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ENERGY

Quarterly report

on European electricity markets

Market Observatory for Energy
DG Energy

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With focus on annual overview for 2024

Directorate-General for Energy, unit A4, Market Observatory for Energy, 2025

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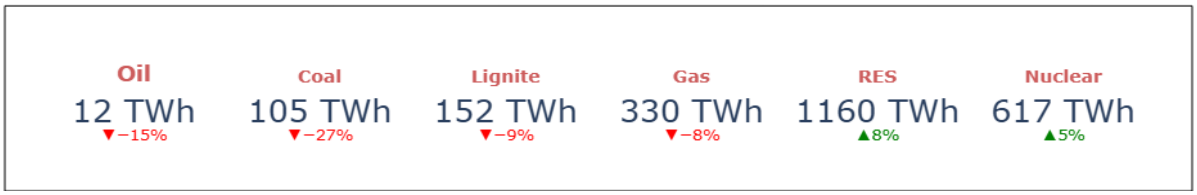

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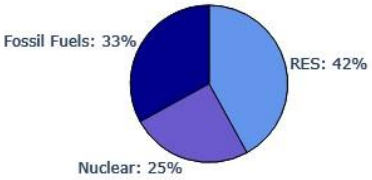
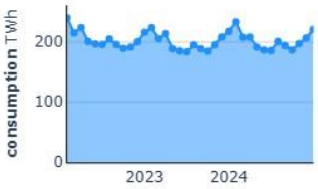


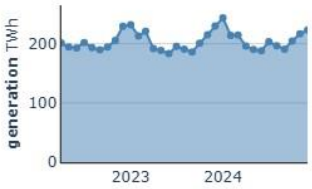
Electricity Mix



Electricity consumption

624 TWh

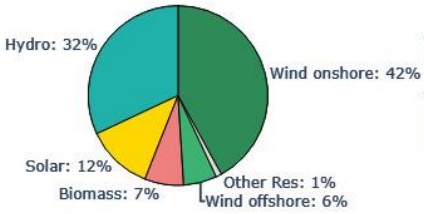
▲4 TWh



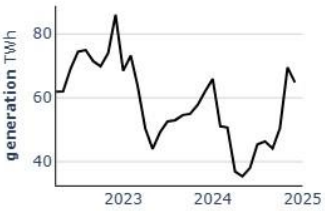
Electricity generation

643 TWh

▼−2 TWh



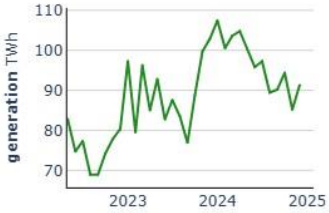
RES generation



Fossil fuel generation

210 TWh

▲11 TWh



RES generation

270 TWh

▼−21 TWh

Electricity Generation of Fossil Fuels vs Renewables: Quarterly Average and Y-o-Y Change

Average Generation Share of Fossil Fuels

33 %

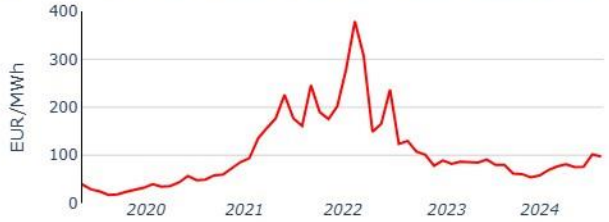
▲2 pp.

Average Generation Share of Renewables

42 %

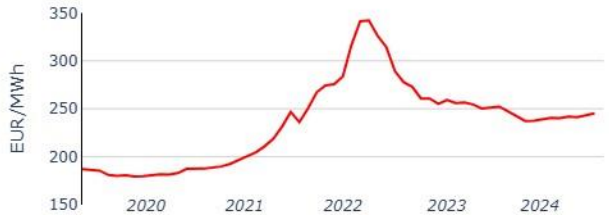
▼−3 pp.

Prices in Q4 2024 and year-on-year comparison



Wholesale prices
84 €/MWh

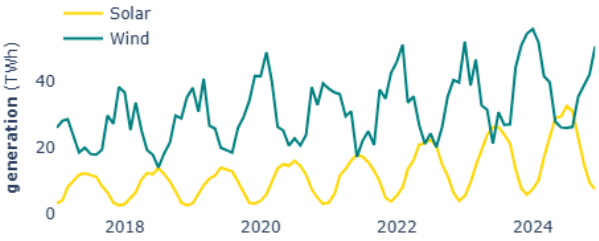
Change y-o-y
−3%
▼−3 €/MWh



Retail prices
244 €/MWh

Change y-o-y
−3 %
▼−8 €/MWh

Renewable energy generation and year-on-year comparison



Renewable energy generation: +16 %

Hydro
85 TWh
▼−10 TWh

Solar
32 TWh
▲5 TWh

Wind onshore
114 TWh
▼−16 TWh

Wind offshore
17 TWh
▼−2 TWh

HIGHLIGHTS OF THE REPORT

- **The year 2024 was marked by a significant growth of renewable generation, which combined with recuperated nuclear and high hydropower generation, lower gas prices, particularly in the first half of the year, and moderated demand, supported lower average wholesale electricity prices since 2021.**
- **The improvements in market fundamentals supported a fall in wholesale electricity prices in European markets in 2024, compared with 2023 and with the historical highs in 2022. The European Power Benchmark averaged 74 €/MWh in 2024, 22% lower than in 2023 and 67% lower than in 2022**. In 2024, prices exhibited significant regional disparities. Prices ranged from a yearly average of 36 €/MWh in Sweden to 109 €/MWh in Ireland. The largest year-on-year price declines in Member States were recorded in France (-40%), and Sweden (-30%), while the lowest decreases were seen in Romania (-1%) and Bulgaria (-2%). In Q4 2024, the European Power Benchmark averaged 92 €/MWh, 8% higher on yearly basis as a result of higher gas prices, rising demand and subdued wind generation.
- **Electricity consumption in the EU rose only slightly (+1%) compared with last year's levels in 2024**. Consumption has not fully recovered yet, compared with pre-crisis levels, as demand is recovering at a moderate pace after the impact of the energy crisis. Demand levels for 2024 were on average still below the 2019-2022 range (-4%). Q4 2024 also registered a small (+1%) increase compared to Q4 2023.
- **The share of renewables increased to 47% in 2024** (from 44% in 2023), while **the share of fossil fuels fell to 28%** (from 32% in 2023).
- **Solar generation hit a new record high, reaching 234 TWh in 2024 (+19%). Solar and wind yearly generation increased by 7% in 2024 (+43 TWh).** Solar generation rose by 19% (+38 TWh) and wind offshore generation increased by 17% (+9 TWh). Hydropower improved its output by 13% (+43 TWh) while onshore wind generation fell slightly by 1% (-4 TWh). Additional installed capacity supported higher levels of solar generation during the year.
- **Fossil fuel yearly generation dropped by 10% in 2024**, supported by renewables generation and moderate demand. In total, coal-fired generation fell by 27% (-54 TWh), whereas less CO2-intensive gas generation dropped by 25% (-30 TWh). Nuclear output rose by 5% (+28 TWh) in 2024.
- **A new record of installed renewable capacity** was reached in the EU in 2024, with additional solar and wind capacity by 16% on a yearly basis (from 366 GW in 2023, to 425 GW in 2024). Between 2023 and 2024, **renewable energy capacity grew by at least 59 GW**, driven by expansions in solar (+46 GW), onshore wind (+11 GW), and offshore wind (+2.5 GW). In contrast, **nuclear capacity declined by 4 GW.**
- **Fossil-fuel power generation saw a slight overall increase of 4 GW.** While gas-fired plants expanded by 10 GW, coal-fired capacity decreased by 3 GW. Additionally, closures of other fossil-fuel power plants further reduced capacity by 3 GW.
- **Carbon prices fluctuated around 52-82 €/tCO_2 in 2024, with an average yearly price of 65 €/tCO_2, 22% lower than in 2023.** Relatively elevated carbon prices supported coal-to-gas fuel switching during the first three quarters of 2024. However, rising gas prices narrowed the gap between coal and gas fuel switching in Q4 2024, making gas-fired generation slightly less profitable than coal-fired generation in that quarter.
- **Retail electricity prices for households in EU capital cities were down by 7% in 2024 (242 €/MWh)**. Retail prices in Q4 2024 remained roughly the same compared to the previous quarter (Q3 2024). The average retail electricity prices for household costumers in EU capital cities fell from January to April 2024, from 252 €/MWh to 237 €/MWh (- 6%) and grew thereafter to reach 245 €/MWh in December. Prices in Q4 2024 were 3% lower than in Q4 2023.
- **2.21 million new electric vehicles (EVs) were sold in the EU during 2024,** a yearly decrease of 6%, but an increase of 11% compared with 2022. Close to 608,000 new EVs were registered in the EU in Q4 2024, 5% less than in Q4 2023. However, this is still the third highest quarterly figure on record and translates into a 22% market share; lower than China (47%), but more than two times the market share registered in the United States (10%). The largest share of new EV sales was recorded in another quarter in Sweden, where 60% of all cars sold in Q4 2024 were EVs. Moreover, in Denmark, Finland, and the Netherlands more than half of all passenger cars sold could be plugged (58%, 55% and 53%, respectively).
- **The number of hours with negative wholesale prices in 2024 (9834) was 52% higher than in 2023**, **representing 3% of total hours**. Most of the hours with negative prices occurred in August (1930), mainly in Northern European markets. The increasing occurrence of negative prices signal the need for short term storage and flexibility, increased interconnectivity, and incentives for demand-side response and storage solutions.

Methodological Note: The rapid changes in gas and electricity markets happening through the energy transition as well as the significant restructuring of the EU's energy supply following the energy crisis, call for reviewing the Quarterly Reports of the European Electricity and Gas Markets so as to make them best fit for purpose. The aim is to ensure a more timely publication, modernise presentation, increase data transparency and an easier access to the data used to produce the reports. All this should increase usability for readers. The process of the review is planned to be carried out gradually attending the feedback we receive on it. As the Commission advances with its review, the quarterly reports will progressively reflect the methodological, technical, and editing changes as well as the comments received from stakeholders.

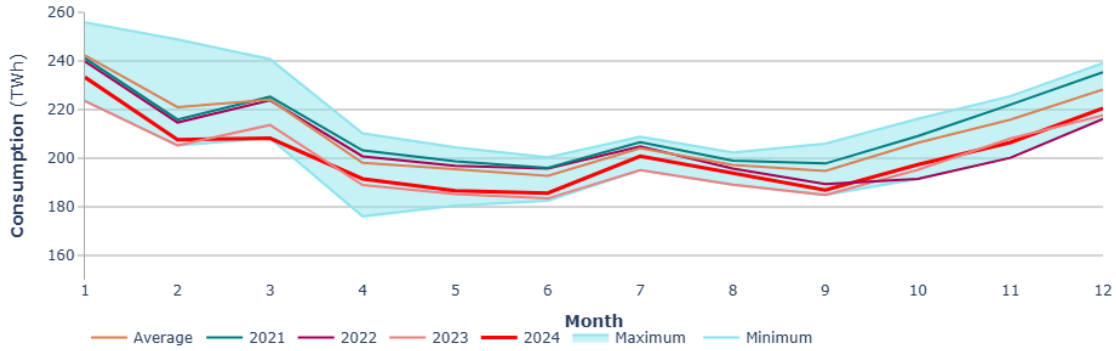
Electricity market fundamentals

1.1 Demand side factors

Electricity consumption *in 2023, 2022 and 2021*

- In 2024, the total electricity consumption in the EU grew by 1% compared with last year's levels. Q4 2024 also registered a small (+1%) increase compared to Q4 2023. Demand levels for 2024 were on average still below the 2019-2022 range.

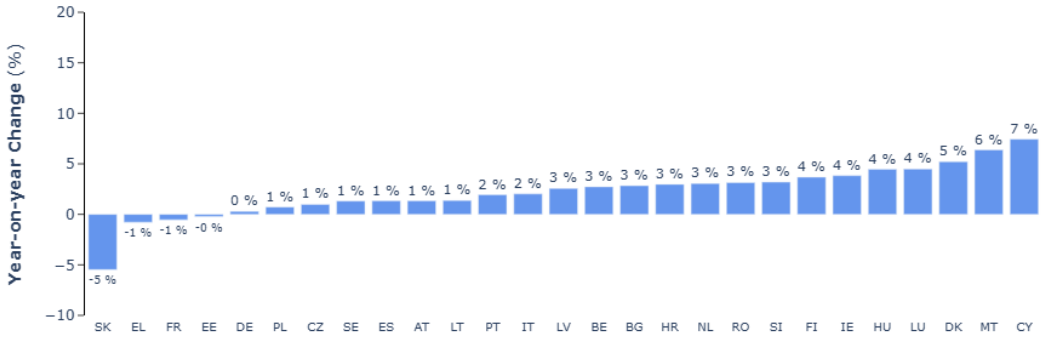
Figure 1 – Monthly EU consumption of electricity



Source: Eurostat

- Error! Reference source not found. sums up changes in electricity consumption over 2024, compared to 2023. EU electricity consumption increased in 2024 compared to 2023, in 22 Member States. The biggest increases were registered in Cyprus (+7%), Malta (+6%) and Denmark (+5%) while slight decreases were registered in France (-1%) and Greece (-1%). A decrease of -5% was registered in Slovakia.

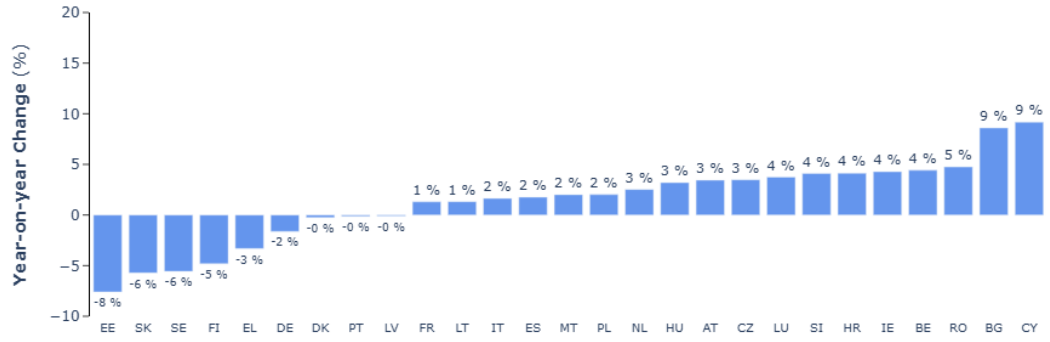
Figure 2 – Yearly changes in electricity consumption **by Member State in 2024 compared with 2023**



Source: Eurostat

- In Q4 2024, the EU electricity consumption was 1% higher than in Q4 2023 (see **Figure 3** below). The largest declines took place in Estonia (-8%), Sweden (-6%) and Slovakia (-6%). Conversely, Cyprus (9%), Bulgaria (+9%), Romania (5%) reported significant increases in consumption during Q4 2024.

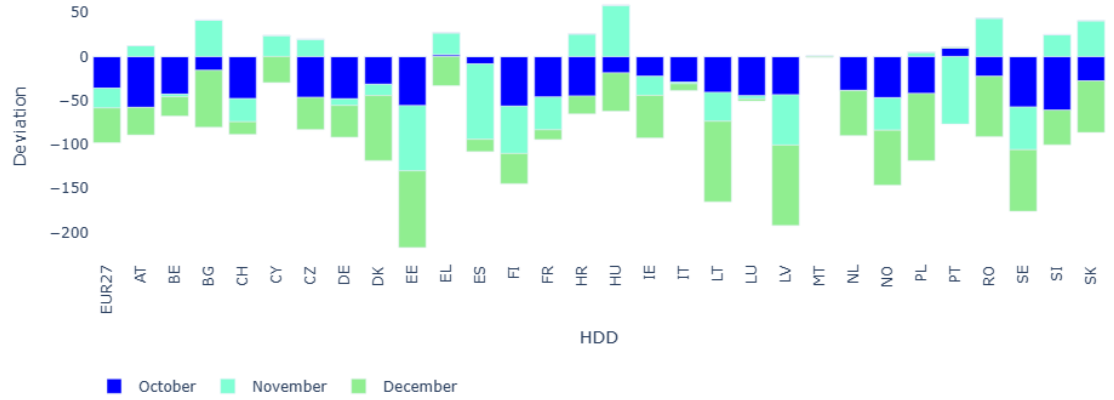
Figure 3 – Yearly changes in electricity consumption **by Member State in Q4 2024 compared with Q4 2023**



Source: Eurostat

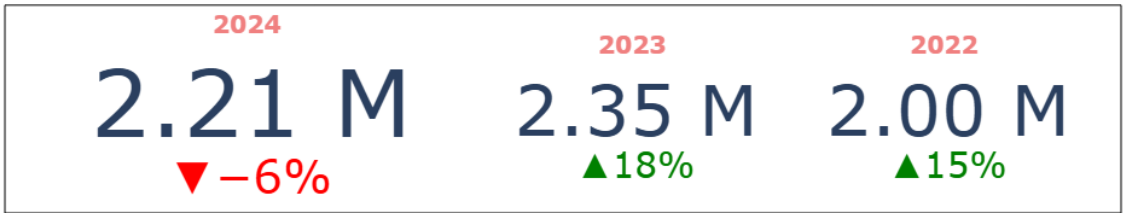
- **Figure 4** illustrates the monthly deviation of actual Heating Degree Days (HDDs) from the long-term average (a period between 1979 and the last calendar year completed) in Q4 2024. EU-wide, the reference quarter was warmer than the historical range. October and December were particularly warmer than the historical average, while November was closer to the average, albeit also registered warmer-than-usual temperatures. Overall, Q4 2024 registered –98 HDDs below the long-term average. Most of the European countries registered warmer-than-average temperatures.

