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QUARTERLY REPORT ON EUROPEAN ELECTRICITY MARKETS

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HIGHLIGHTS OF THE REPORT

- Wholesale electricity prices at EU level in the first quarter of 2018 were relatively stable and the European Power Benchmark index was 45 €/MWh on average, being about 10% lower than in Q1 2017.

- In January 2018 the weather was milder than usual, contributing to low wholesale electricity prices in most of Europe, however, in March there were two cold snaps, resulting in temporary price spikes in many markets.

- Economic growth continued in Q1 2018 in the EU and GDP grew by 2.4% in year-on-year comparison in the EU, electricity consumption grew by 3%, in parallel with the economic growth.

- Most of nuclear capacities in France that were taken offline in the previous two quarters came back to the grid in Q1 2018, contributing to healthy supply margins on the French wholesale market.

- In the Nordic markets, primarily owing to lower-than-usual hydro generation, wholesale electricity prices rose to five-year high in March 2018; at the same time in Spain increasing hydro reserves resulted in a drop in wholesale prices.

- In spite of decreasing coal and stable gas prices, profitability of both coal and gas fired generation further deteriorated in Q1 2018 in many EU countries. Fossil fuels were partly replaced by increasing renewable and nuclear generation in the EU electricity mix.

- Carbon prices rose significantly in Q1 2018, as market players anticipated that regulatory changes, to enter into force in 2019, might result in decreasing oversupply on the emission allowances market.
EXECUTIVE SUMMARY

- In the first quarter of 2018 the European benchmark day-ahead baseload wholesale electricity price index showed a relative stability during most of the time, reaching 45 €/MWh on average, after 50 €/MWh in Q4 2017. In Germany and most of Central and Eastern Europe the quarterly average price was around 30-40 €/MWh, while in the UK it was close to 60 €/MWh. However, wholesale price dispersion across different markets in Europe was lower in Q1 2018 than in Q4 2017.

- Economic growth continued in first quarter of 2018 in the EU and GDP grew by 2.4% in year-on-year comparison, being slightly less than in the previous quarter (2.7%). Electricity consumption in Q1 2018 increased in parallel with the economic growth, by 3%, compared to the first quarter of 2017.

- In January 2018 weather was milder than usual in most of the European continent, implying that heating-related demand for electricity remained moderate, and this contributed to low wholesale electricity prices in most of the markets. In late February and in March 2018 however, two cold snaps impacted many countries in Europe, resulting in sudden electricity price spikes in the wholesale markets.

- Natural gas prices were significantly affected by the aforementioned cold snap at the beginning of March 2018. At the end of the heating season when gas storage levels were already low in whole Europe, the cold weather resulted in sudden price spikes on most of the European gas hubs, lifting the prices to three times as high as the usual magnitude. Although this gas price spike was short-lived, it significantly impacted wholesale electricity prices in most of the markets.

- Although coal prices decreased in the first quarter of 2018, profitability of coal-fired generation and consumption of coal in the power sector decreased in most of the European countries. The profitability of gas-fired generation further deteriorated too, and decreasing use of fossil fuels in the European electricity mix was replaced by increasing renewables and nuclear production. Nuclear generation was helped by significant capacities coming back to the grid in France after the end of safety inspection in the previous two quarters. In many European countries wholesale electricity prices were too low to make fossil fuel based generation profitable, being more and more influenced by other cost elements (e.g.: carbon tax in the UK or emission allowance prices).

- Carbon prices rose significantly, from 8 €/tCO₂e to 13 €/tCO₂e between the beginning and the end of the first quarter of 2018. Market players were anticipating that changes in the regulation relating to the Emission Trading System in the EU (ETS), for example certain provisions on the so-called Market Stability Reserve (MSR), to enter into force in 2019, might reduce the current oversupply in the emission allowance market and could contribute to increase in carbon prices in the future.

- Wholesale electricity prices in the Nordic region rose to five-year high in March 2018, primarily owing to lower than usual hydro electricity generation. At the same time in Spain and Portugal, hydro generation rose to the highest since 2016, contributing to low wholesale electricity prices, being also helped by increasing wind generation. Improving hydro availability in the Balkans helped South East Europe to export a significant amount of power to Central and Eastern Europe. As from the current edition onwards, wholesale and retail electricity markets in Croatia are also covered in the quarterly electricity report.

- Retail electricity prices for household customers increased by 5.6% between April 2017 and April 2018 in the European capital cities on average. Changes in retail electricity prices were mainly driven by increasing energy and supply costs and transmission and distribution costs, but energy taxes also had an upward impact on the final retail prices.
1 Electricity market fundamentals

1.1 Demand side factors

- In the first quarter of 2018 economic growth in the EU-28 continued for the fifth consecutive year and GDP grew by 2.4% in year-on-year comparison, being slightly slower than in Q4 2017 (2.7%). In Q1 2018, according to the data of the European Network of Transmission System Operators (ENTSO-E), consumption of electricity was up by 3% (or by 24 TWh) in the EU-28 in year-on-year comparison. Gross value added in important energy consumer sectors, such as manufacturing and construction, was up by 3.7% and 3.3% respectively, if compared to Q1 2017.

Figure 1 – EU 28 GDP Q/Q-4 change (%)

![Graph showing EU 28 GDP Q/Q-4 change (%)](source: Eurostat)

- Figure 2 shows the monthly deviation of actual Heating Degree Days\(^1\) (HDDs) from the long term averages in January-March 2018 in the twenty-eight Member States of the EU. In January 2018 the weather was generally milder than usual in almost all EU countries, putting a lid on heating related energy needs and on wholesale electricity prices. However, in February the weather turned colder and two cold snaps in early and mid-March resulted in increasing heating needs and rising natural gas and wholesale electricity prices in most of Europe. More details on regional wholesale electricity markets can be found in Chapter 3.

