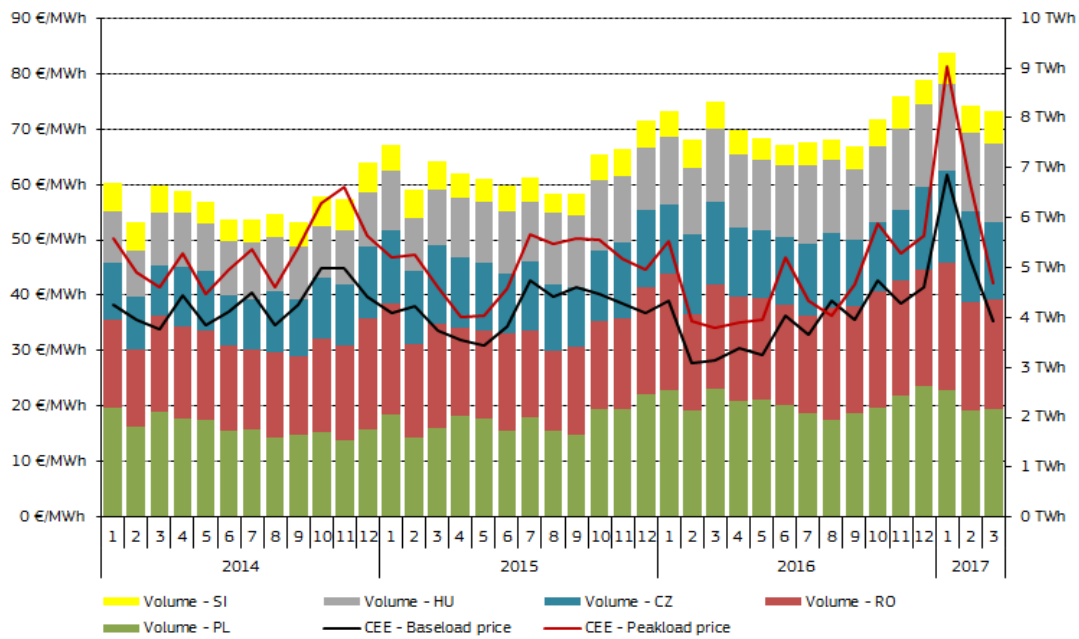
Source: Platts, OMEL, ENTSO-E

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

- The regional monthly average baseload price in Central and Eastern Europe (CEE) showed a significant increase in January 2017 and reached 62 €/MWh, while the monthly average peakload contract rose to 81 €/MWh, both even being above the monthly averages observed during the February 2012 cold spell event. Similarly to the other regions in Europe, high prices measured in January started to decrease and by March 2017 the regional monthly baseload and peakload averages fell back to 35 €/MWh and to 42 €/MWh, respectively, as Figure 28 shows.
- In the first half of Q1 2017 there were many trading days when the daily average temperature was lower by 10 degree Celsius compared to the normal long-term average on that particular day in Poland, Czech Republic, Slovakia and Hungary. Low temperatures have put a pressure on the electricity system, as it resulted in extra demand for residential heating, however, the cold spell also impacted the supply side of the electricity market.
- Figure 29 shows the daily average wholesale electricity prices in the CEE region in the first quarter of 2017. During the weeks of the cold period in January and early February prices in Poland remained low and quite stable, as the country could rely on their domestic generation capacities that covered domestic consumption. In contrast, prices in Hungary and Romania had a significant premium to the Polish prices during these weeks. Prices in the Czech Republic and Slovakia were very volatile and were also higher than the Polish contracts. As of mid-February the harsh winter weather ended, daily average regional prices realigned and remained in the narrow range of 30-40 €/MWh until the end of Q1 2017.
- The daily average wholesale price in Hungary reached its peak on 11 January 2017 (150 €/MWh, though in some trading hours the market price reached 300 €/MWh). This was the result of several factors: In January 2017 Hungary recorded all-time high electricity consumption (4.27 TWh) in a single month. Some planned outages also occurred in the country, impacting significant generation capacities, however, there were unplanned events, amounting to 1,000 MW missing capacities altogether in the Hungarian electricity system. Freezing temperatures resulted in the unavailability of lignite stocks (also being frozen) for electricity generation. Hydro-based electricity generation in the Balkans also decreased as River Danube and other rivers were partially frozen, reducing hydro availability.
- Low hydro availability impacted the general wholesale price level in Romania as well, and on the top of this low renewable generation also added to the upward pressure on the Romanian market prices. In consequence only modest flows were reported from Romania to the neighbouring Bulgaria during the days preceding the introduction of export ban in Bulgaria (see subchapter 4.7).
- High price volatility in the Czech Republic and Slovakia were mainly due to increasing import needs in the southern countries of the CEE region, being satisfied through the infrastructure of these two former countries. In mid-January electricity import capacity curtailments were also imposed in Austria towards Hungary, further increasing the upward pressure on the Hungarian price level.