Figure 4 - Deviation of actual heating days from the long-term average in October-December 2024



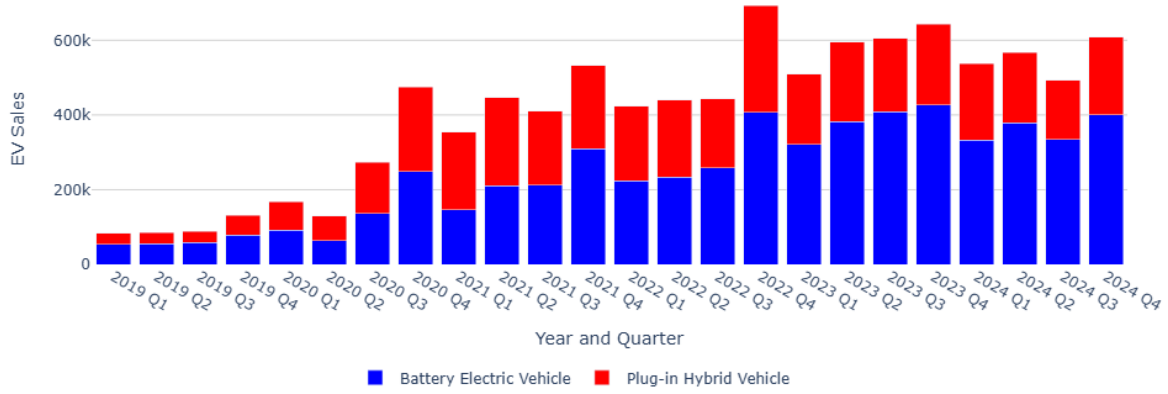
Source: JRC. The colder the weather, the higher the number of HDDs. The warmer the weather, the higher the number of CDDs

- **Figure 6** shows that close to 608,000 new EVs were registered in the EU in Q4 2024 (-5% compared with Q4 2023). This is still the third highest quarterly figure on record and translates into a 22% market share; lower than China (47%), but more than two times the market share registered in the United States (10%). The battery electric vehicles registered a decrease (-6% year-on-year more than 400,000) while the demand for plug-in hybrid vehicles fell slightly (-4% year-on-year to close to 208,000). Hybrid electric vehicles (not chargeable) sales amounted to close to 883,000, registering an all-time high in quarterly sales and an increase of 23% compared with Q4 2023.
- Overall, 2.21 million new EVs were sold in the EU during 2023, a decrease of -6% compared with 2023 figures, but an increase of 11% compared with 2022.



EVs sold in 2024, 2023 and 2022

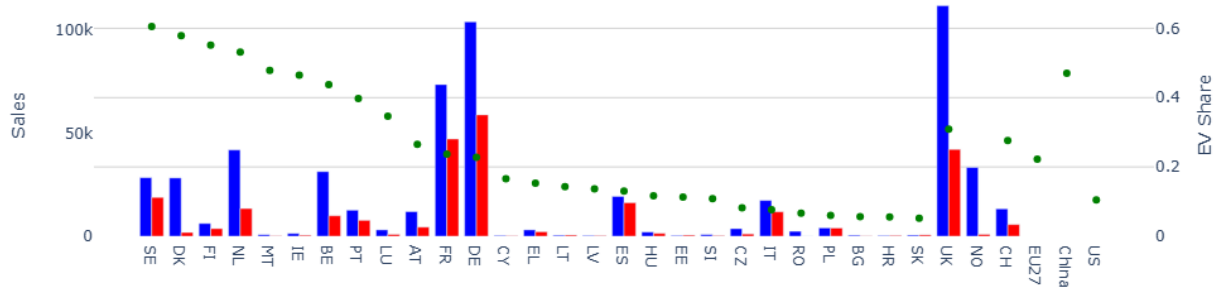
Figure 5 – Quarterly EV sales in the EU



Source: ACEA

- The largest share of new EV sales was recorded in another quarter in Sweden, where 60% of all cars sold in Q4 2024 were EVs. Moreover, in Denmark, Finland, and the Netherlands more than half of all passenger cars sold could be plugged (58%, 55% and 53%, respectively). Germany retained the position of the largest individual market (more than 163,000 EV sales in Q4 2024) followed by France, where sales amounted to more than 121,000 new EVs in the reference quarter.

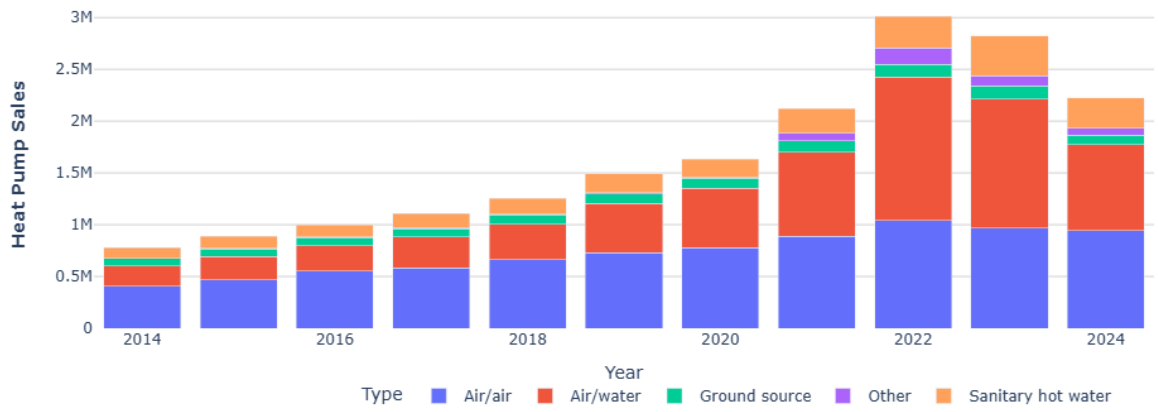
Figure 6 – Electrically chargeable passenger vehicle (EV) sales in selected countries in Q4 2024



Source: ACEA, CPCA, BloombergNEF

- Error! Reference source not found.In 2024, the number of sales of Heat Pumps in selected European States (BE, DE, DK, ES, FI, FR, IT, NL, NO, AT, PL, PT, SE, UK) fell 21% to 2.22 million (from 2.82 million in 2023). The biggest EU markets for sales in heat pumps in 2024 were France, Italy and Germany.

Figure 7 – Yearly Heat Pump sales in Europe



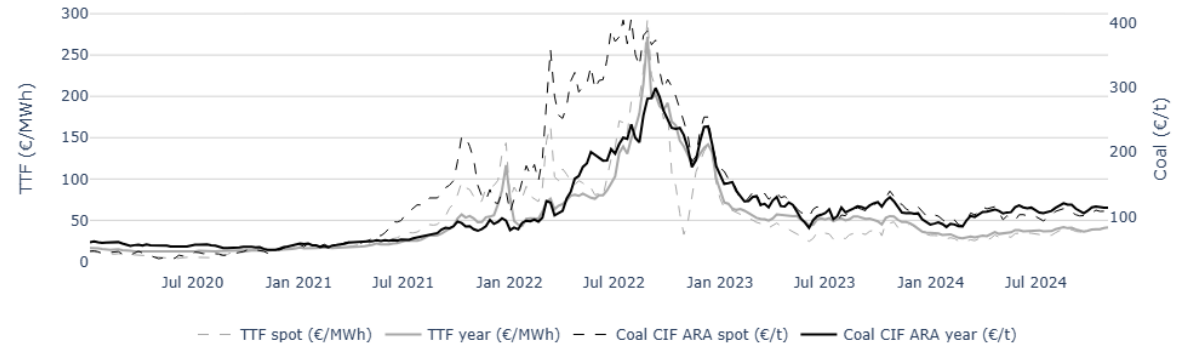
Source: EHPA, 13 European countries (BE, DE, DK, ES, FI, FR, IT, NL, NO, AT, PL, PT, SE and UK)

1.2 Supply side factors

- **Figure 8** reports on developments in European coal and gas prices. Spot and forward gas prices rose through most part of 2024, after reaching lows in February. In 2024, spot gas prices averaged 34 €/MWh, 15% lower than in 2023 (and 72% lower than in 2022). After having reached a minimum of 23 €/MWh in February 2024, spot gas prices moved in an upward trend for the rest of the year. In particular, Q4 2024 saw high and volatile gas prices fuelled by geopolitical tensions. In 2024, spot coal prices declined to 104 €/ton, which is 13% lower than in 2023 and 63% lower than in 2022. Coal prices roughly followed an upward trend, similarly to gas prices, after also having reached a minimum price (85 €/t) in February 2024.

- Moreover, spot gas prices averaged 43 €/MWh in Q4 2024, 5% higher than prices in Q4 2023 (41 €/MWh). TTF day-ahead prices roughly followed TTF forward contracts (month and year ahead) during the beginning of Q4 2023. From November onwards, TTF forward prices slipped into a discount relative to spot prices, signalling a shift into backwardation. Year-ahead prices averaged 42 €/MWh in Q4 2024, 4% lower than in Q4 2023. Thermal coal spot prices, represented by the CIF ARA contract, fell slightly to 109 €/t in Q4 2024 (from 117 €/t recorded in Q4 2024). The year-ahead CIF ARA contract rose to 114 €/t in Q4 2024 (from 109 €/t recorded in Q4 2024).

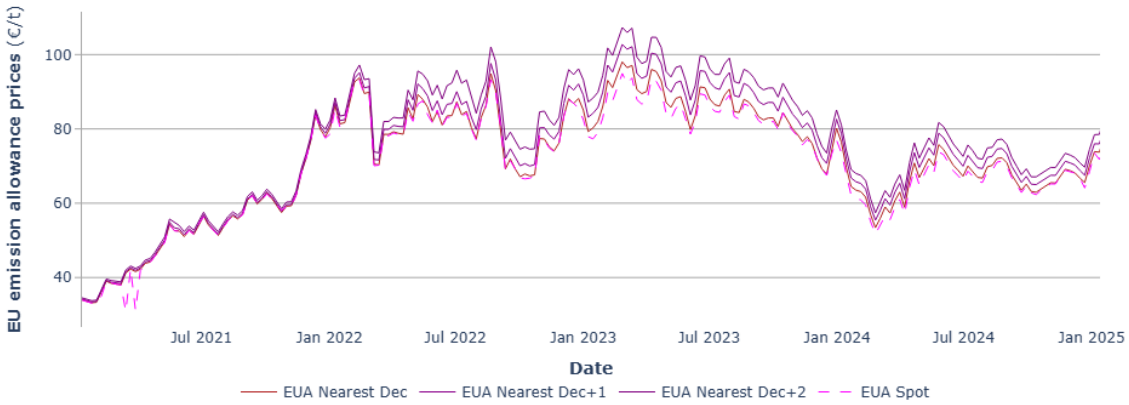
Figure 8 – Weekly evolution of spot and year-ahead coal and gas prices



Source: S&P Global Platts

- The European market for emission allowances, shown in **Figure 9**, followed a broadly upwards moving trend in 2024 after having reached a low in February. Spot prices fluctuated between 52 and 82 €/tCO_2 during 2024. The average spot price of CO_2 in 2024 (65 €/tCO_2) was 22% lower than in 2023. The average spot price in Q4 2024 (66 €/tCO_2) was 14% lower than in Q4 2023.

Figure 9 – Evolution of EU emission allowance spot and future prices from 2020

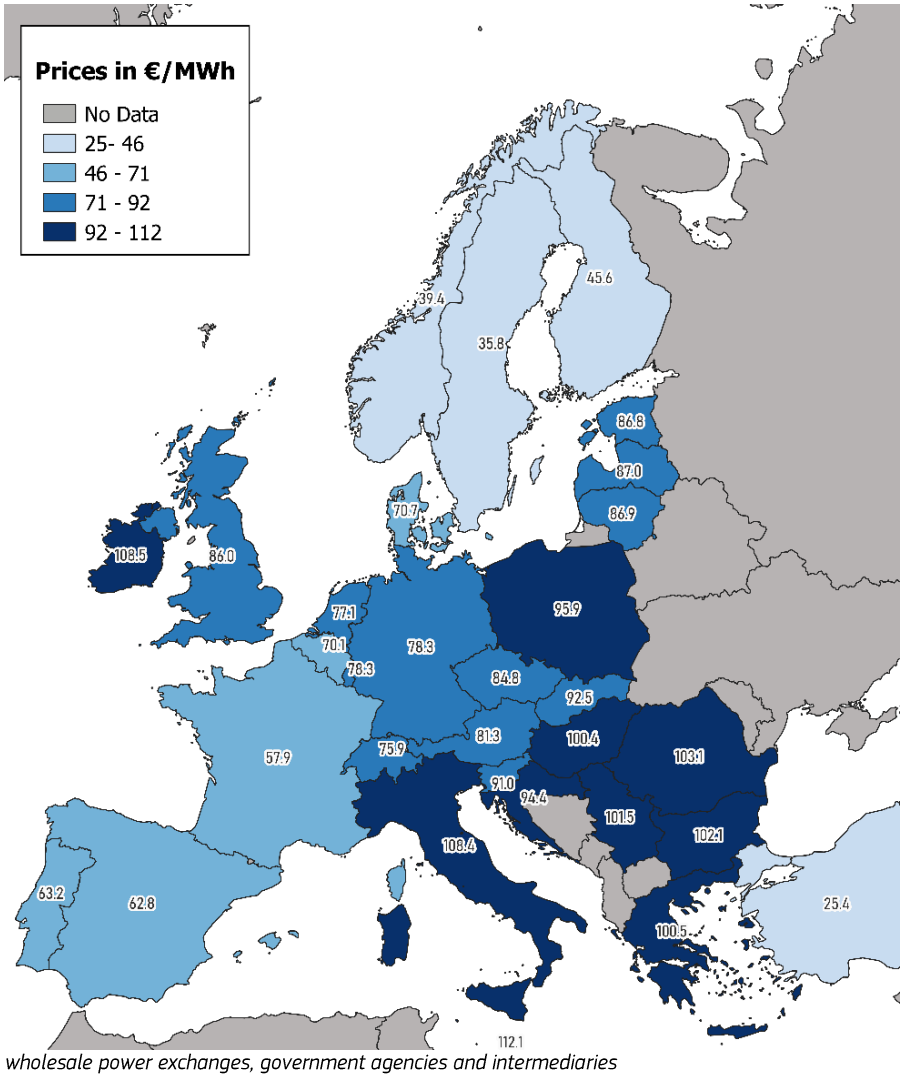


Source: S&P Global Platts

1.3 European wholesale electricity markets and their international comparison

- The map below (**Figure 10**) shows the average day-ahead wholesale electricity prices in Europe in 2024. Average day-ahead wholesale electricity prices in Europe were 22% lower than in 2023 and 67% lower than in 2022. Lower gas prices, higher renewable energy generation, and moderate electricity demand, contributed to the fall in prices. The higher level of renewable energy generation (in particular, solar, but also improved hydropower output) was accompanied by substantial levels of nuclear generation.
- On yearly basis, the European Power Benchmark averaged 74 €/MWh in 2024, 22% lower than in 2023 and 67% lower than in 2022. On a yearly basis, European markets experienced a decline in wholesale electricity prices, ranging from a yearly average of 36 €/MWh in Sweden to 109 €/MWh in Ireland. The largest year-on-year price falls in Member States were registered in France (-40%), and Sweden (-30%). The lowest decreases were seen in Romania (-1%) and Bulgaria (-2%) in 2024, compared with 2023 prices.
- As for quarterly prices, European Union Member States markets saw a mix of developments, but overall, wholesale electricity prices increased in many areas. The increases in gas prices, rising demand and subdued wind generation, contributed to this rise in prices. Year-on-year prices changes ranged from -46% to +40% in Q4 2024 (prices ranges from 38 to 136 €/MWh). The European Power Benchmark averaged 92 €/MWh in Q4 2024, 8% higher on yearly basis, but still 50% lower than in Q4 2022.