Figure 2 – Deviation of actual Heating Degree Days (HDDs) from the long-term average, in January - March 2018

![Graph showing deviation of actual Heating Degree Days (HDDs)](source: JRC. The colder the weather, the higher is the number of HDDs.)

\(^1\) Please refer to the Glossary for the precise meaning of the terms used in the report
1.2 Supply side factors

- Spot coal prices on Figure 3 (as represented by CIF ARA contracts, the most commonly used import price benchmark in North-Western Europe), showed a gradual decrease during the first quarter of 2018 (week 1-13 on the charts), falling from 80 €/Mt at the beginning of the year to 60 €/Mt by the end of Q1 2018. Demand for coal decreased in electricity production as nuclear power generation ramped up again in Central and Western Europe. Furthermore there were sufficient steam coal stocks for the European power plants in Q1 2018, leading to an oversupply situation. According to market information, demand was dragged down on the global coal markets by lower consumption in the Asian markets, primarily in China where stocks for electricity generation were also abundant.

- Spot natural gas prices (represented by Title Trading Facility – TTF in the Netherlands, being the most liquid hub in North-Western Europe) showed a relative stability during most of the time in the first quarter of 2018 and prices remained close to 20 €/MWh. However, a sudden cold spell arrived at the end of February, affecting most of the European continent, which had a significant impact on spot natural gas prices. Given that at the end of the heating season in the winter period most of gas storages in Europe had quite low reserve levels, the unexpected rise in demand for gas resulted in a sudden price spike. On 1 March 2018 the spot gas price on the TTF hub reached 88 €/MWh, and in week 9 the average price was 45 €/MWh, as Figure 3 shows. However, after the end of the cold spell natural gas prices fell back to the ranges of the previous weeks.

- In spite of the increasing volatility on the spot market, year-ahead gas prices remained stable in the first quarter of 2018, reflecting that the aforementioned price spike was rather due to a temporary factor, which did not impact forward contracts. Year-ahead coal prices were in contango to spot contracts, reflecting lower future price expectations on the coal market, however, by the end of Q1 2018 the difference narrowed between spot and forward prices.

- Emission allowance prices continued to increase in the first quarter of 2018 (see Figure 4) and by the end of the quarter they reached 13.3 €/tCO₂e, up from 8 €/tCO₂e at the beginning of 2018. On the demand side of the carbon market, owing to the increasing importance of renewables and energy efficiency policy measures over the last few years, there were not too many factors that could explain the recent carbon price increase. However, market players were anticipating that regulatory changes to enter into force are expected to reduce the current oversupply on the emission allowance market as of 2019 (the so-called Market Stability Reserve mechanism within the framework of the reform of the EU Emission Trading System – ETS). This might lead to higher carbon prices in the future and this started to be priced in the current market contracts in the last few months.

Figure 3 – Weekly evolution of spot and year-ahead coal and gas prices

Source: Platts, Coal is represented by CIF ARA, Principal coal import price benchmark in North Western Europe (in €/Mt) Gas is represented by TTF hub - the Title Trading Facility (NL) gas spot price (in €/MWh)

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2 See for example Platts international coal trader reports
3 See more in Quarterly Report on European Gas Markets, Volume 11, issue 1
Figure 4 – Evolution of free emission allowance spot price

Source: Platts

- 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 2018 coal imports from outside the EU reached 36,600 Mt, whereas in Q1 2017 extra-EU imports amounted to 42,202 Mt. In year-on-year comparison this means a significant decrease of 13.3%. Compared to the first quarter of 2016 coal imports were down by 6%, and by 22% if we compare to the same period of 2015. The significant decrease compared to the first quarter of 2017 can be explained by decreasing use of coal in electricity generation, as compared to Q1 2017 the availability of nuclear capacities was better in Europe. Furthermore, there were a higher amount of coal stocks for power generation in major European countries and thus less import was needed in Q1 2018 in year-on-year comparison. However, as the numbers above show, the role of coal use is decreasing in the European energy sector since several years.

- In the first quarter of 2018 the largest share of extra EU coal imports came from Russia, with a share of 45% in the total, measurably up from the import share in Q1 2017 (35%). Russian coal imports were the most competitive extra-EU sources over the last few quarters, probably owing to favourable shipment costs. The second most important import coal import source was the United States (18%), followed by Colombia (15%) and Australia (11%) All other import sources had a share below 5% in this period, such as Indonesia (4%), South Africa and Canada (2% each).

- In Q1 2018 the estimated EU import bill of hard coal from extra-EU sources amounted to €3.8 billion, while in the first quarter of 2017 the extra-EU import bill was €4.7 billion, showing primarily the impact of decreasing amount of coal imports. At the same time the average extra-EU import coal price slightly went down in year-on-year comparison.

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

Source: Eurostat, COMEXT database
2 European wholesale electricity markets

2.1 Comparisons of European wholesale electricity market and international peers

- As the next map (Figure 6) shows, there were significant price differences in the wholesale electricity prices across the EU in the first quarter of 2018. 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 Q1 2018 in the United Kingdom (60 €/MWh), Ireland (56 €/MWh) and Italy (54 €/MWh). In contrast to the previous few quarters, when Scandinavian countries had the lowest national prices, in Q1 2018 the lowest quarterly wholesale averages could be found in Bulgaria (34 €/MWh), Romania (35 €/MWh) and Germany (36 €/MWh).

- Norway, which is not an EU Member State, had a quarterly average of 38 €/MWh, in the lower end of the European price range, similarly to Serbia (37 €/MWh). In Switzerland however, prices were among the highest in Europe (50 €/MWh).