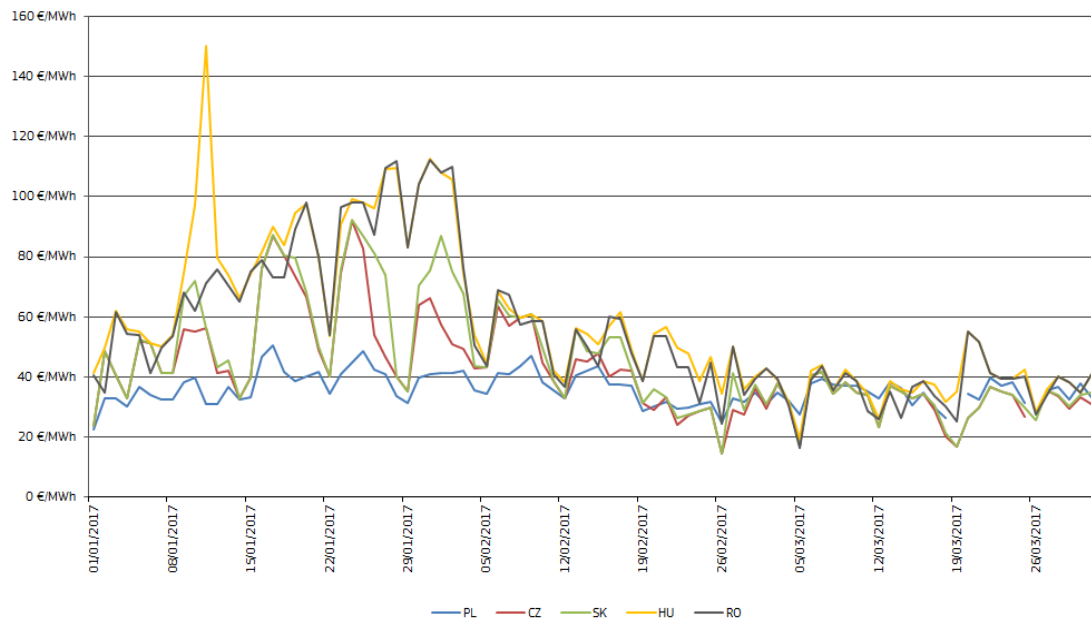


**Figure 28 - Monthly traded volumes and prices in Central Eastern Europe**



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

**Figure 29 - Daily average wholesale power prices in the CEE region**



Source: Platts (EPEX), CEE Regional power exchanges

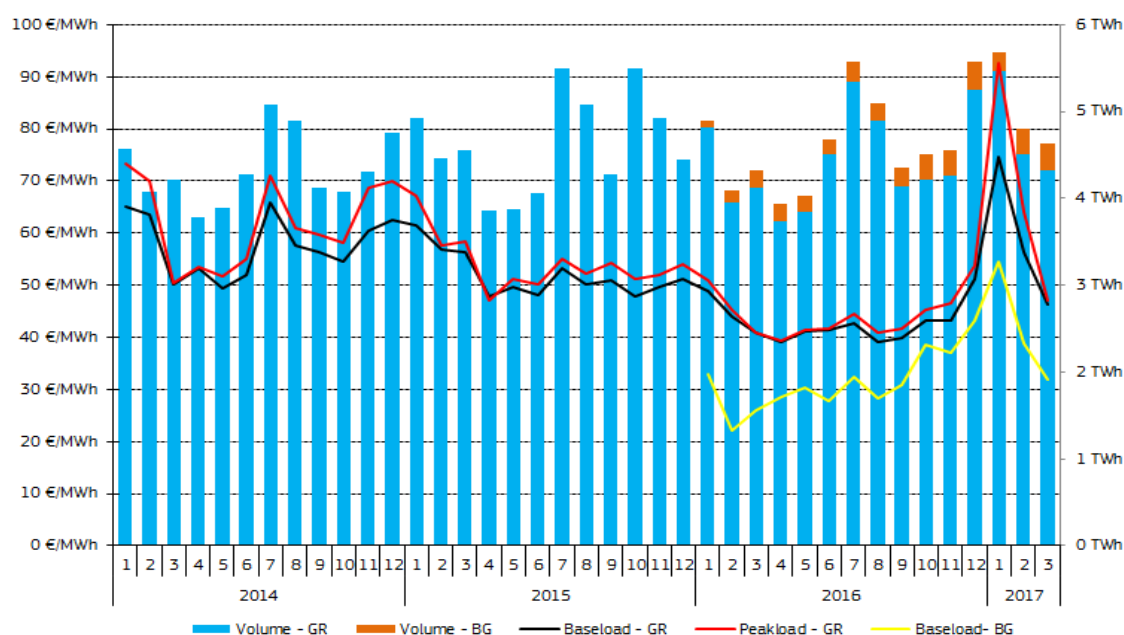
#### 4.7 South Eastern Europe (Greece and Bulgaria)

- In the South East European region the weather was also very cold during January 2017, and this significantly impacted the wholesale electricity prices in Greece, as, as Figure 30 shows: the monthly average baseload price rose between December 2016 and January 2017 from 51 €/MWh to 75 €/MWh, while at the same time the monthly average peakload went up from 54 €/MWh to 93 €/MWh. In Bulgaria the monthly average baseload price went up from 43 €/MWh to 54 €/MWh.
- In January 2017 the monthly average temperature in Greece was 3.3 degree Celsius lower than the January average of the period between 1975 and 2016, while in Bulgaria the deviation from long-term average was -3.6 degree Celsius. However, during most of the time in January 2017 the daily average temperatures were 5-10 degree Celsius

lower than the long-term averages in both countries for given dates, but in the second week of the month the deviation in temperatures was more than -10 degree Celsius, as Figure 31 shows.