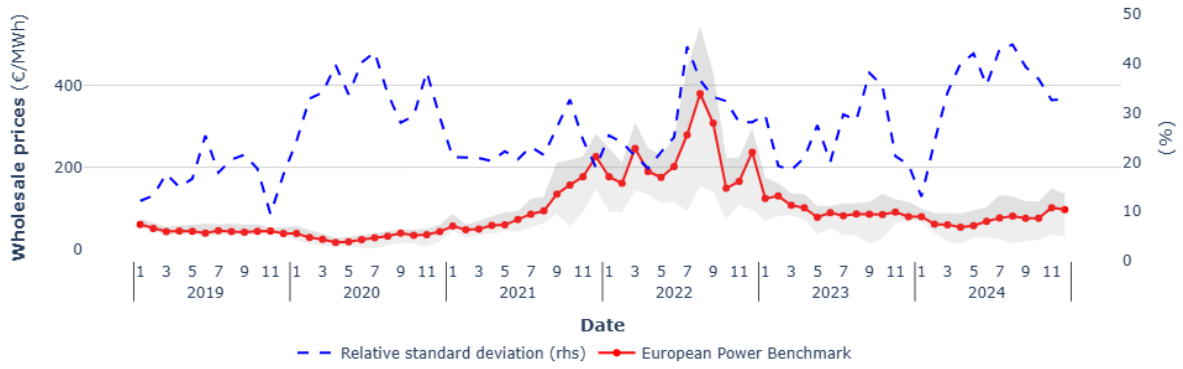
Figure 10 – Comparison of average wholesale baseload electricity prices, 2024



Source: European wholesale power exchanges, government agencies and intermediaries

- **Figure 11** shows the lowest and highest regional prices in Europe represented by the two boundary lines of the shaded area, the weighted EU average of these regional markets (European Power Benchmark), as well as the relative standard deviation of regional prices. The relative standard deviation metric shows in Q4 2024 lower divergence levels than the previous quarter (Q3 2024), albeit at higher levels. The **Annex** provides graphics of the monthly and daily evolution of regional prices in Europe.

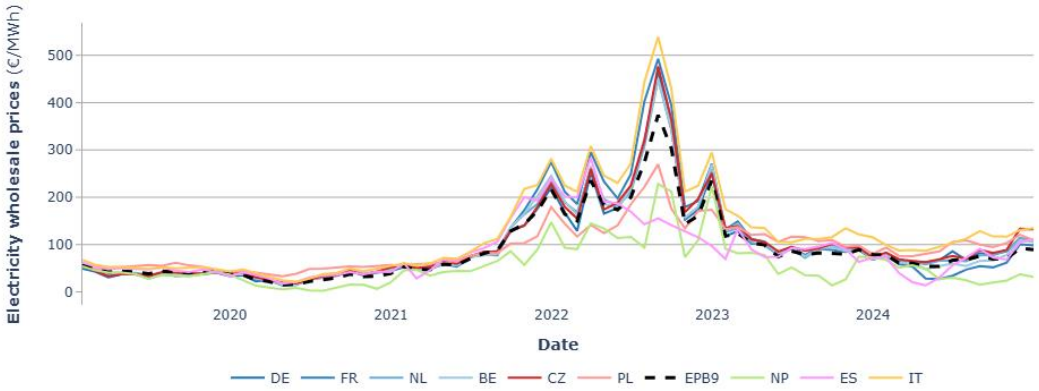
Figure 11 – The evolution of the lowest and the highest regional wholesale electricity prices in the European day-ahead markets and the relative standard deviation of the regional prices



Source: S&P Global Platts, European power exchanges. The shaded area delineates the spectrum of prices across European regions.

- **Figure 12** presents the evolution of weekly average electricity wholesale prices in nine selected European markets. Germany, France and the Netherlands average prices in 2024 were at 78, 58 and 77 €/MWh, respectively, from 95, 97 and 96 €/MWh in 2023. French prices dropped by 40% over the year, due to strong supply fundamentals and a decrease in demand. As a result, large volumes of electricity were exported to neighbouring markets. Italy registered an average yearly price in 2024 of 108 €/MWh, the highest of the nine selected markets. However, Italian prices decreased by 15% compared with 2023 prices.
- Strong solar generation supported lower prices in Spain, averaging 63 €/MWh during 2024 (-28% compared to 2023). At 36 €/MWh, prices in Northern Europe remained significantly lower than in the continent, from 62 €/MWh in 2023.
- Central Eastern Europe markets prices were above those in Central Western Europe, with prices at 96 and 85 €//MWh in average in 2023 in Poland and Czechia, respectively. However, Poland and Czechia also registered yearly prices decrease compared to 2023 (-14% and –16% respectively).

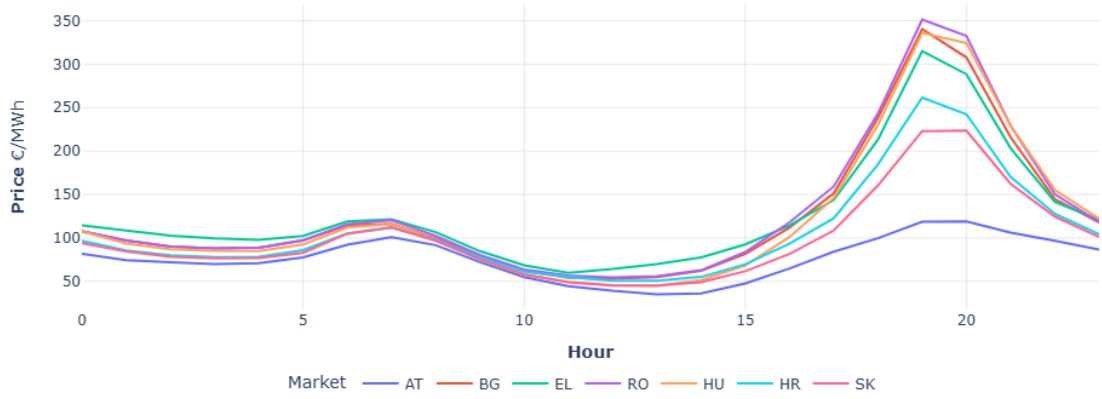
Figure 12 – Weekly average electricity wholesale prices in nine selected European markets



Source: S&P Global Platts, European power exchanges, ENER

- **Figure 13** shows the average hourly wholesale electricity prices evolution between July and September 2024 for selected southern and central eastern Europe markets. During the months of July and September, price sikes were observed in BG, EL, HR, HU and RO, driven by a range of factors, including high electricity demand caused by heat-waves, a drought that significantly reduced hydropower output and unplanned outages in power plants, among others.

Figure 13 – Average hourly wholesale prices in selected SEE and CEE markets from July to September 2024

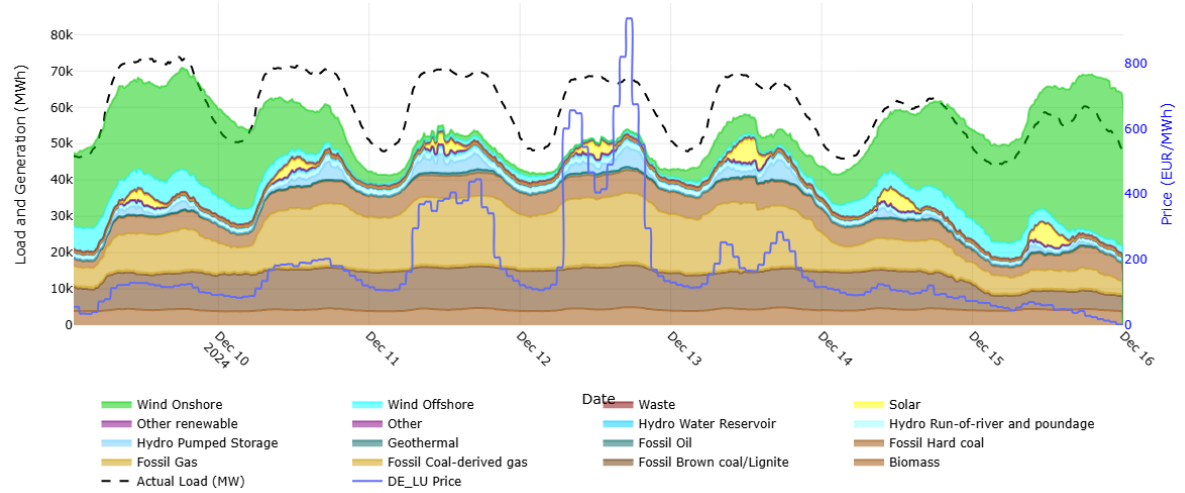


Source: ENER based on ENTSO-E

- **Figure 14** and **Figure 15** illustrate the impact of a *Dunkelflaute* event in Germany, which took place on 12 December 2024. During this period, wind generation plummeted below seasonal average, leading to a substantial increase in day-ahead prices. Prices soared nearly 1000 €/MWh during the evening peak hours. A *Dunkelflaute* (also known as a *dark doldrum*) refers to a period of low wind or solar generation. In this particular example, the lack of wind generation, combined with elevated electricity demand due to cold weather, resulted in the need of compensation

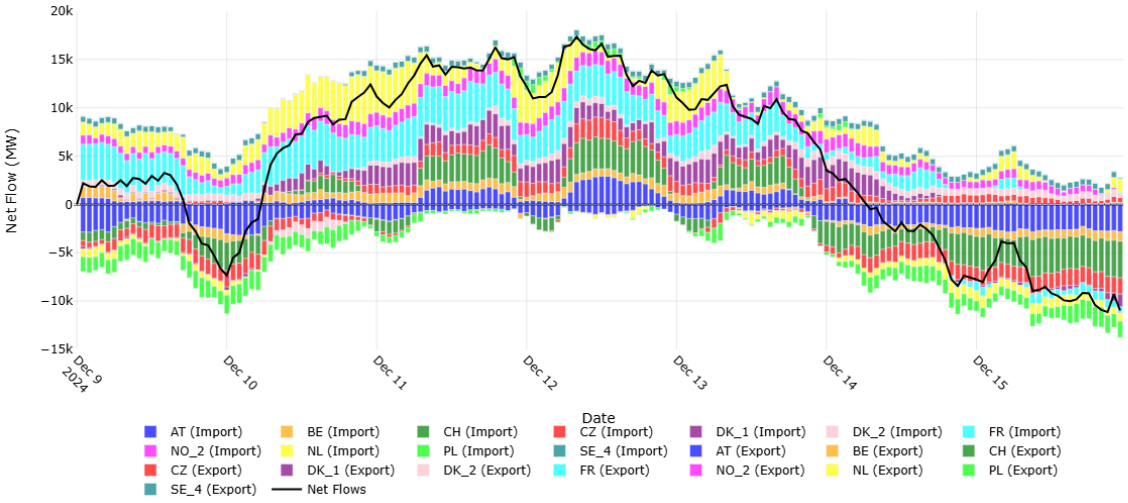
from fossil fuel plants and imports from neighbouring zones. Later that week, wind generation increased again. As a result of this surge in wind power, combined with lower energy demand, prices decreased. This reduction in prices led to a decrease in the need for fossil fuel generation and imports. In fact, Germany became a net exporter of energy for most of that weekend.

Figure 14 – Evolution of wholesale price, load and generation in Germany during 9 to 15 December 2024



Source: ENER based on ENTSO-E

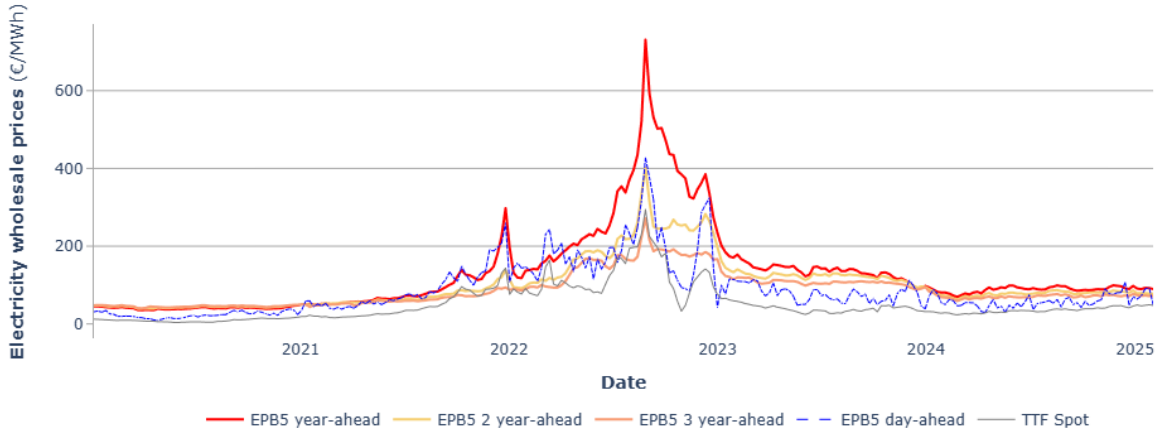
Figure 15 – Evolution of cross border flows - imports (positive) and exports (negative)- in Germany during 9 to 15 December 2024



Source: ENER based on ENTSO-E

- **Figure 16** shows how gas prices (TTF spot prices) were a relevant factor driving future electricity prices. During the energy crisis, we roughly observed a high correlation between gas and electricity prices, with a two-fold leverage effect (proportionality factor induced by gas power plants efficiency and gas being the marginal power plant in electricity price setting).
- In 2024, the average electricity year-ahead, two-year ahead and three-year ahead contracts were respectively 89 €/MWh, 78 €/MWh and 71 €/MWh. The premium of the weekly average between the year-ahead contract and the spot price averaged at 25 €/MWh during 2024.

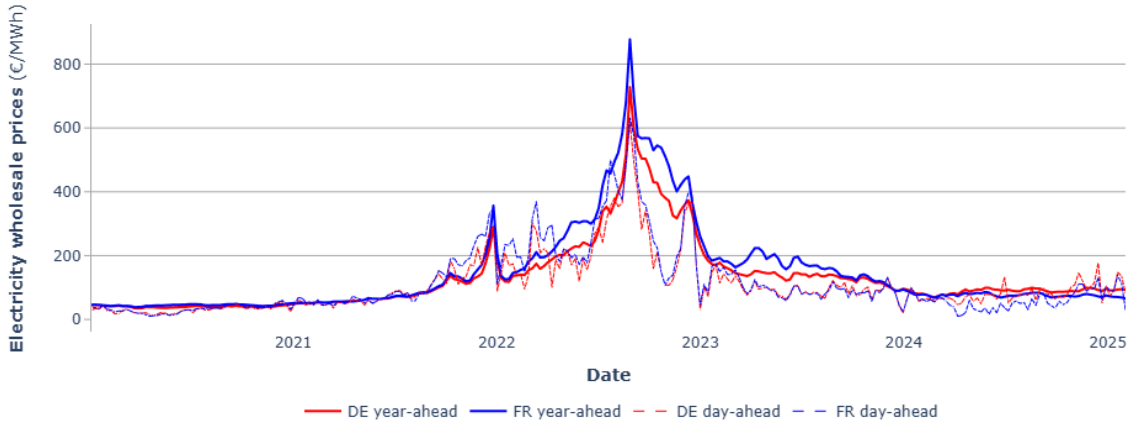
Figure 16 – Weekly futures baseload prices – weighted average of selected European markets



Source: S&P Global Platts.

- **Figure 17** shows the evolution of year-ahead contracts of Germany and France, together with their equivalent spot (day-ahead) prices. The divergence between the two forward contracts increased throughout 2024, with a shift in the trend seen during the energy crisis, with a premium of the German contract over their French equivalent. The average premium averaged 12 €/MWh during 2024. This average premium was at -25 €/MWh in 2023.