- In the first quarter of 2018 wholesale baseload electricity prices reached 45 €/MWh (European Power Benchmark) on average in Europe, which represented a decrease of 9% in year-on-year comparison. Comparing with Q1 2017, in the first quarter of 2018 prices increased by the most in Sweden and Estonia (27% both) and Latvia (25%). whereas the biggest decrease could be observed in Romania (36%), Hungary (32%) and Slovenia (26%).
Figure 6 – Comparison of average wholesale baseload electricity prices, first quarter of 2018

Source: European wholesale power exchanges
In January 2018 wholesale day-ahead electricity prices showed a temporary decrease in most of the European electricity regions, however, in February and March they rose again and finished Q1 2018 at similar levels as in December 2017 in most of the power regions. However, prices in the Nordpoolspot\(^4\) market showed a significant increase and in March 2018 they rose to nearly five-year highs. At the same time prices in the Iberian peninsula and Greece decreased measurably in Q1 2018. Wholesale prices in Central Western Europe\(^5\) (CWE) and in Central Eastern Europe\(^6\) (CEE) showed a discount to the European Power Benchmark (EPB). The UK has retained its price premium to North Western Europe, and remained the most expensive wholesale electricity market in Europe.

Figure 7 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 in February 2018 wholesale electricity prices across different regional markets in Europe reached the highest degree of convergence since several years (the standard deviation was the lowest since mid-2011). However, this was mainly due to higher-than-usual prices in the Nordic market, stemming mainly from local factors (e.g.: hydro reserve levels).

**Figure 7 - The evolution of the lowest and the highest regional wholesale electricity prices in the EU and the relative standard deviation of the regional prices**

![Graph showing 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))

Figure 8 shows the evolution of the European Power Benchmark (EPB) spot wholesale electricity price contract, as well as the German day-ahead baseload and year-ahead contracts (Germany is one of the most liquid markets in Europe with available forward curve price quotations). Whereas the EPB contract reflected the impact of the spike in gas prices in March 2018, German prices remained more stable, owing to the abundant renewables generation in the country. Year-ahead German electricity prices remained stable in Q1 2018, similarly to year-ahead gas contracts, which were not influenced by the temporary gas price spike (see Figure 3).

\(^4\) Nordpoolspot includes Denmark, Estonia, Finland, Latvia, Lithuania, Norway and Sweden

\(^5\) Central Western Europe includes Austria, Belgium, France, Germany, the Netherlands and Switzerland

\(^6\) Central Eastern Europe includes Czech Republic, Hungary, Poland, Romania, Slovakia and Slovenia
Figure 8 - Weekly evolution of year-ahead German wholesale electricity prices, compared with coal and gas year-ahead contracts in 2017

Source: Platts and DG ENER

EPB7 - European Power Benchmark (in €/MWh) is the replacement of the Platts PEP as of January 2017. See more detailed description in the Glossary.

- The next chart shows the evolution of the electricity generation mix in the EU-28. Compared to the same quarter of the previous year, in Q1 2018 the share of fossil fuels (combined share of solid fuels and gas) decreased from 37% to 34%, while the share of renewables (hydro, biomass, wind and solar) rose from 28% to 31%. The share of nuclear also went up from 27.5% to 29%. These changes all-in-all implied lower generation costs in the first quarter of 2018 than a year before. In Q1 2018 there were only short-lived cold spells, unlike January 2017, when the ongoing cold weather prompted intensive use of fossil fuels, resulting in high electricity generation costs.

Figure 9 – Weekly electricity generation mix in EU-28 in the first quarter of 2017 and 2018

Source: ENTSO-E

- In the first quarter of 2018, as both wholesale electricity and natural gas prices in the United Kingdom showed a relative stability during most of the time (and during the short-lived price spikes the gas and the electricity prices moved paralelly), and as carbon prices increased measurably, clean spark spreads showed a slight decrease, however, gas fired electricity generation in the UK still remained profitable - see Figure 10. At the same time in Germany, where wholesale electricity prices were significantly lower compared to the UK, the profitability of gas fired generation, being already in the negative range at the end of 2017, further deteriorated and clean spark spreads fell to the lowest since June 2015, deeply in the negative range.
Most of the European markets in Central and Eastern Europe might have faced clean spark spreads being in the negative range, similarly to the German metric, primarily depending on the local wholesale electricity price, having in most cases a slight premium to Germany.

**Figure 10 – Evolution of clean spark spreads in the UK and Germany, and electricity generation from natural gas in the EU**

![Graph showing clean spark spreads and electricity generation from natural gas.](image)

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

The profitability of coal-fired generation turned into slightly negative ranges in both Germany and the UK by the end of the first quarter of 2018, as the result of relatively stable wholesale prices, decreasing coal prices and increasing carbon prices, as Figure 11 shows. Besides carbon prices, in the UK the carbon tax also plays an important role, making coal-fired generation much more costlier. Coal-fired generation might have been operated with zero or slightly positive profitability in most of the European countries in Q1 2018, bearing in mind the local wholesale prices premiums to Germany.

In parallel with decreasing profitability of gas-fired generation, in the first quarter of 2018 electricity generated from gas in the EU-28 fell to 116 TWh, being 6% lower than in Q1 2017. As profitability of coal-fired generation also decreased in the first quarter of 2018, electricity generated from coal decreased to 75 TWh\(^7\), being 5% lower in year-on-year comparison.