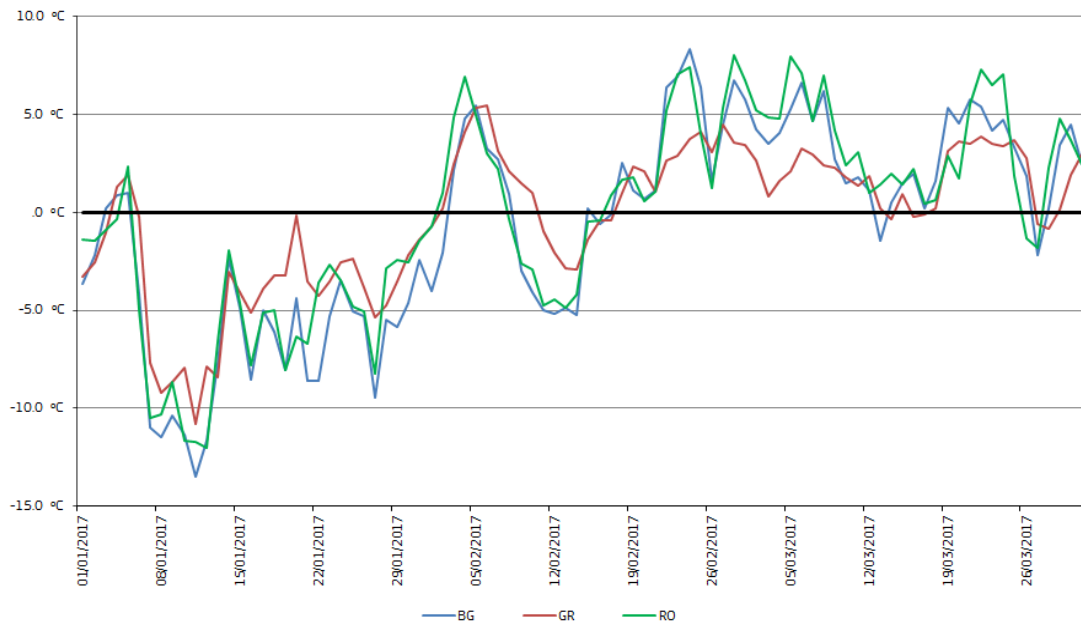
- During Q1 2017 the daily wholesale electricity price in Bulgaria peaked at 126 €/MWh on 10 January, while the quarterly peak in Greece could be observed on 24 January, with a daily average of 114 €/MWh, as Figure 32 shows. On the demand side low temperatures resulted in increasing demand for heating needs, as in Bulgaria heating in the residential sector is highly electricity dependent. On the supply side of the electricity market, low temperatures reduced the availability of hydro generation sources, and in the consequence of freezing temperatures lignite stocks were not able to be used for electricity generation (both because of transport problems amid wintry weather conditions, and of the frozen lignite stocks).
- In Bulgaria electricity export restrictions were imposed in order to protect the domestic market customers. The Ministry of Energy has approved an effective export ban of electricity (which did not impact the cross-border flows through Bulgaria, only exports from Bulgarian generation sources) between 13 January and 8 February 2017. In consequence of the export ban day-ahead prices fell below the prices in the neighbouring Greece and Romania (see Figure 32). Further measures were taken in order to shift power volumes to the regulated electricity market (assuring the supply for the residential sector) from the liberalised market.
- The export ban was not the best solution from an internal market point of view, as in this case the cooperation between the countries in the region was not effective and cross border emergency agreements were cancelled or disregarded. Unilateral export bans have undermined the confidence and had spill over effects on the neighbouring markets, and on the top of this electricity generators in Bulgaria have lost an estimated € 27 million owing to non-generated electricity, relating to the export ban.
- On 11-12 export curtailments in Greece were also imposed, and gas-fired power generation units were instructed to switch to diesel, however, this measures did not exert much influence on the domestic wholesale electricity price level. Within the framework of regional cooperation, Greece requested emergency electricity transport from the neighbouring TSOs, but this request has not been met. Furthermore, the interconnector with Italy was not functioning during the weeks of the cold spell.