Figure 17 – Weekly German and French year-ahead contracts



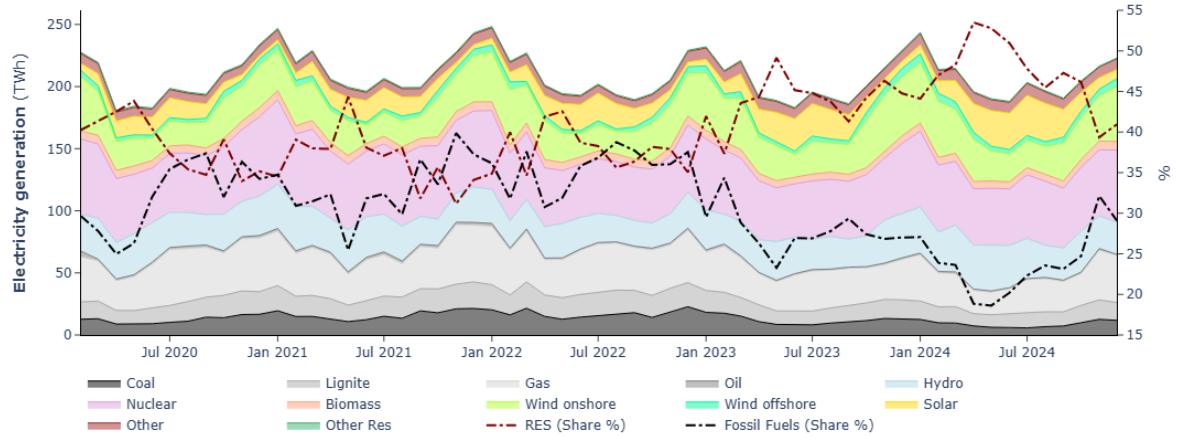
Source: S&P Global Platts.

1.4 Electricity mix in the EU

Electricity generation in 2024 compared to 2023. Source: ENTSO-E

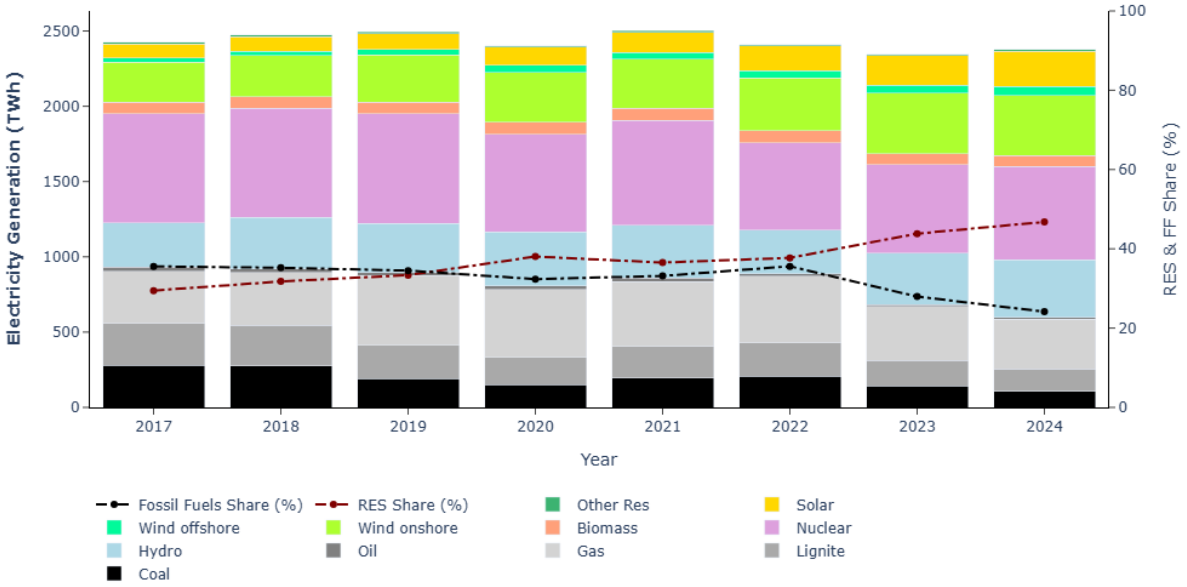
- **Figure 18** shows the monthly evolution of the electricity mix in the EU. In 2024, the RES generation reached a record of 1 160 TWh (+8% compared with 2023) constituting 47% of the electricity mix (from 44% in 2023). In April 2024, the share of the electricity generated through RES reached a historical high-record level of 54%, widening the gap between RES and Fossil-Fuel generated electricity.
- In 2024 compared with 2023, the share of the electricity produced from fossil fuels further declined to 28% from 32%, due to a decrease of the electricity generated through coal (-27%), oil (-15%) and gas (-8%). The share of electricity produced through nuclear remained stable at 24%.

Figure 18 – Monthly electricity generation mix in the EU



Source: ENTSO-E. Fossil fuel share calculation covers power generation from coal, lignite, gas, oil and others.

Figure 19 – Yearly electricity generation mix in the EU



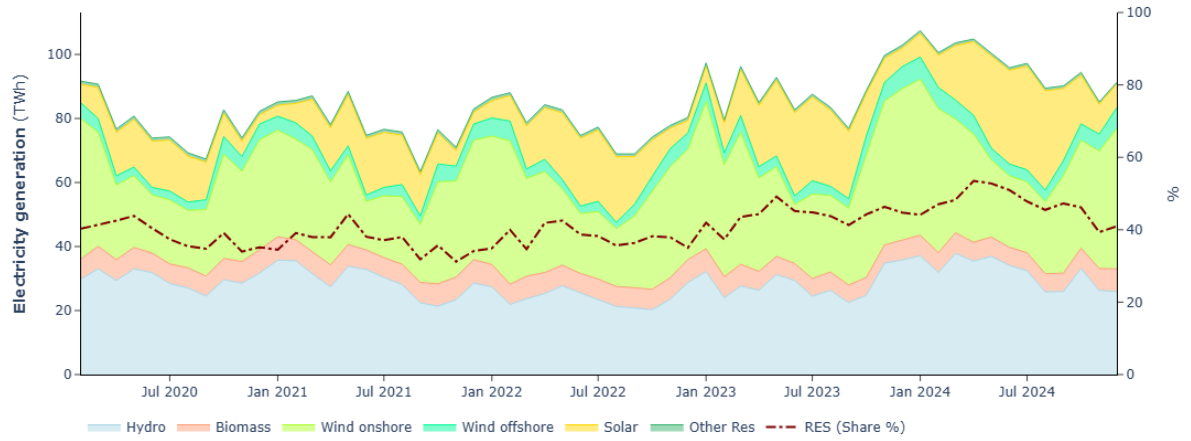
Source: ENTSO-E

- **Figure** depicts the evolution of monthly renewable energy generation in the EU, alongside its share in the electricity generation mix. The growth of the share of renewable energy generation in 2024 compared to 2023 (47% and 44%, respectively) was supported mainly by a remarkable increase of +19% in solar generation (+38 TWh) and 13% in hydro (+43 TWh) particularly during the summer. The increase was also supported by a +17% increase in offshore wind output (+9 TWh). A decrease of 1% in wind onshore output was however observed (-4 TWh). The notorious rise in solar and wind onshore generation was supported by increased levels of new solar and wind onshore capacity installed in the EU in recent years. Wind and solar generation together (694 TWh) registered an increase of +7% (+43 TWh). Mild weather and increased rainfall also supported record level of renewable energy generation.

Renewable Electricity Generation in 2024 compared to 2023

Wind Onshore	Wind Offshore	Solar	Hydro	Biomass
399 TWh	61 TWh	234 TWh	383 TWh	74 TWh
▼−1%	▲17%	▲19%	▲13%	▲4%

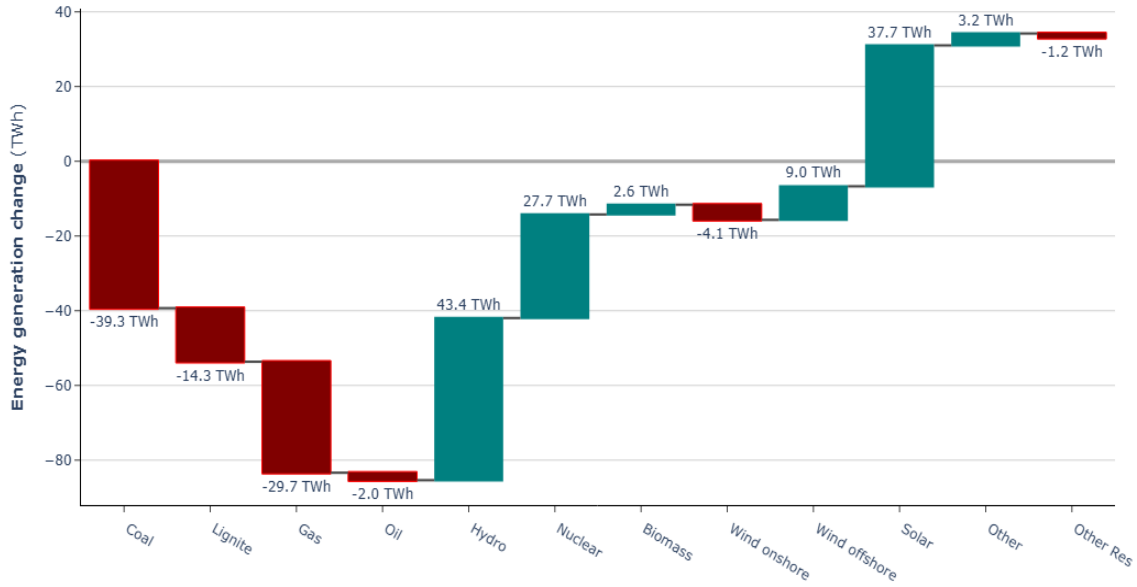
Figure 19 – Monthly renewable generation in the EU and the share of renewables in the power mix



Source: ENTSO-E. Data represent net generation.

- **Figure 20** Error! Reference source not found.visualises changes in the EU27 electricity generation in 2024 compared to 2023. Between 2024 and 2023, fossil fuel generation dropped by 10% (-82 TWh), supported by coal, gas, lignite, and oil generation falling by 39 TWh (-27%), 30 TWh (-25%), 14 TWh (-9 %), and 2 TWh (-17%) respectively. Hydro and solar generation registered the biggest absolute increase (respectively +43 and +38 TWh) compared to 2023. Solar also registered the biggest relative increase between 2024 and 2023 (+19%).

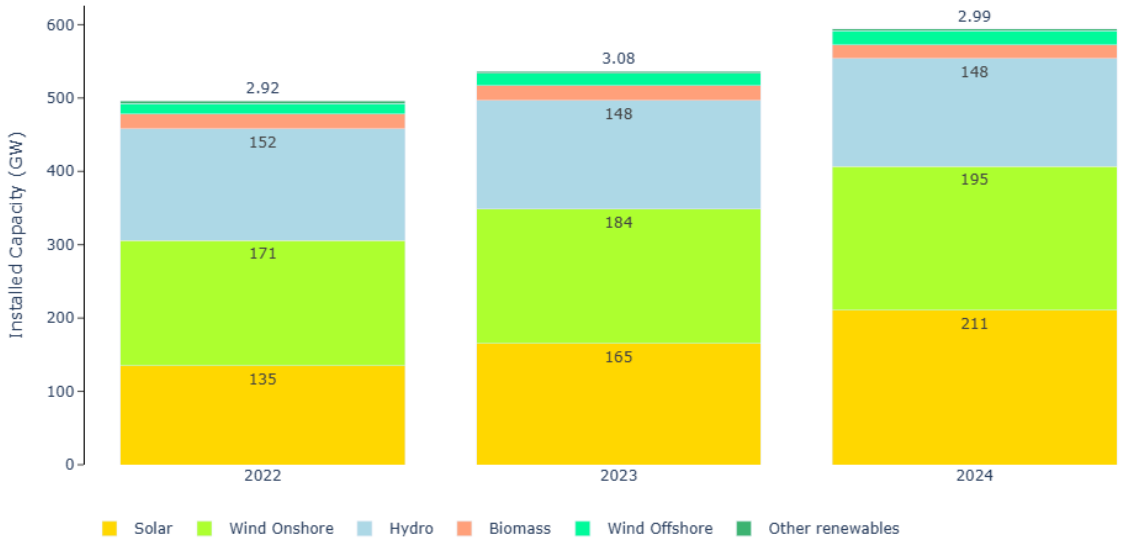
Figure 20 – Changes in power generation in the EU between 2024 and 2023



Source: ENTSO-E.

- **Figure 21** maps renewable installed power capacity in the EU in 2024, 2023 and 2022. Rising carbon-free generation in the EU was greatly helped by a 28% of increased annual solar capacity in 2024. Moreover, wind onshore and offshore grew by +6% and +12% of installed capacity, respectively (+6% combined). Overall, wind and solar combined installed capacity grew by +16% in 2024, from 366 GW in 2023, to 425 GW in 2024.

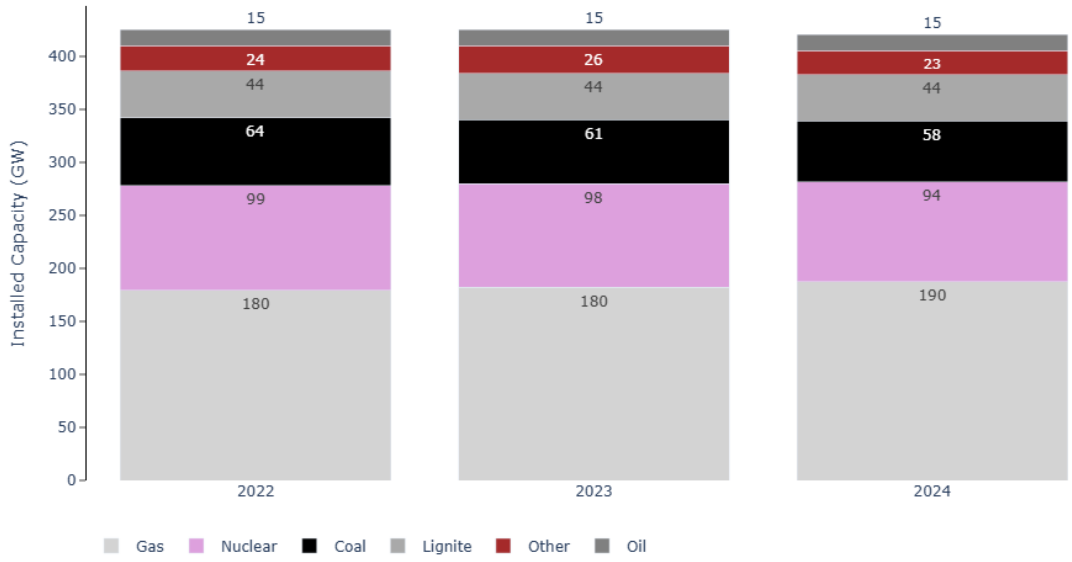
Figure 21 – Installed capacity - renewables



Source: ENTSO-E Net Generating Capacity Statistical Reports. Note: Certain smaller renewable plants might have been excluded from the total. More official statistics, such as Eurostat, might therefore differ. These are however published with a lag of year.

- **Figure 22** maps conventional (fossil fuel and nuclear) installed power capacity in the EU in 2024, 2023 and 2022. Nuclear generation fell by -4% in 2024, while coal installed capacity fell by -5%. Lignite installed capacity remained stable. Gas-fired installed capacity rose by +6% in 2024.