**Figure 11 – Evolution of clean dark spreads in the UK and Germany, and electricity generation from coal in the EU**

![Graph showing clean dark spreads and electricity generation from coal.](image)

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

\(^7\) The amount of electricity generated from coal does not include lignite fired generation
The next chart (Figure 12) shows the increasing frequency of occurrence of negative hourly wholesale electricity prices in some markets, where this phenomenon is the most frequent in the EU. Negative hourly prices usually appear when demand for electricity is very low (e.g.: on Sundays or during longer public holidays, such as Christmas, Easter or Pentecost) and when variable renewable generation (wind and solar) is abundant, combined with ongoing relatively non-flexible baseload power generation (e.g.: nuclear). Negative hourly prices are not beneficial for electricity producers, as during these periods they have to practically pay to market actors to buy the generated electricity, resulting in welfare losses.

As it can be followed on the chart, the number of hours with negative wholesale prices shows a growing trend over time, however, on other markets they practically do not exists, either because local electricity market regulations did not allow the market price to fall below zero, or because of insignificant share of variable renewables.

Negative hourly prices call for better integration of variable generation sources in the grid and for a market design and infrastructure that enables flows of electricity between neighbouring markets, avoiding local oversupply and excessive demand situations.

Figure 12 – Number of negative hourly wholesale prices on some trading platforms

As Figure 13 shows, in the first quarter of 2018 the gap between wholesale electricity prices in Europe and the US temporarily decreased, as in the US wholesale prices showed a sudden increasing, primarily owing to high natural gas prices amid harsh winter conditions. At the same time, wholesale electricity prices in Europe remained stable. However, after the end of the cold weather in the US prices fell to the level of the end of the last year. As result, in January prices in the EU and the US were almost equal, however, the quarterly EU/US wholesale price ratio was 1.9.

Wholesale electricity prices in Japan showed a significant increase in February 2018, reaching more than 110 €/MWh, which might have been related to increasing use of natural gas in power generation during the winter period and high LNG import landed prices. In Australia wholesale prices were comparable with the EU peers; there were no signs of price spikes being similar to the 2017 summer period.
2.2 Traded volumes and cross border flows

- Figure 14 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. Similarly to the last few years, in Q1 2018 the highest trade volumes could be observed on the German market, followed by the Nordic markets, France and the UK. Traded volume of electricity shows a high degree of seasonality, following the higher consumption during winter periods.

- In the first quarter of 2018, similarly to earlier years, the total monthly traded volume of electricity showed a slight decrease between January and March (from 1,047 TWh to 953 TWh) In Q1 2018 as a whole, the traded volume of electricity on the observed platforms amounted to 2,964 TWh, down from 3,268 TWh in Q4 2017 and decreased by 6% compared with Q1 2017, when the total traded volume was 3,166 TWh.
• Figure 15 shows the comparison of volumes in different market segments of electricity trading on the most liquid electricity trading platforms in the EU. In Q1 2018 in year-on-year comparison the total traded volume of electricity decreased in Germany (by 9% or 170 TWh), United Kingdom (by 25% or 82 TWh) and in the Nordic markets (by 18% or 76 TWh). In contrast, in France traded volume of electricity increased (by 40% or 77 TWh), in Italy (by 24% or 20 TWh) and in Central and Eastern Europe (by 12% or 16 TWh).

• In different segments of the electricity trade the extent of the decrease in traded volumes was also different. In Q1 2018 the overall traded volume decreased by 6% in year-on-year comparison, however, in the case of the over-the-counter (OTC) trade the decrease was only 4.3%, while the volume of exchange-executed contracts fell by 13.7%. Consequently, the share of exchange-executed trade decreased from 28% to 26% between the first quarter of 2017 and 2018.

**Figure 15 - Comparison of electricity traded volumes in some important day-ahead, forward and OTC markets, first quarter of 2018**

![Figure 15](image)

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

• 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 16 shows the evolution of the quarterly regional churn rates between the beginning of 2015 until the fourth quarter of 2017. In Q4 2017 churn rates in the majority of the observed electricity markets did not change too much compared to the previous quarter; in the UK the rate decreased from 4.5 to 3.1, in the Nordic markets it went down from 3.8 to 3.3 and in Italy it grew from 1.5 to 2.1. In year-on-year comparison the churn rate decreased in Germany (from 18.9 to 13.6), and in the UK (from 4.8 to 3.1) and in the Nordic markets (from 4.4 to 3.3).

**Figure 16 Quarterly churn rates on selected European wholesale electricity markets**

![Figure 16](image)

Source: Trayport, London Energy Brokers Association (LEBA), ENTSO-E and DG ENER computations
As Figure 17 shows, in the first quarter of 2018 the net export position of Central Western Europe (CWE) power region peaked in January, reaching more than 8 TWh, when the wholesale electricity prices were the lowest in the quarter. This was also related to increasing nuclear generation in the region, as significant capacities came back to the grid after safety inspections in the previous quarters (See Chapter 3.1). Then in February and March, as prices started to increase, the price discount to the other regions decreased, as well as the net export. The CWE region mainly exported its generated electricity to Italy, UK and the CEE region.

By March 2018 the South-Eastern Europe (SEE) region reached its strongest net electricity exporter position in the last six years, primarily owing to the abundant hydro generation in the region and to high prices in some parts of Central and Eastern Europe (CEE). The CEE region itself remained in net electricity importer position in Q1 2018.

The Nordic region was in the strongest net importer position by the end of Q1 2018 since November 2016, primarily owing to high domestic wholesale electricity prices in consequence of lower-than-usual hydro electricity generation. On the other hand, the Iberian-peninsula was in net exporter position in March 2018, exporting its electricity surplus to France, owing to increasing hydro and wind electricity generation.

Italy retained its strong net importer position during Q1 2018, mainly importing its electricity need from Central and Western Europe, The British Isles was also net importer and the Baltic-states were close to import-export equilibrium.