**Figure 30 - Monthly traded volumes and prices in Greece and Bulgaria**



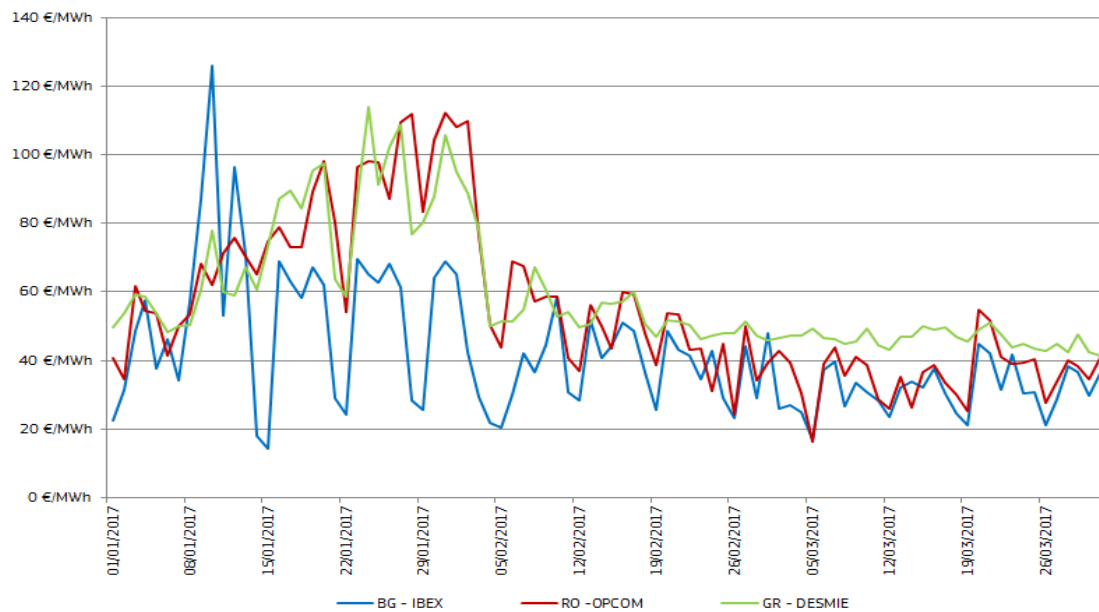
Source: LAGIE, IBEX

**Figure 31 – Deviation of the daily average temperature from the average of the period between 1975 and 2016**



Source: ENTSO-E

**Figure 32 – Comparison of daily average day-ahead prices in Bulgaria, Greece and Romania**

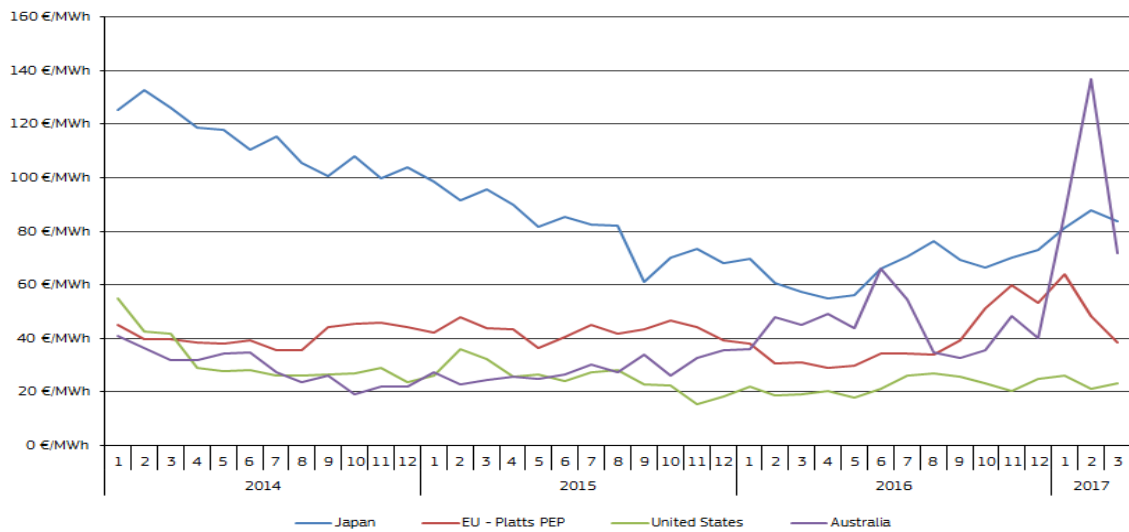


Source: IBEX, LAGIE, OPCOM

## 5 International outlook – comparing EU power prices with international peers

- As Figure 33 shows, in the first quarter of 2017 the gap between wholesale electricity prices in Europe and the US widened, in the consequence of surging prices in the EU and price stability in the US. The quarterly EU/US wholesale electricity price ratio was 2.1 in Q1 2017, being higher than the usual range of 1.5-2 in the past few quarters. In Australia wholesale prices showed a sharp upturn in January-February 2017, as in some parts of the country the weather conditions sparked more intensive use of costlier gas-fired generation sources. In Japan the wholesale electricity prices also slightly increased in the first quarter of 2017, in the consequence of rising LNG prices in the Asian markets.

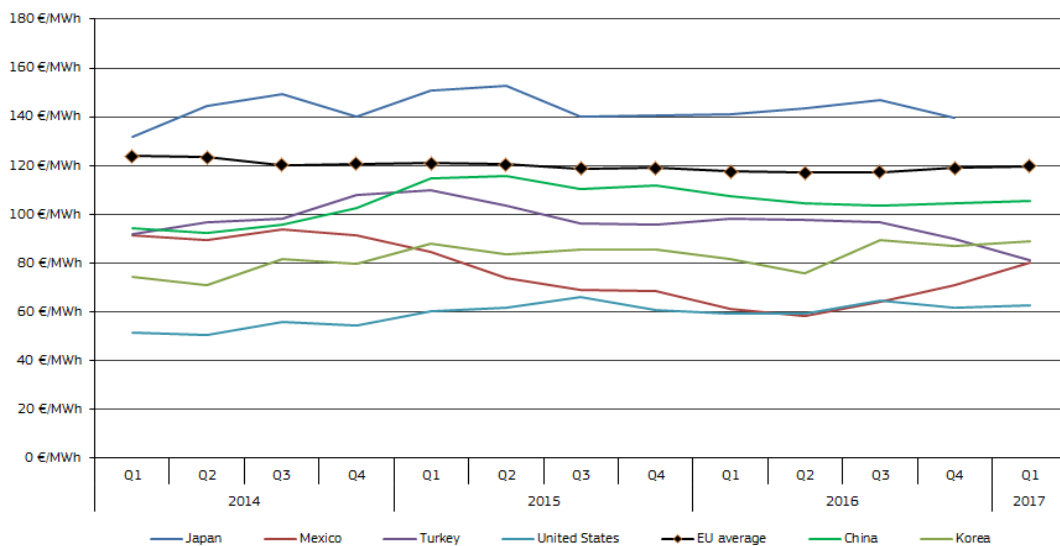
**Figure 33 – Comparison of the monthly average wholesale electricity prices in Europe, US, Japan and Australia**



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

- In this report retail electricity prices paid by European industrial customers are compared with industrial electricity prices in the United States, Japan, China, Mexico and Turkey, as Figure 34 shows.
- Similarly to the differences in wholesale prices, in Q1 2017 industrial customers in the United States had to pay about half as much for electricity than in the EU on average. In Mexico prices started to decouple from the US peers and in Q1 2017 they grew by 30% higher, though compared to the EU average they were still lower by a third. In contrast, customers in Japan had to pay 20% more than their European counterparts.
- In Turkey the decrease in industrial electricity prices continued in Q1 2017 and prices were 30% lower than the EU average, which might have also been related to the depreciation of the Turkish lira against the euro. Industrial prices in China were around 10% lower than the EU average, whereas in Korea this negative gap amounted to 20% in the first quarter of 2017.

**Figure 34 - Comparison of the average EU retail electricity price paid by industrial users with the prices of some international competitors**