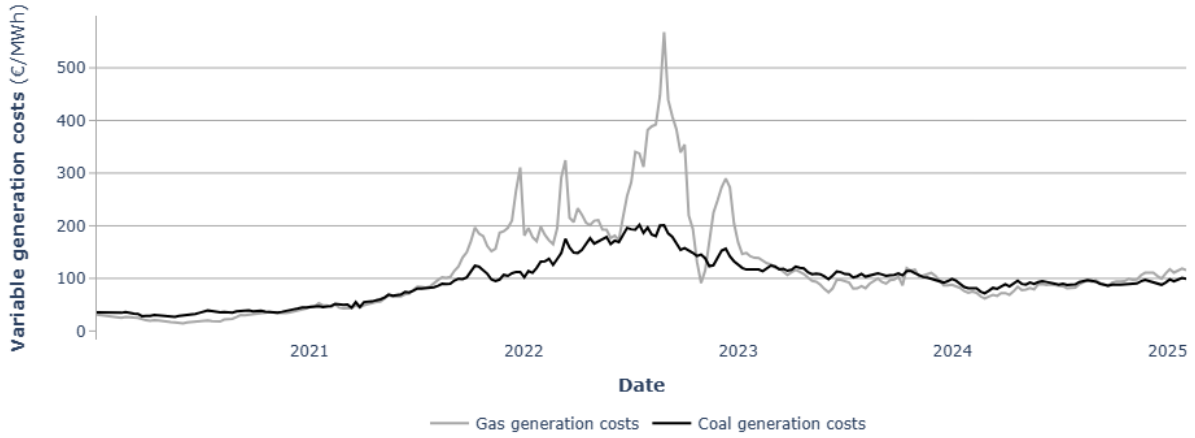
Figure 22 –Installed capacity – fossil fuel and nuclear



Source: ENTSO-E Net Generating Capacity Statistical Reports

- **Figure** shows the impact of gas prices on estimated gas and coal-fired generation variable costs for estimated average power plants (fuel and emission allowances costs). Lower gas prices and relative high level of carbon prices (despite registering a decline followed by fluctuating prices since the end 2023) supported coal-to-gas fuel switching in most of the first three quarters of 2024. However, this trend began to fade away and intensified in the opposite direction in Q4 2024, as rising gas prices narrowed the gap between coal and gas fuel switching. As a result, gas-fired generation became slightly less profitable than coal-fired generation in Q4 2024, while the overall trend continued into Q1 2025.

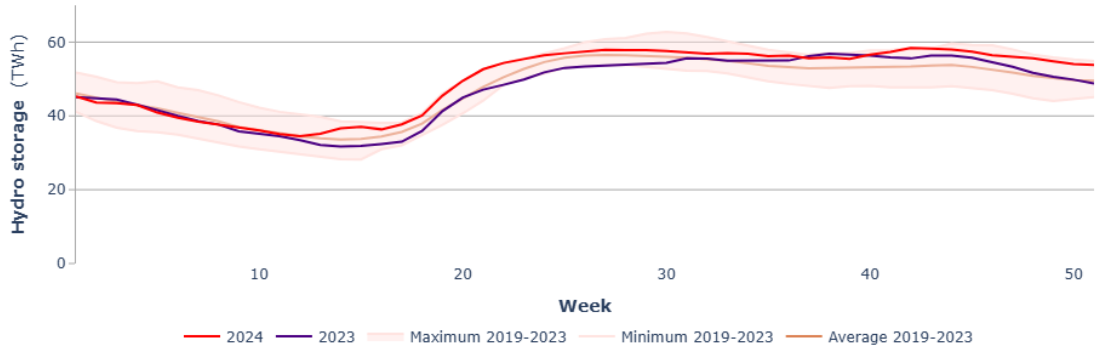
Figure 23 – Estimated variable generation costs of coal- and gas-fired power plants.



Source: S&P Platts, ENER.
Note: Thermal efficiency values used for coal- and gas-fired plants were 41% and 55% respectively. Emissions intensity values used were 0.85 and 0.37 tCO2e/MWh respectively for coal- and gas-fired generation.

- **Figure 24** shows the sum of 2024 levels of hydro reservoirs in the reported markets. In 2024, the overall sum of hydropower reservoirs increased (+5% compared with 2023 levels). Levels of hydro reservoirs stayed above the 2019-2023 average from March onwards.

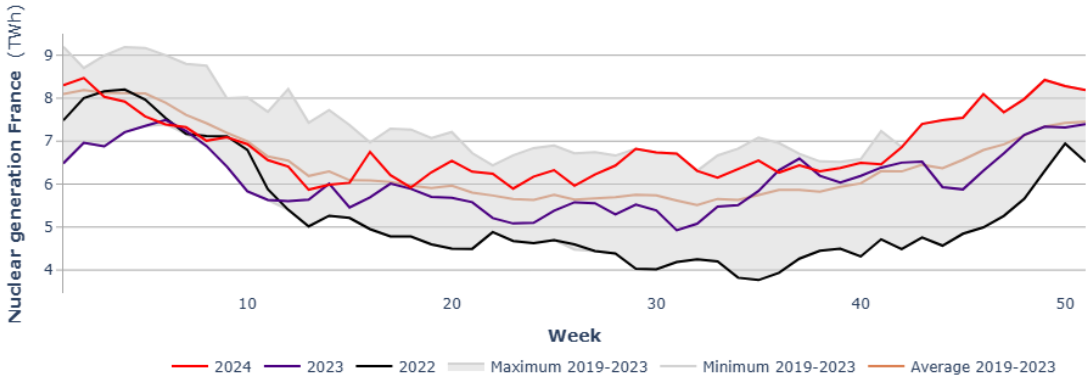
Figure 24 - Aggregated EU hydropower reservoirs – weekly



Source: ENTSO-E. Aggregated hydropower reservoirs for Austria, Bulgaria, Spain, Finland, France, Greece, Hungary, Italy, Lithuania, Latvia, Portugal, Romania and Sweden.

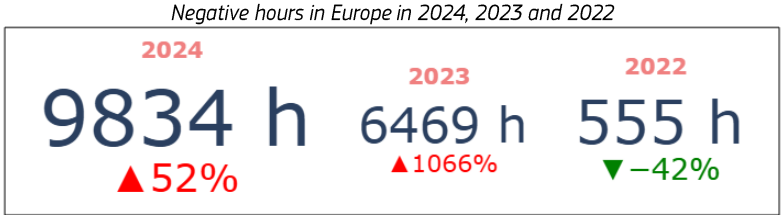
- As shown in **Figure 25,** French nuclear output amounted to 360 TWh in 2024 and was up by 13% compared to 2023t. This was the highest nuclear output since 2019. In 2022, the French nuclear output (278 TWh) was the lowest since 1998.

Figure 25 - Weekly nuclear electricity generation in France



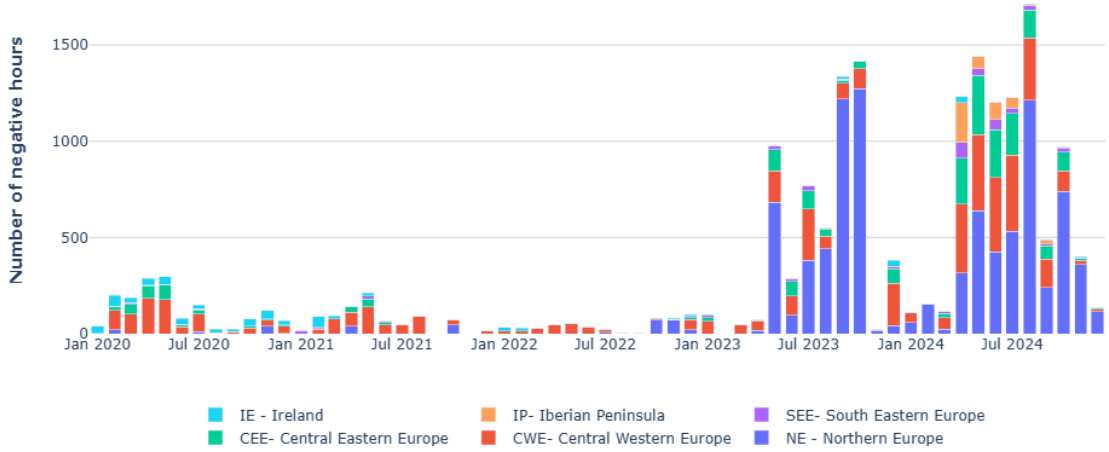
Source: ENTSO-E

Negative hours in Europe in 2024, 2023 and 2022



- **Figure 26** show the monthly frequency of the occurrence of negative hourly wholesale electricity prices in selected European markets. Negative hourly prices generally occur when electricity demand is lower than expected and when variable renewable energy generation is abundant, combined with large and relatively inflexible baseload electricity generation (e.g. nuclear or lignite). In such cases, conventional power plants offer their output for a negative price to avoid switching the unit off and having to go through the costly and high-maintenance operation of restarting the facility when they want to enter the market again.
- In 2024, the number of occurrences of negative hours reached a new record of 9834 in European markets (representing 3% of total hours), compared with 6469 in 2023 (+52%). August registered a record number of 1930 hours with negative prices in the selected European markets. In Q4 2024, the occurrence of negative hours amounted to 1551, -22% from Q4 2023. In particular, Bulgaria, Greece and Spain saw the occurrence of negative prices for the first time.

Figure 26 – Number of negative hourly wholesale prices on selected day-ahead trading platforms in Europe.

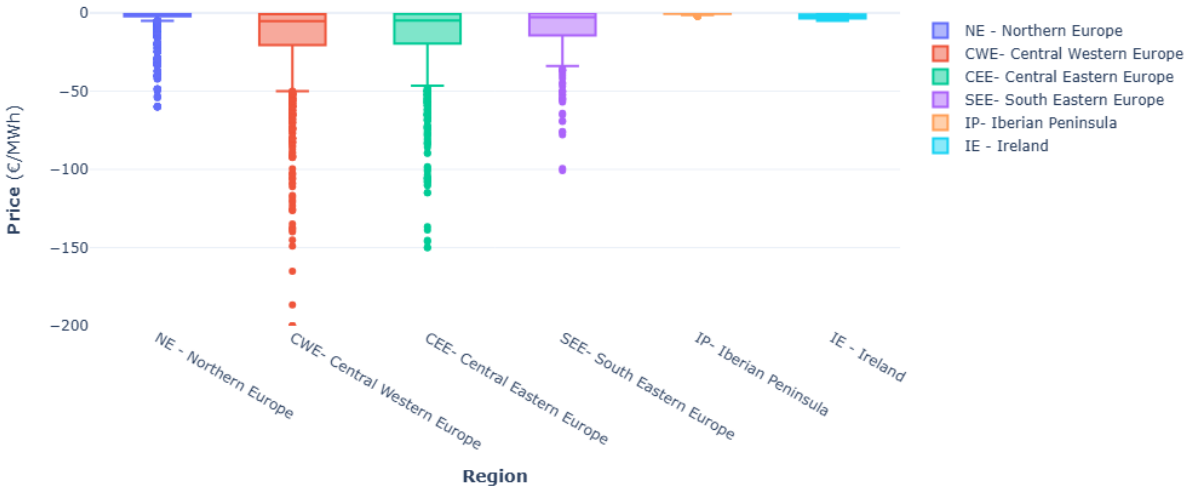


Source: ENTSO-E.

- **Figure 27** illustrates the magnitude distribution of negative prices in selected regions of Europe. Notably, the occurrences of negative prices in Northern Europe were characterised by a low range of prices, with outliers reaching

as low as -60 €/MWh. Similarly, Ireland and the Iberian Peninsula also exhibit a low range of negative price with fewer outliers. In contrast, CWE, CEE and SEE regions displayed a higher magnitude of negative prices, with prices ranging from close to zero to -20 €/MWh and – 15 €/MWh, respectively. Moreover, outliers in these regions extended beyond -100 €/MWh, indicating more pronounced deep negative prices.

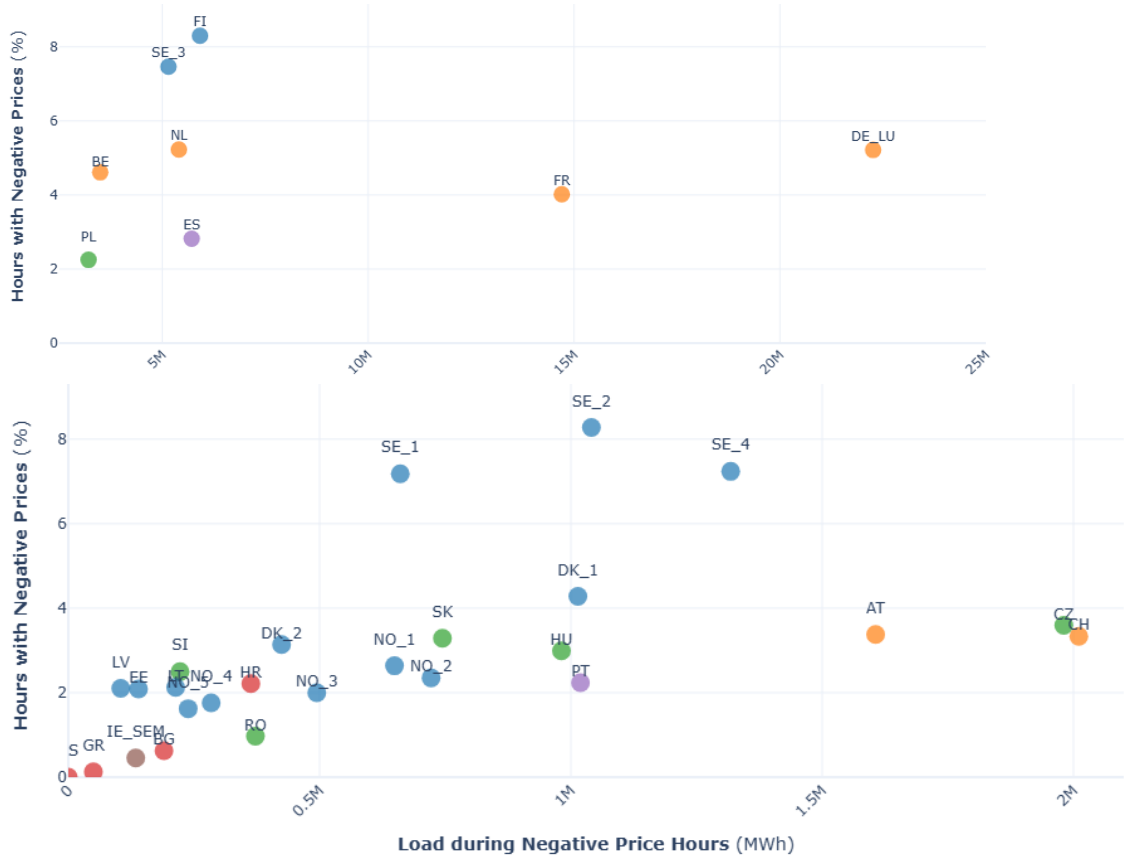
Figure 27 – Distribution of negative hourly wholesale prices on selected day-ahead trading platforms in Europe



Source: ENER based on ENTSO-E.

- **Figure 28** provides context on the percentage of yearly occurrence of negative prices and the corresponding load in those specific hours within the European bidding zones. Larger load bidding zones, such as Germany/Luxemburg and France, registered around 4-5% of hours with negative prices in 2024. Smaller bidding zones in terms of load during those negative price hours, like the Swedish bidding zones and Finland, saw an occurrence of negative price hours, at around 7-8% of the time. Additionally, a large group of bidding zones with less than 2 million MWh of load in 2024 during those negative price hours recorded less than 4% occurrence of negative prices.

Figure 28 – Percentage of negative prices and load in 2024 by bidding zones

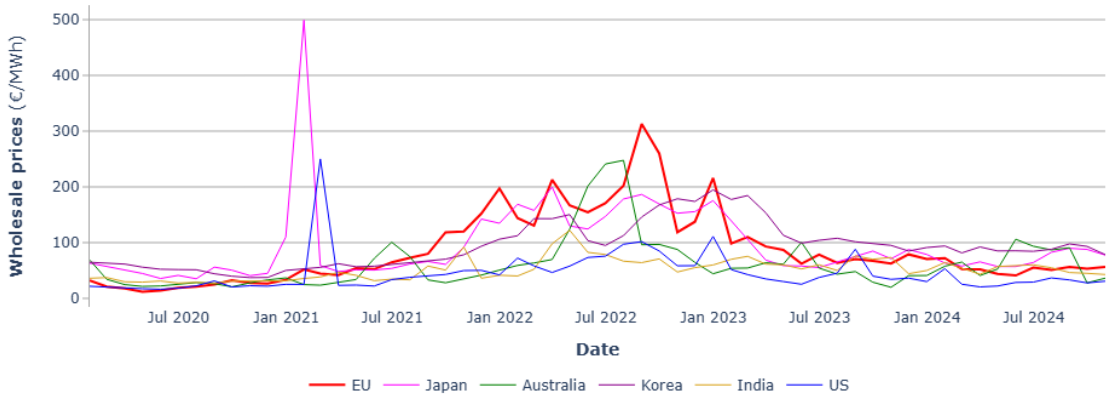


Source: ENER based on ENTSO-E.