Figure 17 - EU cross border monthly physical flows by region

- Figure 18 shows the ratio of net electricity flow position to the domestic electricity generation in each region. Unlike the previous chart, showing absolute net cross border position numbers, this chart enables cross region comparison of net positions relating to the domestic production, thus eliminating differences in the market size.

- Italy (Apennine-peninsula) imported 20% of its electricity need on average in Q1 2018. In South Eastern Europe, as the region became a strong net exporter, around 15% of the total production was exported. The Baltic region followed the seasonal pattern and got closer to the equilibrium in the first quarter of 2018. In the case of the other regions the net cross border position was less than 10% compared to domestic production.
3 Regional wholesale markets

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

- In January 2018 the monthly average wholesale baseload electricity price in the CWE region fell below 33 €/MWh, while in the same month the average peakload was 40 €/MWh, as Figure 19 shows. In February, both the monthly average baseload and peakload contracts rose significantly (to 44 €/MWh and 48 €/MWh), and in March prices receded only slightly from the average of February 2018.

- The daily average regional day-ahead baseload prices remained well-aligned during most of the time in Q1 2018, however, in the German market the wholesale price showed measurable discounts on many trading days, especially during lower periods of demand (e.g.: weekends) and/or periods of abundant variable renewable generation, as Figure 20 shows. At the same time, the wholesale electricity prices in Belgium, France and the Netherlands turned up significantly at the beginning of March (the Belgian daily average wholesale price reached 102 €/MWh on 2 March 2018), in parallel with the temporary price spike on the most important Western European natural gas hubs.

- On New Year’s Day in 2018 the daily average wholesale electricity price fell below zero in Germany, and on this day there were many trading periods in the CWE region when several markets encountered negative hourly prices. In the first quarter of 2018 there were 70 hours on the German market and 8 hours on both the French and the Belgian markets with negative prices, as Figure 21 shows.

- On the demand side of the wholesale electricity market temperatures can exert significant influence on the price level, as cold weather drives up both heating related demand for power and feedstock prices (e.g: natural gas) used for electricity generation. In January 2018 the weather was milder than usual across the CWE region, contributing to the low wholesale electricity price level, however, at the end of February and mid-March 2018 two cold spells resulted in price hikes in some regional markets.

- On the supply side, wind generation amounted to 14.5 TWh in January 2018 in Germany, ensuring around 30% of the country’s monthly electricity mix. However, in February wind generation dropped below 8 TWh and in March 2018 it only managed to increase above 10 TWh. Low wholesale electricity prices in the region in January were also owing to high renewables generation. As it can be followed on Figure 22, the amount of variable renewable generation (wind and solar) can significantly impact daily average prices in the German wholesale electricity price market.

- In February-March 2018 the share of coal and gas went up in the generation mix in the CWE region. Decreasing coal prices in the first quarter of 2018 put a lid on increasing generation costs. However, the impact of the aforementioned natural gas spike in early March could be clearly followed in the evolution of wholesale electricity prices.
prices in France and the Benelux countries. Hydro reserves, being at fairly high levels at the beginning of the year, showed a decreasing trend both in France and Switzerland over Q1 2018, also impacting the generation costs by limiting the role of competitive hydro power.

- In contrast to the previous quarter, nuclear availability and generation in the first quarter of 2018 in France (see Figure 23), was comparable with values in the same period of the last two-three years. Most of generation capacities being offline for safety inspections in the preceding two quarters were back to the grid.

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

![Graph showing monthly exchange traded volumes and average prices in Central Western Europe.](source)

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

![Graph showing daily average wholesale power prices.](source)
Figure 21 – Number of negative hourly wholesale electricity prices in Germany, France and Belgium in the first quarter of 2018

Source: Platts, ENTSO-E

Figure 22 – The impact of the variation of the amount of daily combined wind and solar generation on daily average wholesale electricity prices in Germany, in the first quarter of 2018

Source: Platts, ENTSO-E

Figure 23 – The weekly amount of generated nuclear electricity in France

Source: ENTSO-E
3.2 British Isles (UK, Ireland)

- In the first quarter of 2018 wholesale baseload electricity prices both in the UK and Ireland underwent a measurable increase. While in January 2018 the average price in the UK was 56 €/MWh, in March it reached 65 €/MWh, and over the same period the average monthly price in Ireland rose from 52 €/MWh to 64 €/MWh, which latter was the highest since January 2014 (see Figure 24).

- During most of January and February 2018 daily temperatures in the UK and Ireland were around the long term averages, not resulting in additional heating related electricity demand. However, during the last days of February and early days of March 2018 and later during a mid-March weekend daily average temperatures were lower by 7-8°C than usual.

- In March 2018, close to the end of the heating season gas storage levels in the UK and in continental Europe were low. Consequently, unexpected cold spells resulted in a sudden price spike on the NBP gas hub in the UK at the beginning of March 2018, as Figure 25 shows. On 1 March 2018 NBP spot gas price reached 88 €/MWh and this also impacted wholesale electricity prices, reaching their peak in the following days (104 €/MWh in the UK and 81 €/MWh in Ireland).

- Increasing electricity consumption in the UK during the cold days in March was mainly satisfied by increasing coal-fired generation (see Figure 26) as coal use in the UK electricity mix reached 3.9TWh in that month, being the highest since January 2017. Increasing wind power generation in this period also helped in satisfying higher electricity demand, however, UK had to import more electricity from the continent to cover all needs. At the same time, both fossil fuel and renewable generation decreased in Ireland in year-on-year comparison, leading to decreasing electricity exports to the UK, turning Ireland to net electricity importer country in March 2018.