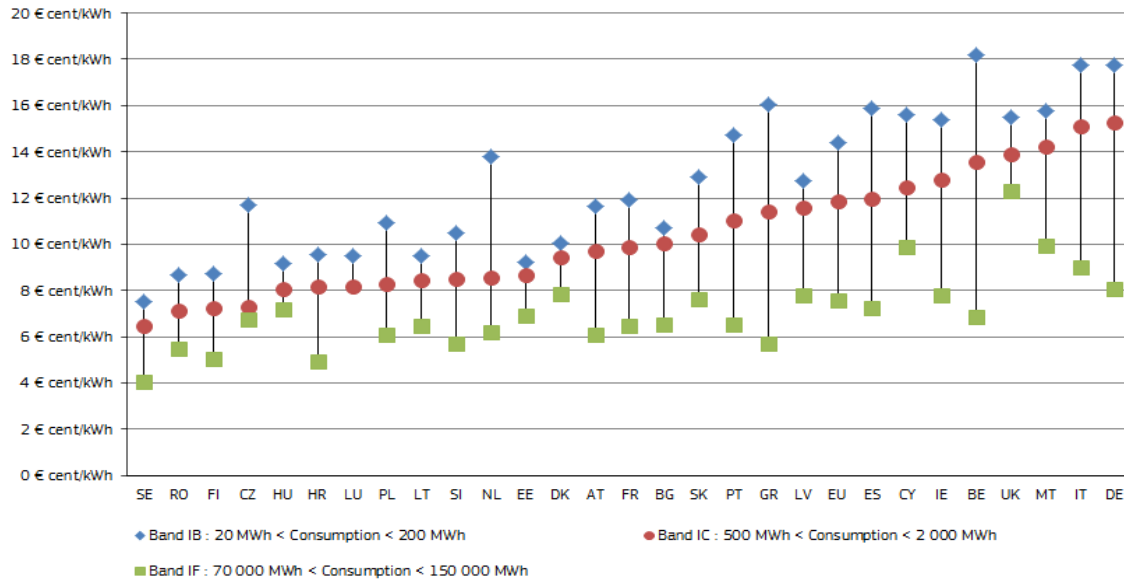
Source: IEA, CEIC, Eurostat and DG ENER

## 6 Retail electricity prices in the EU

- Figure 35 and Figure 36 show the monthly estimated retail electricity prices in March 2017 in the 28 EU Member States for industrial customers and households for three different levels of annual electricity consumption (Eurostat bands I<sub>B</sub>, I<sub>C</sub> and I<sub>F</sub> for the industrial customers and bands D<sub>B</sub>, D<sub>C</sub>, D<sub>d</sub> 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) for the household prices and the Producer Price Indices (PPI) for the industrial customers, based on the time series of twice-yearly retail energy price data from Eurostat.
- In the case of industrial customers with low annual consumption Italy was the most expensive country in March 2017 (with a price of 17.8 Eurocent/kWh), while Sweden was the cheapest (7.5 Eurocent/kWh). At the same time in the case of households, retail electricity prices were the lowest in Bulgaria (9.6 Eurocent/kWh), while households with low annual consumption had to pay the most in Belgium (34.3 Eurocent/kWh).
- In the case of industrial customers, having medium level annual electricity consumption (Band I<sub>C</sub>), the monthly ratio of the highest and the lowest price in the EU was 2.4 (Sweden: 6.5 Eurocent/kWh, Germany: 15.3 Eurocent/kWh), while in the case of large industrial customers it was 3.1 (Sweden: 4.0 Eurocent/kWh, United Kingdom: 12.3 Eurocent/kWh). In the case of households with medium level annual consumption (Band D<sub>C</sub>) the highest-lowest price ratio was 3.2 (Bulgaria: 9.6 Eurocent/kWh, Belgium: 31.0 Eurocent/kWh) in March 2017.
- 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 is a convergence in retail electricity prices, as the relative standard deviation mostly decreases over time, even though there are some temporary deviations from this trend. In contrast, the relative standard deviation even increased in the last two years in the case of households, implying the divergence of household retail prices across the EU. However, in the first quarter of 2017 household prices showed signs of convergence, 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.
- The convergence of wholesale electricity prices across Europe can be better tracked in the convergence of retail industrial prices, as industrial customers are normally not subject to regulated end-user prices, have better bargaining power at concluding electricity purchase contracts, and the share of the so-called energy supply component (showing strong correlation with wholesale electricity prices) is higher in their final retail price, whereas the share of non-market elements, such as network costs, taxes and levies are lower than in the case of households. As retail household prices contain VAT and other non-recoverable taxes and levies, the increasing importance of taxes in the final household retail prices is an important factor behind the non-convergence of household retail prices across the EU.
- 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 April 2017 the highest retail electricity prices paid by households could be observed in Copenhagen (31.3 Eurocent/kWh) and in Berlin (30.9 Eurocent/kWh), while the cheapest capitals in the EU were Sofia (10.7 Eurocent/kWh) and Bucharest (11.1 Eurocent/kWh). Compared with April 2016, an outstandingly high price increase could be observed in Nicosia (40%) and the second highest increase was in Madrid (12.5%) across the EU, while retail electricity prices decreased the most in Riga (10.5%) and Vilnius (10.2%).
- Figure 40 shows the change in household retail electricity prices between April 2016 and April 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 costs increased by the most in Nicosia (by 4.5 Eurocent/kWh), which must have been strongly related to increasing crude oil prices over the last twelve months. Energy costs decreased by the most in Vilnius. Energy taxes increased measurably in Bratislava and Luxembourg and they went down by the most in Rome. Transmission and distribution costs had the biggest downward impact on the final retail prices in Bratislava, possibly resulting from a change in the reporting methodology, as energy taxes were up by the same extent compared to April 2016. At the distribution costs increased in Rome and Warsaw.

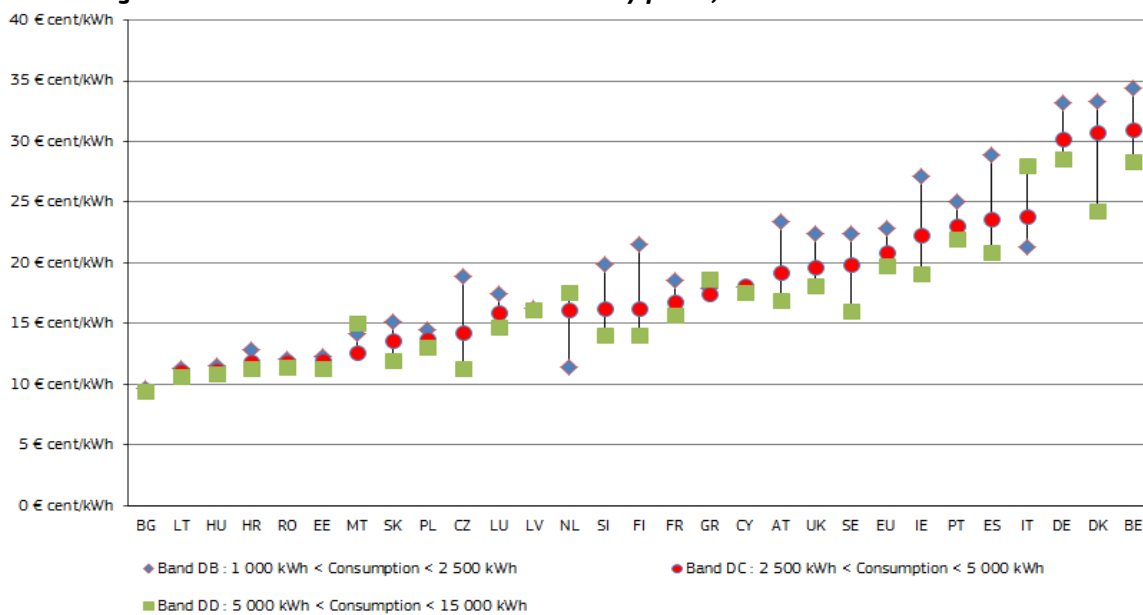
- In Madrid there were significant changes in the reporting practice of different price components, resulting in re-classification of cost elements from the group of network costs to taxes and levies, better showing the impact of different policy measures (e.g.: capacity payment, renewable generation incentives, annuities of the tariff deficit, etc.). In consequence, network costs became lower and the tax component higher compared to the last observation period.
- 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 first quarter of 2017.