- **Figure 29** compares price developments in wholesale electricity markets of selected major economies. Most markets saw power prices easing due to year-on-year improved fundamentals in global energy markets.
- In the U.S., wholesale electricity prices in selected regional markets saw year-on-year changes ranging from -57% (ERCOT) to +13% (NYISO) in 2024, supported by lower gas prices, increased from renewable energy sources and new battery storage capacity[1]. In 2024, the US average price of selected markets was 26% lower than in 2023.
- In Japan, year-on-year prices fell by 11% in 2024, supported by lower international LNG prices. Japan relies heavily on fossil-fuel power generation, and it is one of the three most important LNG buyers in the global market. Prices in Korea also fell by 25% during the year.
- In Australia, wholesale electricity prices rose by 29% year-on-year in 2024. Prices in India registered a year-on-year fall of 15% in 2024.

[1] EIA (2025) "U.S. wholesale electricity prices were lower and less volatile in 2024"

Figure 29 – Monthly average wholesale electricity prices in international markets (D-A markets)

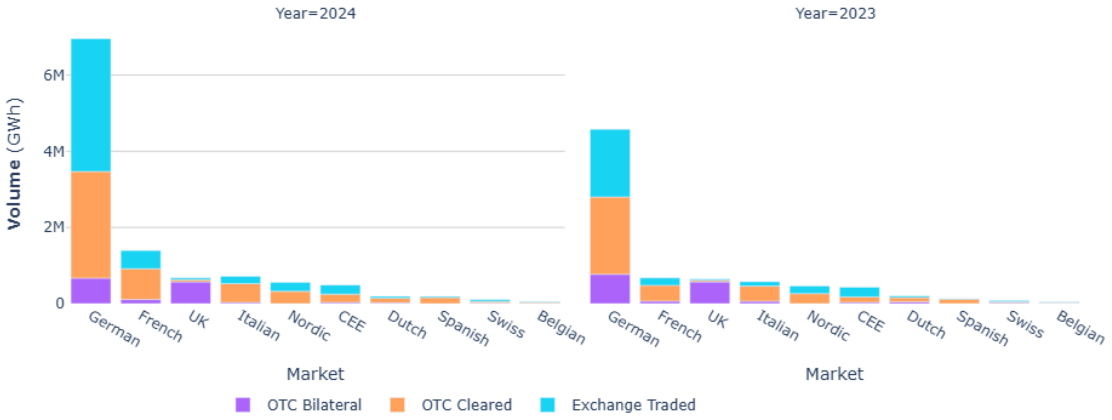


Source: European Power Benchmark based on S&P Global Platts and ENTSO-E Transparency Platform, JPEX (Japan), AEMO (Australia), and the arithmetic average of selected PJM West, ERCOT, MISO Illinois, CAISO, NYISO Hudson Valley and ISONE Internal regional wholesale hubs in the United States.

1.5 Traded volumes and cross border flows

- **Figure 30** shows annual changes of traded volumes of electricity in the main European markets in 2024, including exchange-executed trade and over-the-counter (OTC) trade. Selected markets and regions witnessed a year-on-year improvement in trading activity. The increase in total traded volumes between 2023 and 2024 (+45%) reflects the level of recovery in trading activity in the electricity sector. Activity also grew in OTC cleared contracts in 2023 (+42%) but decreased in OTC bilateral (-8%).
- In 2024, Germany was by far the largest and most liquid European market, as total volume was equivalent to 61% of the total traded volumes under observation (113 TWh).
- The biggest year-on-year increases were seen in France (+107%), Germany (+52%) and Spain (+48%). Greece and the Netherlands saw decreases of respectively –15% and –4% in their total traded volumes compared to 2023.

Figure 30– Annual change in traded volume of electricity on the most liquid European markets

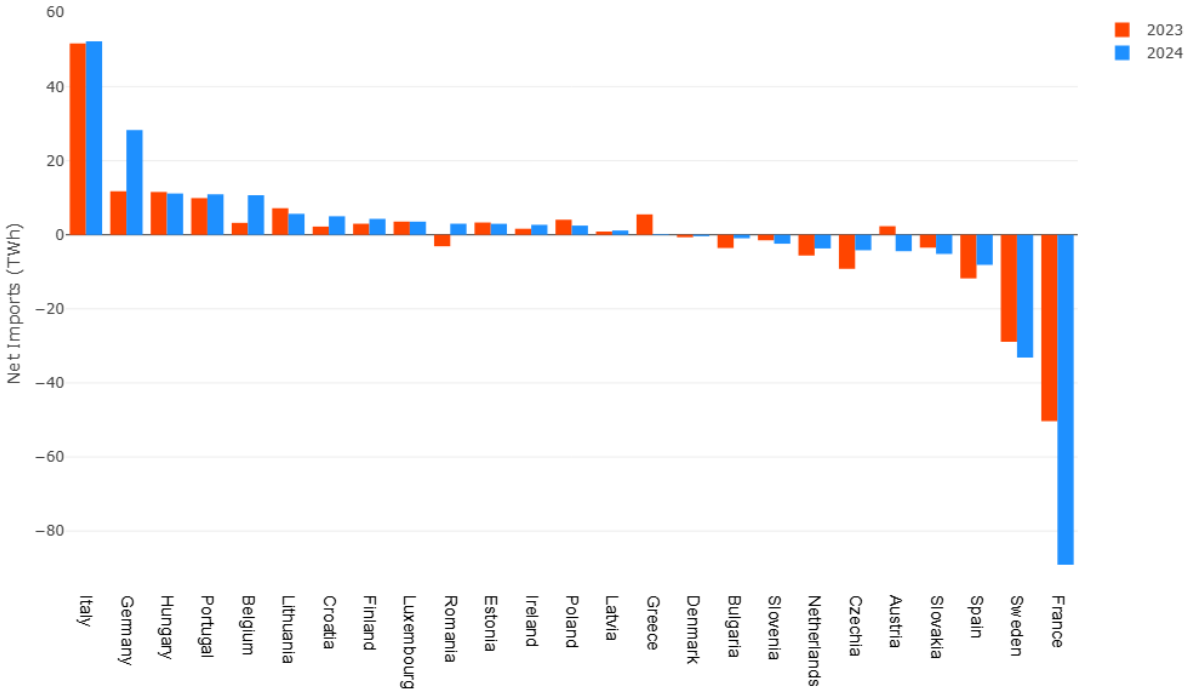


Source: Trayport, London Energy Brokers Association (LEBA) and DG ENER computations

- **Figure 31** compares net balances of physical electricity flows among EU Member States in 2024 and 2023. In 2024, the net trading position followed historical trends, completing the reversal of the trade disruptions observed in 2022.
- France set a record as a net exporter in 2024 (89 TWh), +39 TWh. The improved situation of the French nuclear fleet, coupled to an increase in renewable generation supported a rise in export flows, allowing France to consolidate its position as the main EU net exporter in 2024.

- Sweden was the second largest net exporter (33 TWh), thanks to a significant discount in wholesale electricity prices vis-à-vis the neighbouring and other continental European markets. In 2024, the other important EU exporters were Spain (8 TWh) and Slovakia (5 TWh).
- The biggest EU importers were Italy (52 TWh), Germany (28 TWh), Hungary (11 TWh) and Portugal (11TWh).

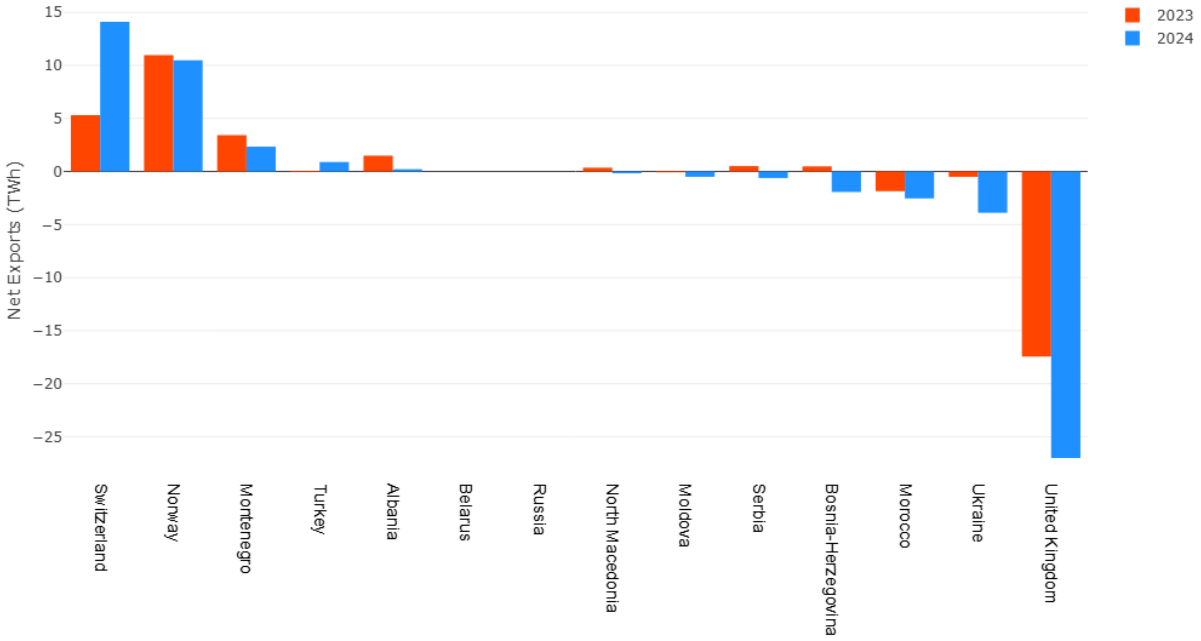
Figure 31 – Member States' net scheduled commercial export/import positions within the EU in 2024 and 2023



Source: Scheduled Commercial flows ENTSO-E, TSOs

- **Figure 32** shows netted electricity exchanges with EU neighbours in 2024. Great Britain's export balance declined further, increasing its net imports from the EU to 27 TWh. Meanwhile, Switzerland surpassed Norway as the largest net exporter to the EU, with major exports directed to Germany (7 TWh) and Italy (20 TWh).
- Net exports from the EU to Ukraine amounted to 4 TWh in 2024, an increase from 2023 (0.5 TWh). Commercial exchanges of electricity between Continental Europe and Ukraine/Moldova started in June 2022, after the successful synchronisation of the power systems. Ukraine halted exports to Continental Europe after the massive Russian attacks of their energy infrastructure in October 2022. Since then, the TSOs of Continental Europe have regularly increased the capacity available for trading.

Figure 20 – Extra-EU electricity commercial scheduled exchanges in 2024 and 2023 – netted



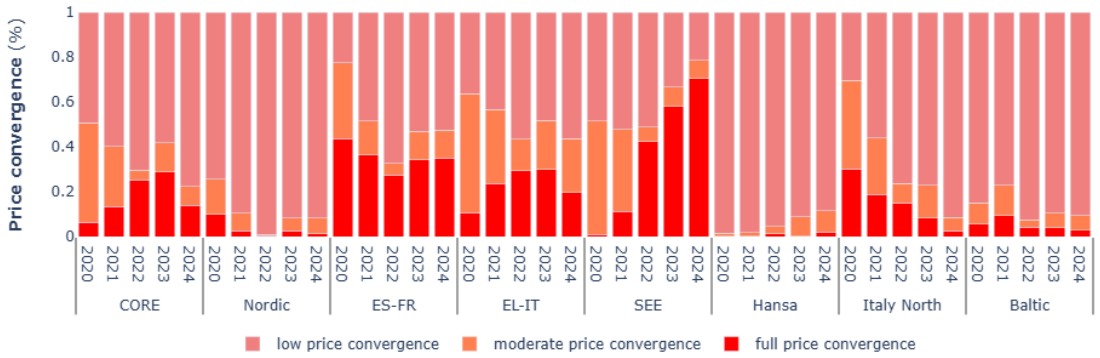
Source: Scheduled Commercial Flows ENTSO-E, TSOs. Positive values indicate net flows into the EU.

2 Focus on developments in annual wholesale prices

2.1 Day-ahead price convergence

- **Figure 21** illustrates the degree of price convergence in day-ahead markets within selected European regions, expressed in percentages of hours in a given year. Price convergence provides an indication of the level of market integration. It is important to note that achieving complete price convergence is not a goal in itself because it would demand investing excessively in network infrastructure.
- Longer-term drivers of price convergence are market coupling initiatives or the expansion of interconnection capacities. In the short term, fluctuations in convergence may also be caused by factors not necessarily related to the level of market integration, such as changes in the amount of cross-zonal capacity designated by TSOs for commercial purposes, outages of transmission lines, significant shifts in the power mix or in consumption patterns.
- The Flow-Based Market Coupling Mechanism (Core FB MC) improves the European power grid's capacity to handle fluctuations in variable renewable energy sources (in place since June 2022. The CORE region comprises BE, CZ, DE, FR, HR, HU, LU, NL, RO, AT, PL, SK, SI. In the CORE region (excluding PL), the number of occurrences of full price convergence fell from 29% to 14% of hours in 2024. In 2024, prices exhibited significant regional disparities. Notably, SEE and CEE saw a price decorrelation from western European bidding zones in summer. The situation in SEE was worsened by a combination of factors, including high electricity demand caused by heatwaves, a drought that significantly reduced hydropower output, unplanned outages in power plants, exacerbating the situation in the region.
- The Nordic, the Baltic and the Hansa Capacity Calculation Regions (CCR) remained at low convergence levels in 2024. In the SEE CCR, full price convergence rose in 2024 (from 58% to 70% of hours). Italy and Greece full convergence levels fell to 20% of the time in 2024. The Italy North CCR registered lower full price convergence levels in 2024.

Figure 21 – Price convergence on day-ahead markets in selected regions as percentage of hours in a given year



Source: ENTSO-E, ENER calculations. The CORE region includes BE, CZ, DE_LU, FR, HR, HU, LU, NL, RO, AT, SK and SI. (PL is not included). The Baltic region includes EE, LV, LT, FI, SE4 and PL bidding zones. The Nordic region includes 12 bidding zones of Norway, Sweden, Finland and Denmark. The SEE region includes EL, BG, RO. The Hansa region includes DE_LU, NL, PL, SE4, DK1 and DK2. The Italy North region includes FR, IT-NORTH, AT and SI.

2.2 Average annual price levels and volatility

- **Figure 34** maps annual changes in average day-ahead baseload prices and in hourly price dispersion across European day-ahead markets. After the turmoil in energy commodity markets in 2022, in 2024 average day-ahead baseload prices were generally lower than in 2023.
- Most markets experienced an increase in levels of price volatility in 2024 compared with 2023 (measured as relative standard deviation of hourly prices and plotted on the right-hand scale of the chart).

Figure 22 – Changes in average baseload prices and hourly price volatility in European day-ahead markets between 2024 and 2023

Source: ENTSO-E, ENER calculations. Italy is represented by the national average (PUN), the rest of the markets under observation correspond to bidding zones. Ireland has a common bidding zone with Northern Ireland (ISEM). Prices in Great Britain are represented by the N2EX power market.

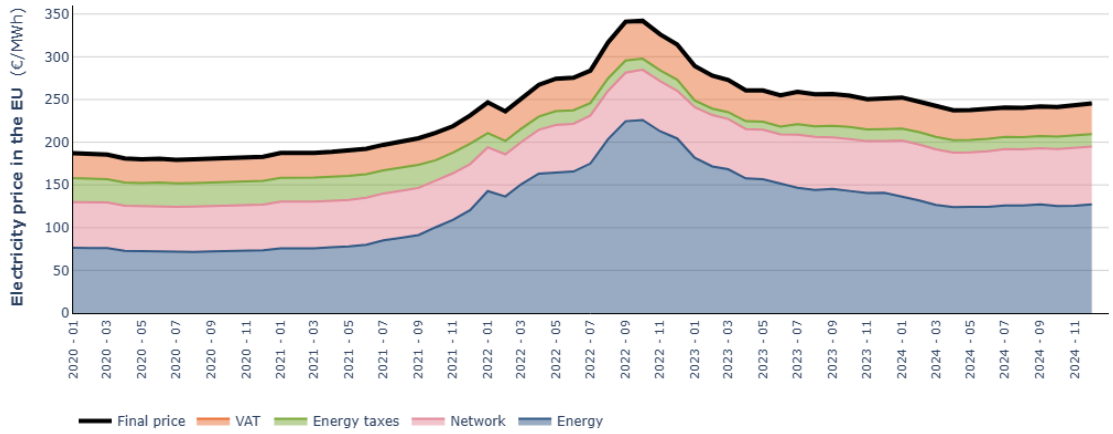
2.3 Retail electricity markets in the EU

2024	2023	2022
242 €/MWh	262 €/MWh	290 €/MWh
▼−7%	▼−10%	▲52%

Retail electricity prices in 2024, 2023 and 2022.