- During the whole Q1 2018 the UK retained its price premium over the continental markets. However, the biggest monthly premium did not occur in March 2018 when wholesale prices turned up sharply both in the UK and Western Europe, rather in January when abundant wind power generation led to low prices in the CWE region (e.g.: price premium to the Dutch market reached 18 €/MWh in January, while it was only 13 €/MWh in March 2018 on monthly average). Consequently, improving electricity interconnection between the UK and North-Western Europe and further increasing renewable penetration in the UK could lead to decreasing British premium to the continental markets.

Figure 24 – Monthly electricity exchange traded volumes and average day-ahead wholesale baseload prices in the UK and Ireland

![Figure 24](source: Nordpool N2EX, SEMO)
3.3 Northern Europe (Denmark, Estonia, Finland, Latvia, Lithuania, Norway, Sweden)

- Between January and March 2018 the monthly average wholesale system electricity baseload price in the Nordpoolspot market rose from 33 €/MWh to 43 €/MWh and (see Figure 27), reaching the highest monthly baseload price since April 2013. The daily average system baseload price reached its quarterly peak on 1 March 2018 (65 €/MWh), in parallel with price spikes on the other wholesale electricity markets of North-Western Europe.

- In the first quarter of 2018, especially in February and March, daily average temperatures were significantly lower than usual across the countries of the Nordic region during most of the time, which impacted heating-related demand for electricity. Electricity has important role in heating in many Nordic countries, especially Sweden and Finland.

- Hydro availability across the Nordic region (see Figure 28) followed its seasonal pattern of decrease in the first quarter of 2018, however, due to the increasing demand for electricity, by March 2018 the combined hydro reserves of Norway, Sweden and Finland fell below the values of the last few years. Decreasing regional hydro generation, coupled with decreasing nuclear in Sweden and increasing fossil fuel based generation in Denmark all contributed to increasing electricity generation costs across the regional markets. Wind power generation was also lower in Q1 2018 in Sweden, if compared with the same quarter of 2017.
• Regional prices across the Nordic countries remained well-aligned during most of the time in Q1 2018, as it can be followed on Figure 29. However, during excessive cold periods Baltic prices showed a measurable premium to other markets of the region as electricity imports from Russia had to be ramped up in order to satisfy increasing electricity needs.

• In March 2018 the Nordic region became a net electricity importer, as wholesale electricity prices were generally higher than some countries in Central and Western Europe. The net importer position was a result of decreasing electricity exports to Central Europe and significant imports from the Russian market.

Figure 27 - Monthly electricity exchange traded volumes of and the average day-ahead wholesale prices in Northern Europe

![Figure 27 - Monthly electricity exchange traded volumes of and the average day-ahead wholesale prices in Northern Europe](source: Nordpool spot market)

Figure 28 –Weekly combined hydro reservoir levels (Norway, Sweden and Finland) in the Nordic region in different years

![Figure 28 –Weekly combined hydro reservoir levels (Norway, Sweden and Finland) in the Nordic region in different years](source: Nordpool spot market)
3.4 Apennine Peninsula (Italy)

- The Italian wholesale baseload electricity price, (see Figure 30) showed a decrease in January 2018 compared to the previous month and reached 49 €/MWh on average. In February and March the monthly wholesale price turned up again and was 57 €/MWh in both month.
- Looking at the daily average wholesale electricity price, from the beginning of the year until mid-February 2018 it was stable around 50 €/MWh, then at the end of the month it rose sharply to 107 €/MWh. In the second half of March 2018 it fell back in the range of 50-60 €/MWh to finish the quarter with a high degree of stability.
- In Italy the weather was generally milder in January 2018 and during most of February compared to the usual winter temperatures. However, at the end of February and mid-March, similarly to most of Central and Western Europe, temperatures were lower by several degrees compared to the long term daily average.
- Spot natural gas prices on the Italian PSV hub reacted similarly to the arrival of the cold snap in early March. The PSV price reached 64 €/MWh, being three times as high as the usual magnitude. Increasing gas prices resulted in higher electricity generation costs as gas normally ensures the marginal cost setting factor on the Italian wholesale electricity market.
- Increasing demand for electricity in March 2018 was covered through higher electricity imports from Central and Western Europe and by increasing domestic production. Besides coal-fired generation, being a flexible alternative in the period of high-priced natural gas, renewables, such as hydro and wind power, also increased, which helped in keeping a lid on Italian wholesale prices.
- As Figure 31 shows, regional area prices in Italy, in contrast to the previous two quarters, remained well-aligned, indicating that during this time of the year in those electricity areas, which might not have sufficient interconnection capacities to mainland Italy, supply was sufficient to cover electricity demand and thus area prices remained close to the Italian national system price.
3.5 Iberian Peninsula (Spain and Portugal)

- In the first quarter of 2018 the monthly average wholesale baseload contracts in Spain and Portugal, unlike most markets in Europe, continued their downward trend that started in the previous quarter. Between December 2017 and March 2018 the monthly baseload day-ahead contract fell from 60 €/MWh to 41 €/MWh in Spain and from 50 €/MWh to 39 €/MWh in Portugal. In the same period the monthly average peakload price went down from 63 €/MWh to 41 €/MWh in Spain and from 67 €/MWh to 45 €/MWh in Portugal. Such low monthly average prices as in March 2018 were last seen in the Iberian markets in June 2016 - see Figure 32.

- Both in Spain and Portugal the weather was milder than usual in most of January-February 2018, and the cold snaps in March did not impact the wholesale electricity markets so deeply as in Central and Western Europe, thus no sharp price upturns could be observed. In contrast, the daily average wholesale price fell below 10 €/MWh twice in March 2018 (on the 11th and on the 30th).