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



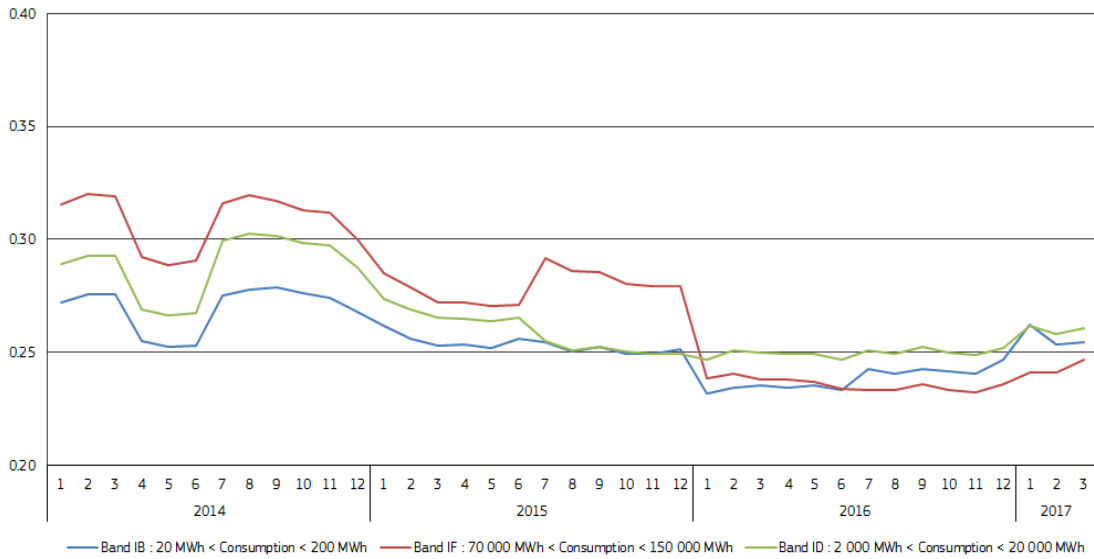
Source: Eurostat, DG ENER

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



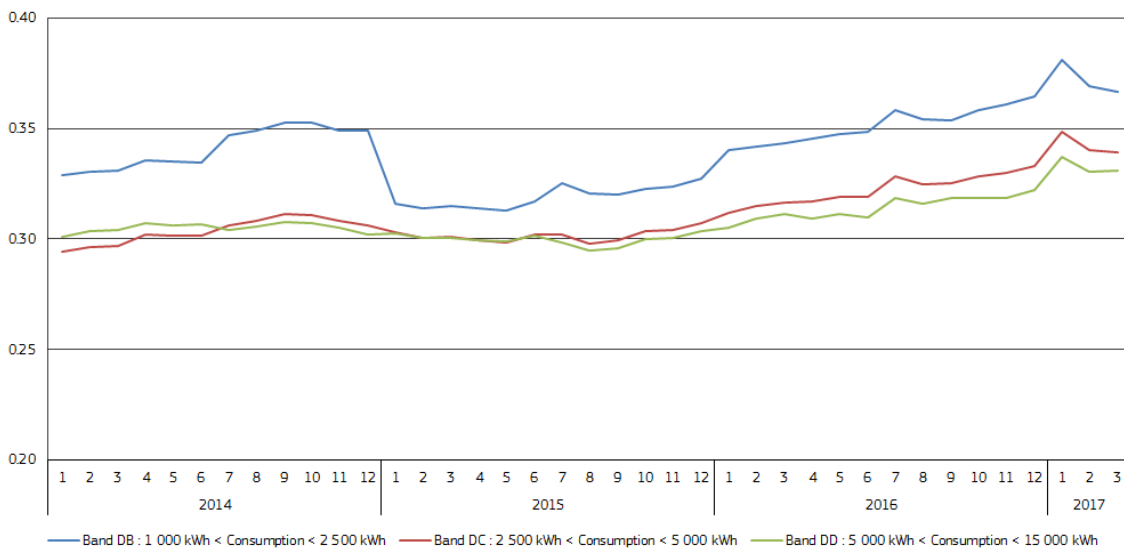
Source: Eurostat, DG ENER

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



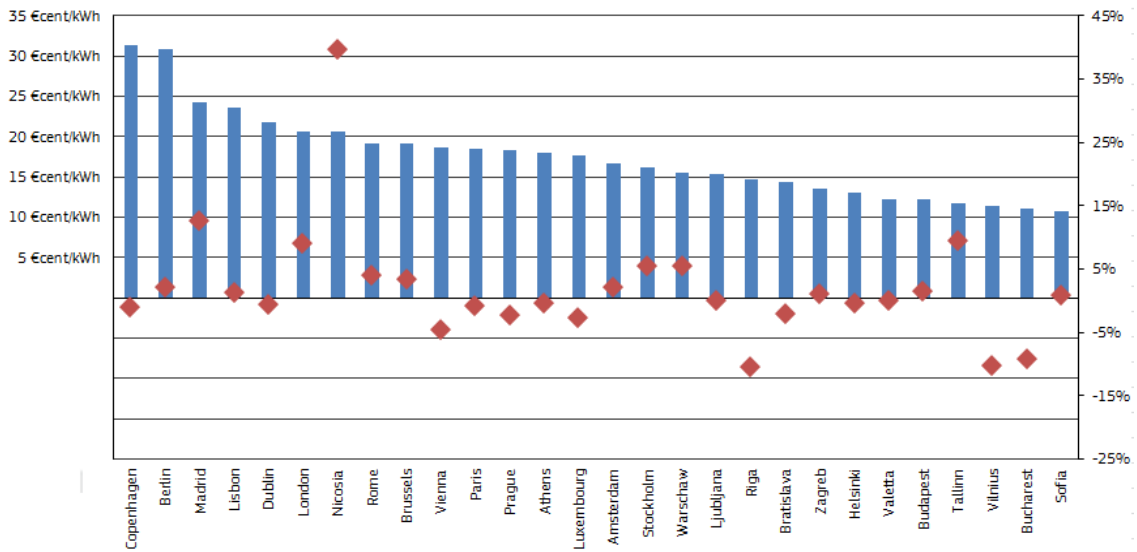
Source: Eurostat, DG ENER

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



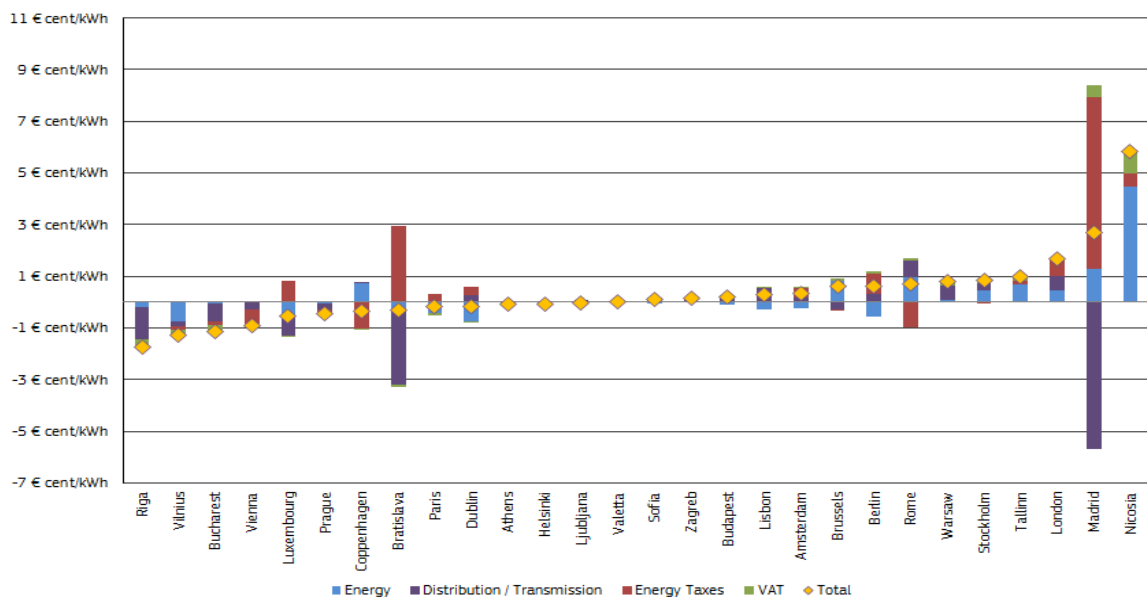