- Retail prices continued to decrease in 2024, driven by lower wholesale prices. **Figure 35** shows the monthly evolution of the EU average residential retail electricity prices over the last few years. The average retail electricity prices for household costumers in EU capital cities fell from January to April 2024, from 252 €/MWh to 237 €/MWh (- 6%), and grew thereafter to reach 245 €/MWh in December. Prices in Q4 2024 decreased by 3% compared to Q4 2023.

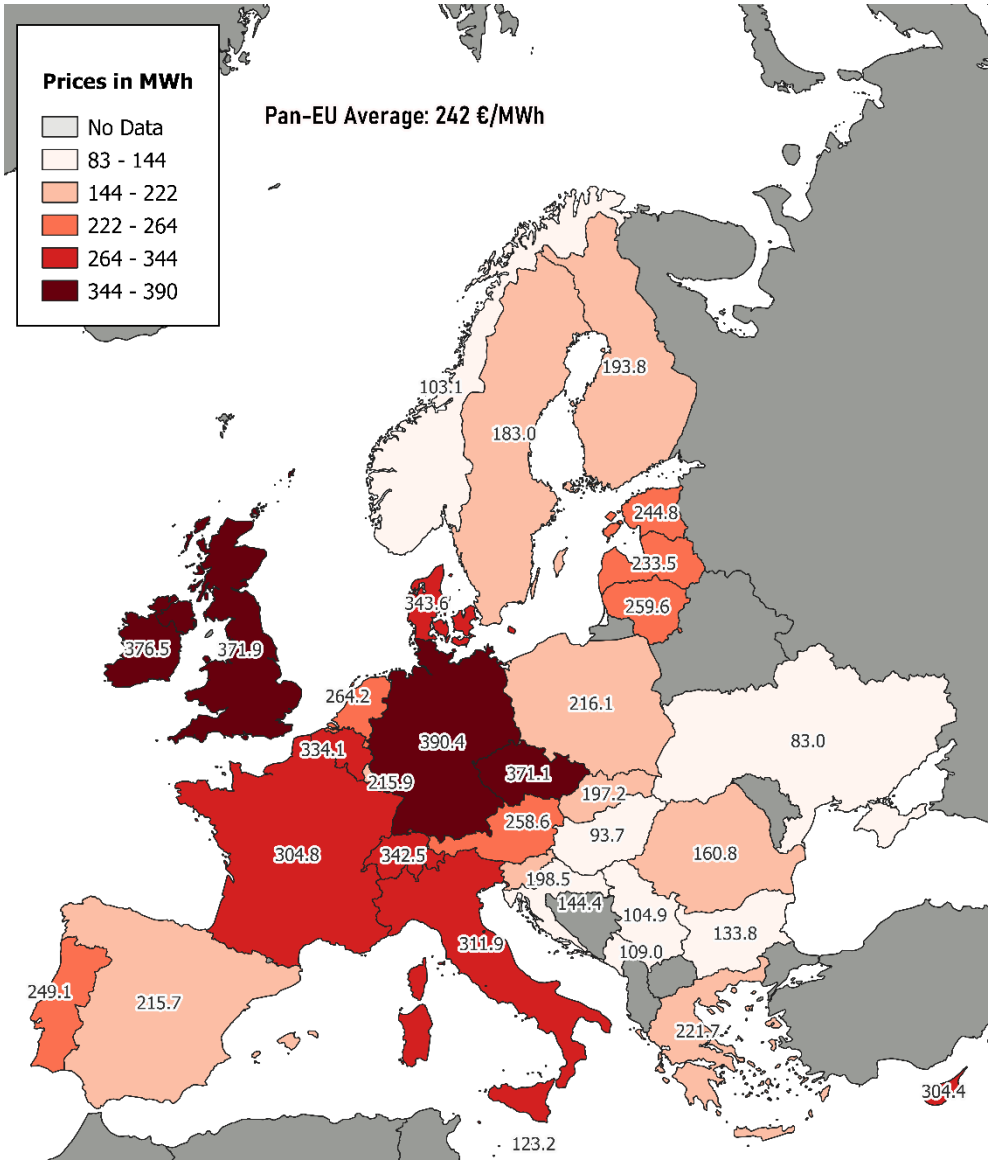
Figure 23 – Monthly average electricity price in the EU, paid by typical household customers



Source: VaasaETT

- **Figure 36** shows the average yearly electricity prices paid by households in capital cities in EU Member States and other European countries with typical annual consumption.

Figure 24 –Average household retail electricity prices in European capitals, 2024



Source: VaasaETT

- **Figure 37** shows retail electricity prices for representative household consumers in European capital cities, and their composition divided into four categories (energy, network charges, energy taxes and the value added tax). In 2023, the highest average yearly prices were observed in Ireland, Italy and Germany (471, 415 and 405 €/MWh, respectively). The lowest ones had been observed in Hungary, Malta and Bulgaria (97, 123 and 142 €/MWh).
- In 2024, the energy component share was, in average, of 53% which is a decrease of 6 percentual points compared to 2023. Meanwhile, the network and Tax component increased by 4 and 2 percentual points respectively, while the VAT component remained unchanged.

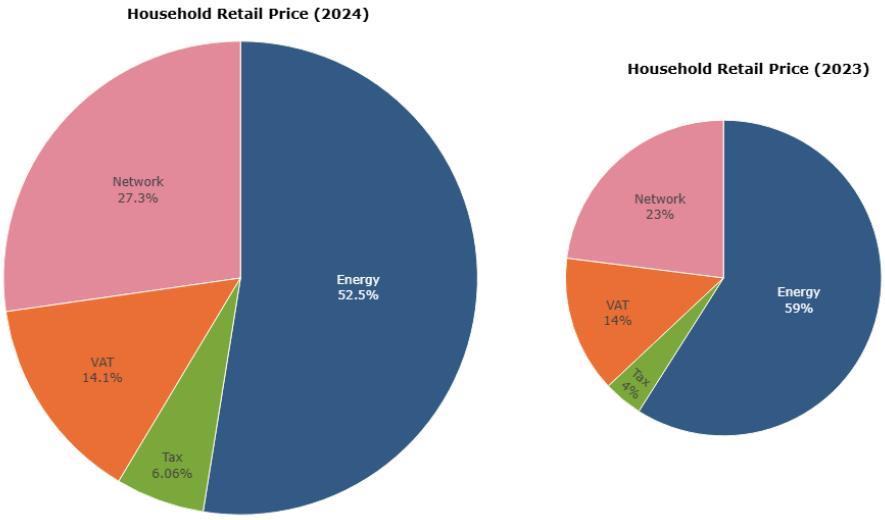
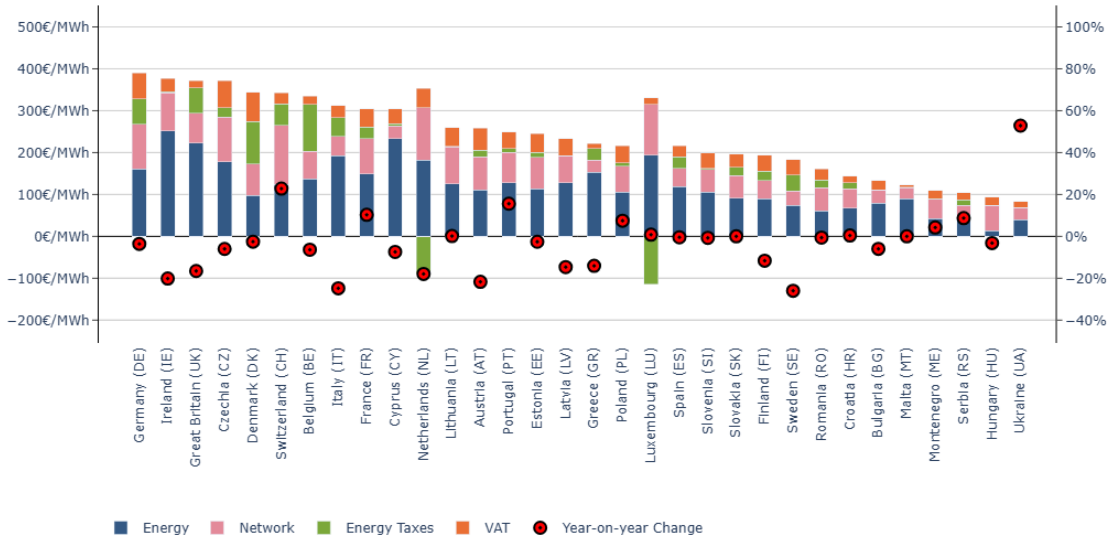


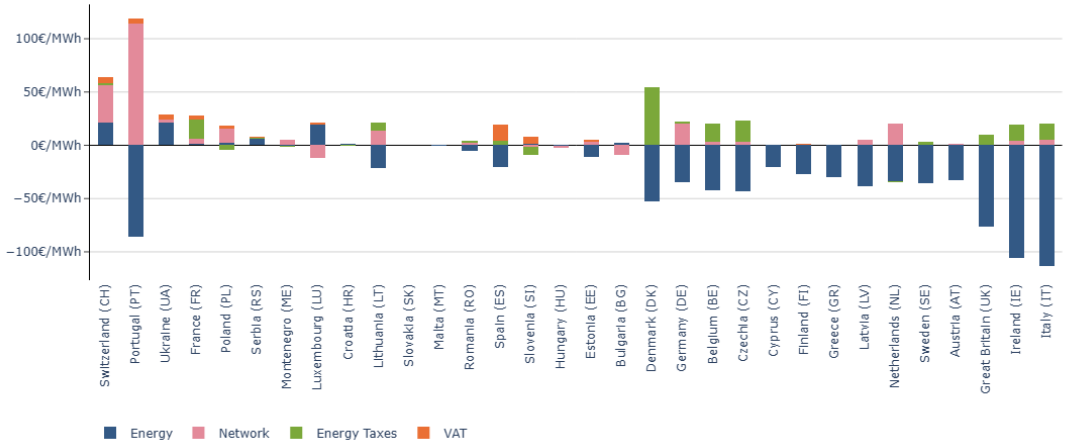
Figure 25 – The Household Energy Price Index (HEPI) in European Countries, 2024



Source: VaasaETT

- Compared to 2023, the largest price decrease in relative terms in the EU in 2024 were observed in Italy (-103 €/MWh), Ireland (-95 €/MWh) and Austria (-72 €/MWh). Portugal, France and Poland registered increases of respectively 33€/MWh, 28€/MWh and 15 €/MWh
- As shown in **Figure 38**, decreasing prices in some EU capitals were driven mostly by lower wholesale prices. Increasing prices in Poland, Portugal and France can be explained by increased network tariffs and energy taxes.

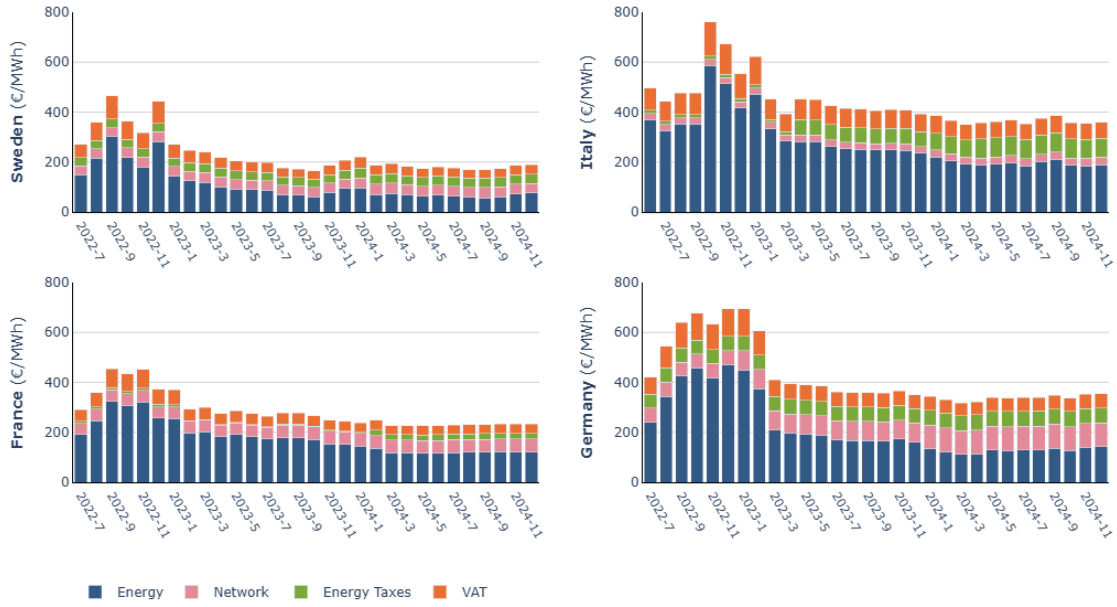
Figure 26 – Year-on-year change in electricity prices by cost components in European Countries comparing 2023 and 2024



Source: VaasaETT

- **Figure 39** shows industrial SMEs (IB Band) electricity prices for selected Member States across the years. End user prices in Italy were at 378 €/MWh, which is more than in Germany (338 €/MWh), France (232 €/MWh) and Sweden (183 €/MWh).

Figure 27 –Industrial retail prices for SMEs in selected EU countries



Source: VaasaETT

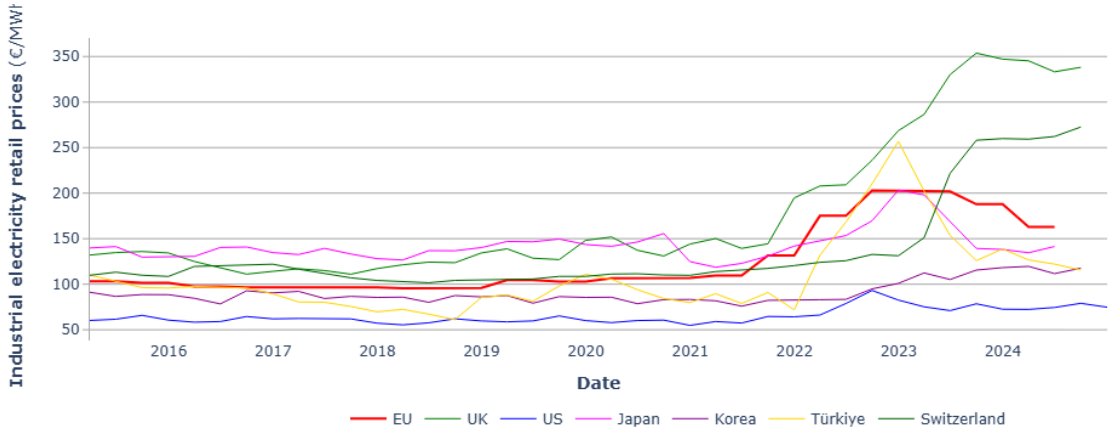
2.4 International comparison of retail electricity prices

- **Figure 40** displays industrial retail prices paid by consumers in the EU[2] and in its major trading partners. According to the latest available data, electricity prices for industrial users in the EU registered a year-on-year decrease in the first half of 2024 compared to the first half of 2023 (-19%), signalling an improvement of electricity prices at industrial level following the impact of the energy crisis. In Q4 2024, the US (+3%) registered a slight year-on-year

[2] The EU average is reported biennially in the Eurostat database. The prices in the quarter reflect electricity non-household retail prices from 1H 2024 for the ID band.

increase in prices, while remaining significantly lower than in the EU. In Q3 2024, the United Kingdom (-4%) registered a year-on-year decrease in prices. Conversely, prices in Korea rose (+2%) but only by a small margin.