- As it can be followed on Figure 33, showing the evolution of the monthly electricity generation mix in Spain, in the first quarter of 2018 the share of hydro and wind followed an increasing trend while the share of coal and gas...
decreased compared to the previous quarter, implying a shift towards technologies with lower marginal generation costs, also contributing to keep wholesale market prices low.

- The share of wind power rose to 33% in the monthly generation mix in March 2018, which was the biggest since the beginning of available time series (2010). At the same time, after a nearly two-year long dry period, the share of hydropower in the Spanish generation mix rose above 20%, being the biggest share since May 2016. Hydro availability also improved significantly in Portugal. At the same time the combined share of coal and gas fell below 20%, being the lowest since the second quarter of 2016.

- As the Vandellos-2 nuclear reactor, having a nameplate capacity of 1 GW, was taken off the grid in the consequence of an unplanned outage and other reactors also operated on reduced availability, impacting around a quarter of the Spanish nuclear capacities, the share of nuclear power generation fell below 20% in March 2018, which was lower than in the same month in the previous years.

- In January–February 2018, as Figure 34 shows, net inflows from France were significantly up compared to November–December 2017. In March 2018 however, Spain became net electricity exporter to France, as competitive domestic renewable generation enabled to export electricity to the cold-snap-impacted French wholesale electricity market, having tight supply margins in this period.

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**Figure 32 – Monthly electricity exchange traded volumes and average day-ahead prices in the Iberian Peninsula**

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**Figure 33 – Monthly evolution of the electricity generation mix in Spain**

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

- The regional wholesale average price contracts in Central and Eastern Europe (CEE) showed only slight increases between January and March 2018. The monthly baseload average price rose from 36 €/MWh to 41 €/MWh in this period, while the monthly peakload average went up from 45 €/MWh to 53 €/MWh, as Figure 35 shows. The regional weighted average of daily market price reached its trough on New Year’s Day (when the daily average price in Czech Republic, Slovakia and Slovenia fell below zero), and its peak (64 €/MWh) at the beginning of March 2018.

- In the first quarter of 2018 the evolution of the daily temperatures in the CEE region were similar to most of Central and Western Europe: January was generally milder than usual, and at the end of February and mid-March two cold spells impacted the regional weather, resulting in temperatures being 10°C or even 15°C lower than the long term average. Consequently, at the beginning of March 2018 most of regional wholesale prices showed a temporary upturn (in Hungary the daily average wholesale price peaked at 78 €/MWh on 1 March), as Figure 36 shows.

- However, at the same time in the Czech Republic Temelin-1 nuclear reactor, with its 1.1 GW nameplate capacity, was put back in operation after a long fuel recharge period. This weighed on wholesale electricity prices in the Czech Republic, going against the regional peers which showed sudden spikes. In Hungary however, one of the reactors of the Paks nuclear plant, having a nameplate capacity of 500 MW, was taken offline for the whole month of March. The temporary disruption of domestic capacities resulted in a high share (43%) of imports in the country’s electricity consumption, which could be mainly satisfied from cheap import sources from the Balkans.

- In the first two months of 2018 hydro availability in Romania and the Balkans remained low compared to the seasonal average. However, as the weather turned rainier at the beginning of March, hydro reserves and generation started to increase, which resulted in lower wholesale electricity prices in Romania and cheap electricity import sources for net electricity importer countries in the CEE region (e.g.: Hungary, Slovenia). The Balkans and South East Europe became the most important electricity import source for the CEE region in March 2018, overtaking Central Western Europe (see Chapter 2.2).
3.7 South Eastern Europe (Bulgaria, Croatia, Greece and Serbia)

- Wholesale electricity prices in the South-Eastern Europe (SEE) region decreased measurably in the first quarter of 2018: while in January average regional baseload price stood at 53 €/MWh and the regional average peakload was 54 €/MWh, in March they fell to 44 €/MWh and 45 €/MWh, respectively, as it can be followed on Figure 37. The baseload price in Bulgaria and Serbia were below the Greek peers during most of the time in Q1 2018, on quarterly average the Serbian price had a discount of 12 €/MWh to Greece, while the Bulgarian market had a discount of 16 €/MWh.

- Looking at the daily average price contracts (see Figure 38), Greek prices were close to 50 €/MWh during most of the time in January-February 2018, while at the same time the Bulgarian, Croatian and Serbian daily contracts were closely aligned and fluctuating between 30-50 €/MWh. In March however, Greek prices became lower and, albeit keeping their discount to the Greek market, wholesale prices in Bulgaria, Croatia and Serbia became even more volatile than in the beginning of 2018. Wholesale electricity markets in the Balkans are not very liquid; this is one reason for bigger price volatility. On the other hand, change in hydro power availability can also be a significant factor in the wholesale price formation, as besides coal and lignite hydro is an important generation
source in the region. In Bulgaria a large share of domestic power generation is ensured by nuclear (37% in Q1 2018), providing for a cheap electricity source.

- Greece was among the few EU Member States where the weather was milder than usual throughout the whole first quarter of 2018 and which the cold snap touching most of the European continent did not impact significantly. This could also contribute to lower demand for electricity and decreasing wholesale prices in March 2018. However, in Croatia and Serbia temperatures were lower during the cold snap periods, and increasing demand for electricity can be followed on Figure 38, as prices in the two countries turned up sharply at the beginning of March 2018.

- As the weather was relatively mild, electricity consumption in Greece decreased from 4.9 TWh to 3.9 TWh between January and March 2018. Electricity imports to Greece remained practically constant over this period, and domestic generation decreased. Decreasing domestic electricity generation in Greece mainly stemmed from lower fossil fuel use; at the same time the share of wind power and solar increased slightly. This shift in domestic generation towards less costlier technologies, combined with cheap power imports from the Balkans, resulted in lower overall power generation costs and wholesale electricity prices on the Greek market.