Source: Eurostat, DG ENER

**Figure 39 – The Household Energy Price Index (HEPI) in the European capital cities - Electricity prices in April 2017, and changes in household electricity prices compared to April 2016**



Source: Vaasaett

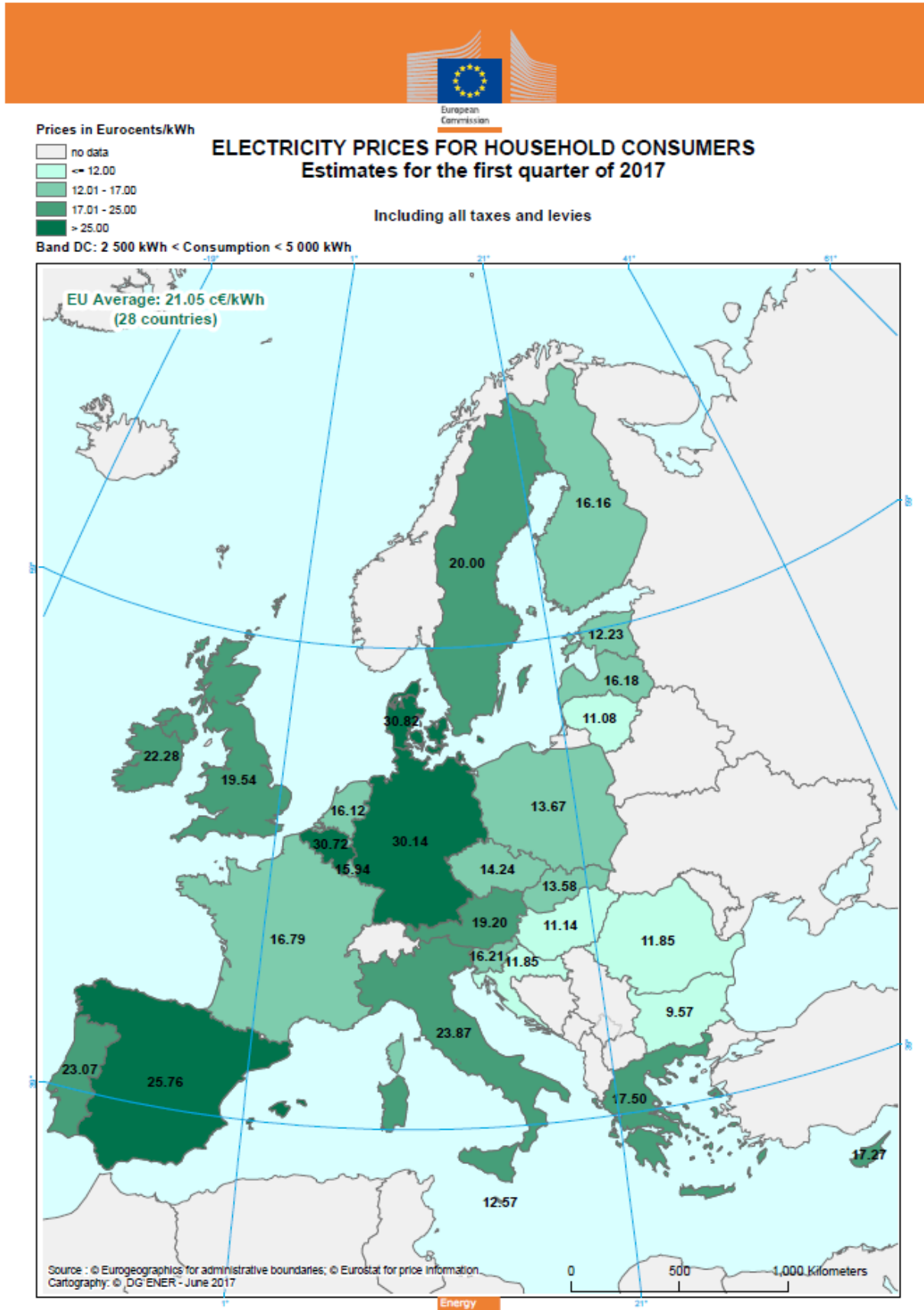
**Figure 40 – Change in electricity prices and their cost components in the European capital cities, between April 2016 and April 2017, in Eurocent/kWh**



Source: Vaasaett

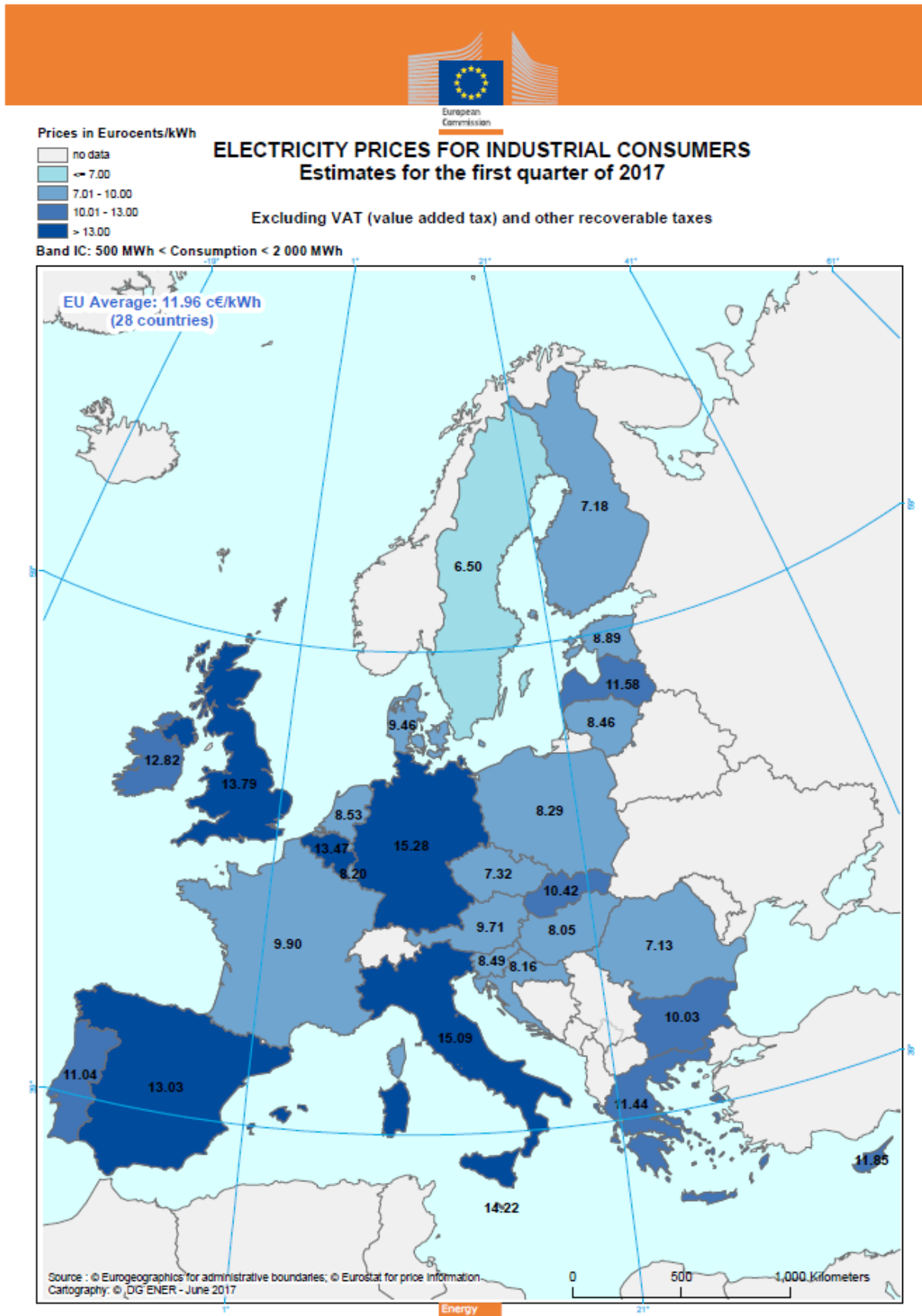


Figure 41- Electricity prices (inclusive of taxes) – Households – Estimated for the first quarter of 2017



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

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



Source : Data computed from Eurostat half-yearly retail electricity prices and consumer 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 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*.

**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.

**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.