**Figure 37 - Monthly traded volumes and prices in South-Eastern Europe**

![Monthly traded volumes and prices in South-Eastern Europe](source)

Source: LAGIE, IBEX

**Figure 38 – Comparison of weekly average day-ahead prices in Bulgaria, Greece, Romania and Serbia**

![Comparison of weekly average day-ahead prices in Bulgaria, Greece, Romania and Serbia](source)

Source: IBEX, LAGIE, OPCOM, SEEPEX
4 Retail markets in the EU and outside Europe

4.1 Retail electricity prices in the EU Member States

- Figure 39 and Figure 40 show the monthly estimated retail electricity prices in March 2018 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 March 2018 Germany and Italy were the two most expensive countries (respectively 17.7 Eurocent/kWh and 17.6 Eurocent/kWh), while Finland and Sweden were the cheapest (8.4 Eurocent/kWh and 8.8 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 (33.9 Eurocent/kWh) and in Denmark (33.2 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 March 2018 the EU was 2.2 (6.9 Eurocent/kWh in Finland and 15.3 Eurocent/kWh in Germany), while in the case of large industrial customers it was 2.7 (4.4 Eurocent/kWh in Sweden, 11.8 Eurocent/kWh in the United Kingdom). 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 39 – Estimated industrial retail electricity prices, March 2018 – without VAT and recoverable taxes and levies

Source: Eurostat, DG ENER
Figure 40 – Estimated household retail electricity prices, March 2018 – all taxes included

- Figure 41 and Figure 42 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, in the first quarter of 2018 differences in retail prices across the Member States decreased slightly compared to the previous quarter, and in the case customers with low or medium level annual electricity consumption the price differential (measured by the standard deviation) was the lowest in the last three years, implying a better retail price convergence across the EU. In the case of large electricity consumers the price differential also decreased, however it is still bigger than in 2016. In the first quarter of 2018 prices on the European wholesale electricity markets also became slightly more convergent (See Chapter 2.1).

- In the case of households, the convergence of retail electricity prices of customers with medium and larger annual consumption improved slightly, while in the case of customers with small annual consumption it practically remained unchanged, if compared to the previous quarter. Price convergence developments on the wholesale electricity markets have normally higher impact on the industrial retail prices, as in the case of these customers the share of energy supply costs is higher in the final price than in the case of household customers, and consequently and the share of the so-called non-market elements (network charges and taxes and levies) is lower.

Figure 41 – Relative standard deviation of retail electricity prices in the EU Member States in three industrial customer consumption groups

Source: Eurostat, DG ENER
Figure 42 - 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 first quarter of 2018.
Figure 43 - Electricity prices (inclusive of taxes) – Households – Estimated for the first quarter of 2018

Electricity prices for household consumers
First quarter of 2018
Including all taxes and levies

Band DC: 2 500 kWh < Consumption < 5 000 kWh

Source: Data computed from Eurostat half-yearly retail electricity prices and consumer price indices
Figure 44 – Electricity prices (without VAT and non-recoverable taxes) – Industrial consumers – Estimated for the first quarter of 2018

Source: Data computed from Eurostat half-yearly retail electricity prices and consumer price indices
4.2 Retail electricity prices in the EU capital cities

- Figure 45 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 March 2018 the highest retail electricity prices paid by households could be observed in Copenhagen and Berlin (31.4 Eurocent/kWh and 30.8 Eurocent/kWh, respectively), while the cheapest capitals in the EU were Sofia, Vilnius and Budapest (10.8 Eurocent/kWh, 11.3 Eurocent/kWh and 12 Eurocent/kWh, respectively). Compared with March 2017, a significant price increase could be observed in Tallinn (24.5%) and Bucharest (18.6%). Prices also went up in Prague (13.4%), and Amsterdam (12%). Retail electricity prices decreased the most in Nicosia (6%).

Figure 45 – The Household Energy Price Index (HEPI) in the European capital cities - Electricity prices in March 2018, and changes in household electricity prices compared to March 2017

- Figure 46 shows the change in household retail electricity prices between March 2017 and March 2018, 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 Bucharest (by 2.1 Eurocent/kWh) and in Tallinn and Prague (both by 0.9 Eurocent/kWh), and they decreased measurably in London (1 Eurocent/kWh) and Berlin (0.8 Eurocent/kWh).
- Energy taxes increased measurably in Zagreb and Amsterdam, (by 0.9 Eurocent/kWh in both cities) and in Luxembourg they went down by 0.6 Eurocent/kWh.
- Transmission and distribution costs had the biggest upward impact on the final retail prices in Tallinn (1.6 Eurocent/kWh), Riga and Luxembourg (both by 1.2 Eurocent/kWh), whereas in Nicosia network costs decreased by 1.1 Eurocent/kWh.)
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 some important trading partners of Europe, presented on the next chart (Figure 46). 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 decreasing price premium to EU wholesale electricity benchmark can also be tracked in the retail market.

- Retail industrial electricity prices in China and in Korea showed a discount of 15-25% to the EU benchmark, however, this gap was constant over the last few quarters, as prices in the EU and these two countries were relatively stable. Retail electricity prices in Mexico and Turkey however, showed an increasing discount to the EU benchmark in Q4 2017, owing to the depreciation of the local currency in these two countries vis-à-vis the euro.
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. The estimated quarterly average retail electricity prices on the maps for households and industrial customers are computed as the simple arithmetic mean of the three months in each quarter.

**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.