Figure 28 – Retail electricity prices paid by industrial customers in the EU and its main trading partners



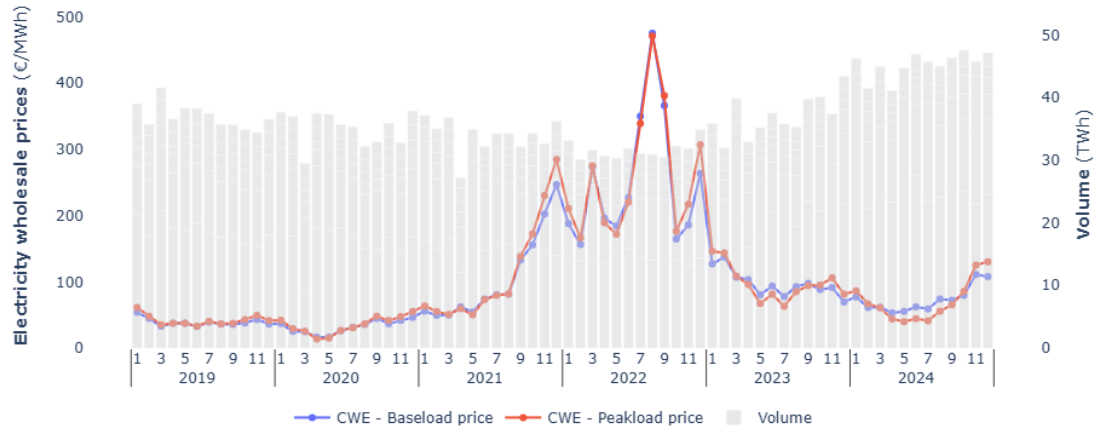
Source: Eurostat, EIA, DESNZ, IEA, DG ENER computations. Industrial prices in the EU are represented by the ID consumption band for the purposes of international comparison.

Annex

Regional wholesale markets

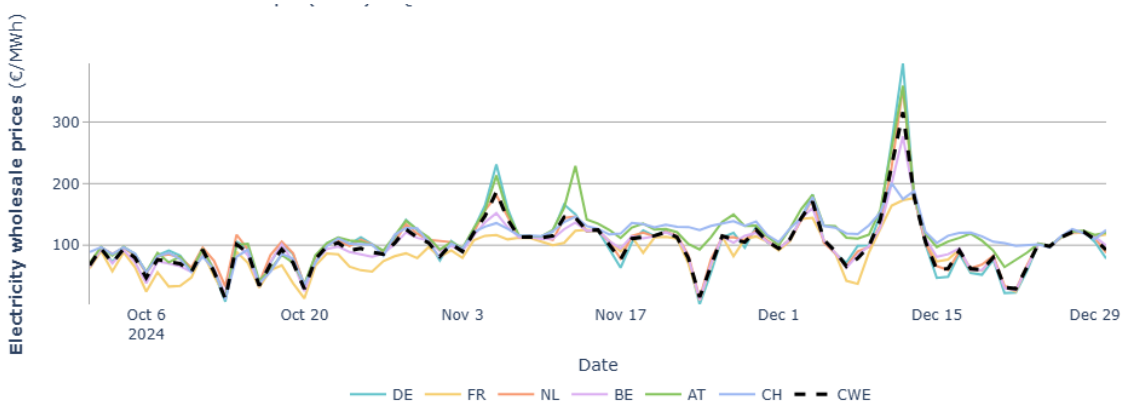
2.5 Central Western Europe (Austria, Belgium, France, Germany, Luxembourg, the Netherlands, Switzerland)

Figure 29 – Monthly exchange traded volumes of day-ahead contracts and monthly average prices in Central Western Europe



Source: S&P Global Platts, ENTSO-E, EPEX.

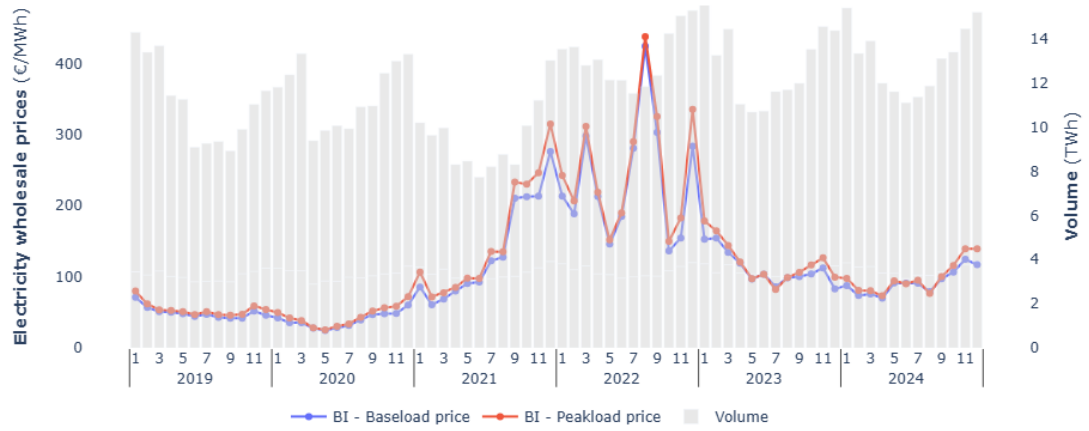
Figure 30 – Daily average power prices on the day-ahead market in the CWE region



Source: S&P Platts, ENTSO-E, EPEX

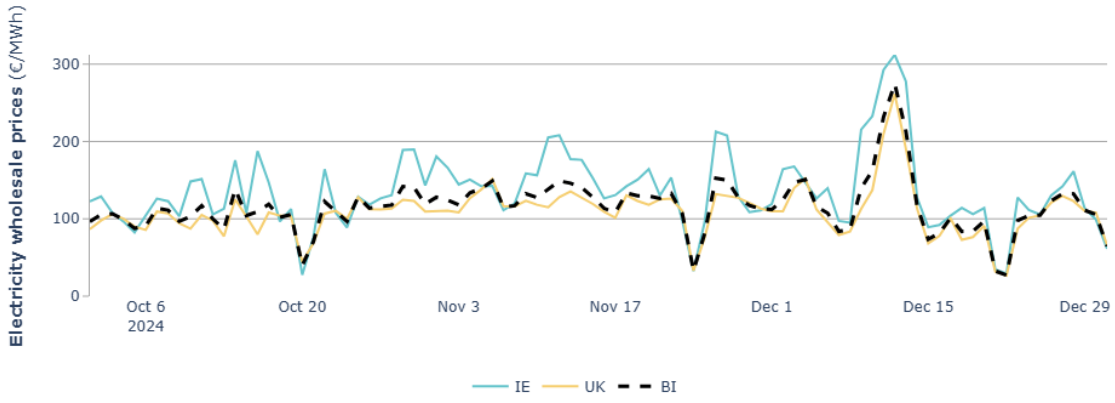
2.6 British Isles (GB, Ireland)

Figure 31 – Monthly exchange traded volumes of day-ahead contracts and monthly average prices in Great Britain and Ireland



Source: Nord Pool N2EX, SEMO, Utility Regulator

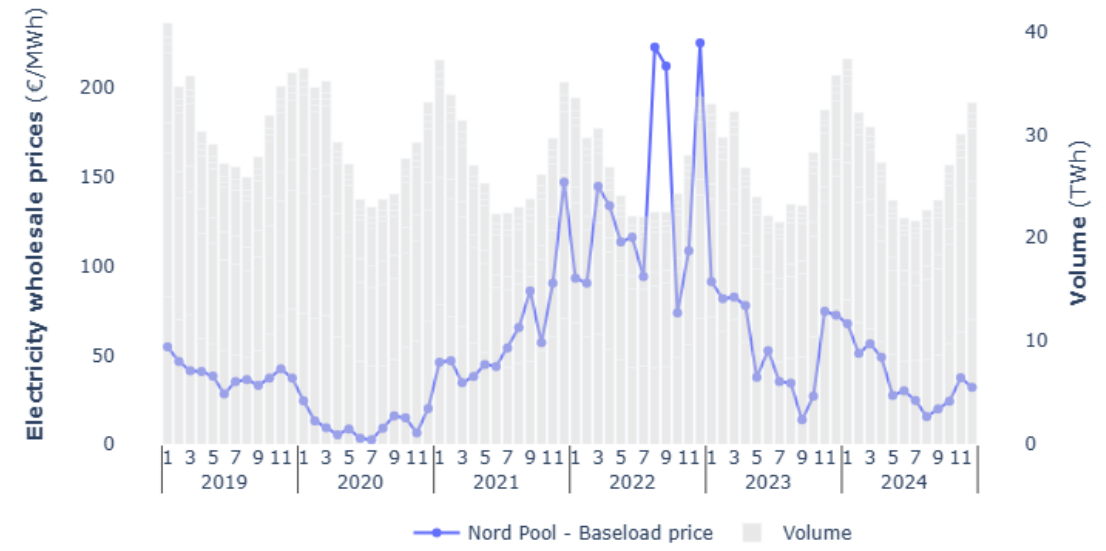
Figure 32 – Daily average electricity prices on the day-ahead market in Great Britain and Ireland



Source: Nord Pool N2EX, SEMO

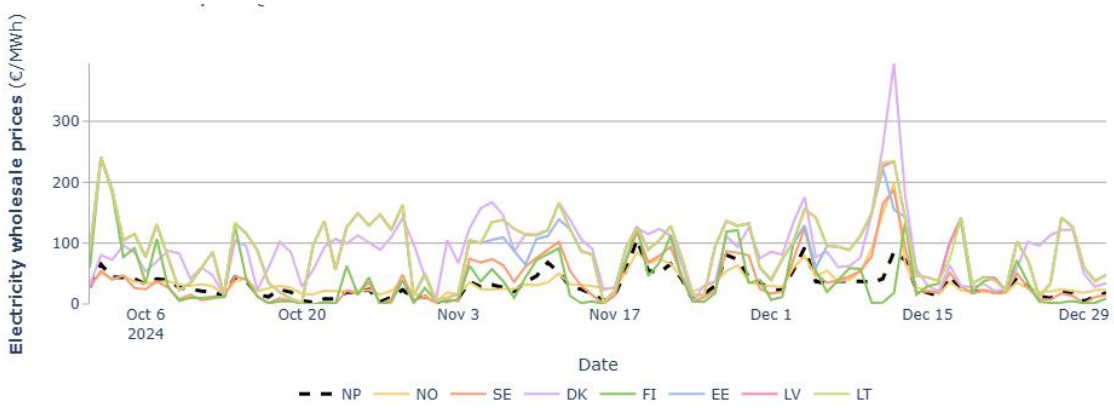
2.7 Northern Europe (Denmark, Estonia, Finland, Latvia, Lithuania, Sweden, Norway)

Figure 33 – Monthly electricity exchange traded volumes and the average day-ahead wholesale prices in Northern Europe



Source: S&P Global Platts, Nord Pool spot market

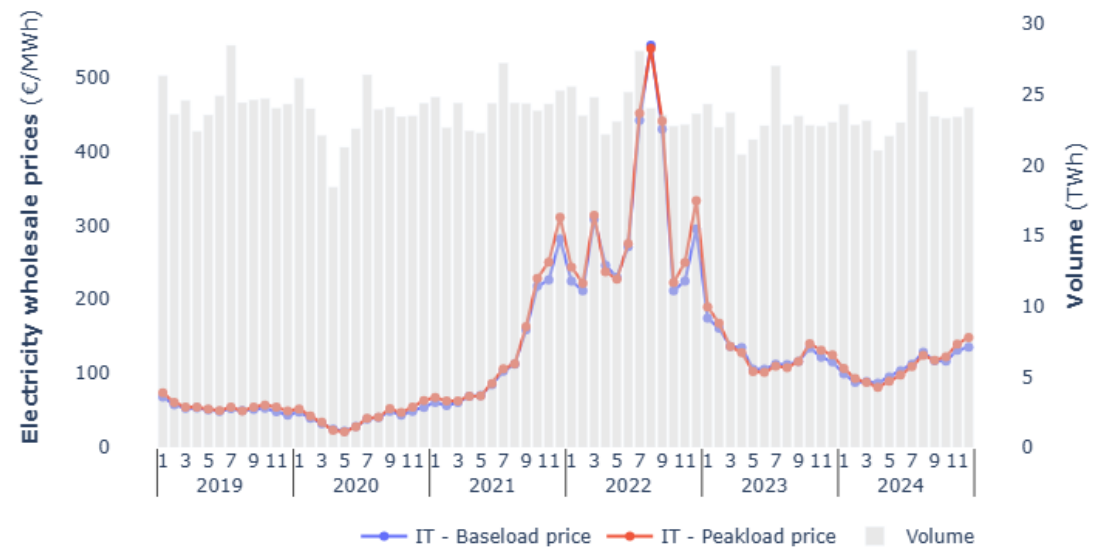
Figure 34 – Daily average regional prices and the system price on the day-ahead market in the Nordic region



Source: S&P Global Platts, Nord Pool spot market

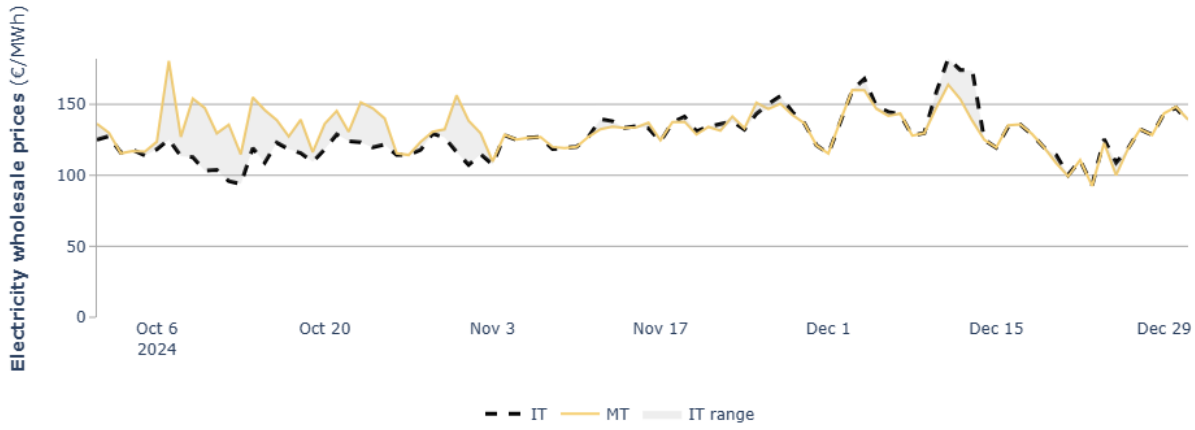
2.8 Apennine Peninsula (Italy, Malta)

Figure 35 – Monthly electricity exchange traded volumes and average day-ahead wholesale prices in Italy



Source: GME (IPEX)

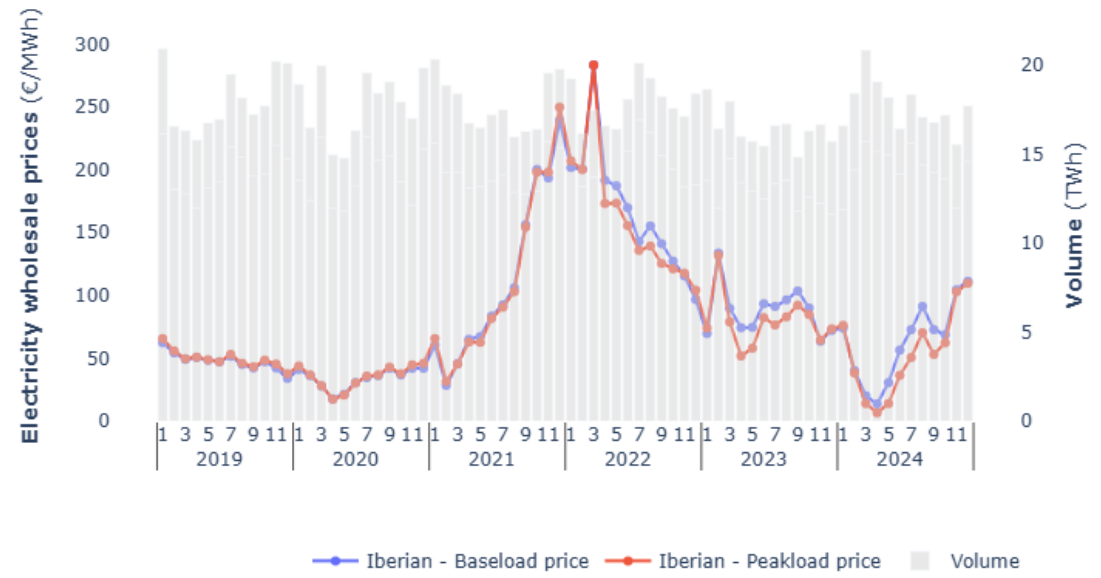
Figure 36 – Daily average electricity prices in the Italian day-ahead market, within the range of different area prices



Source: GME (IPEX)

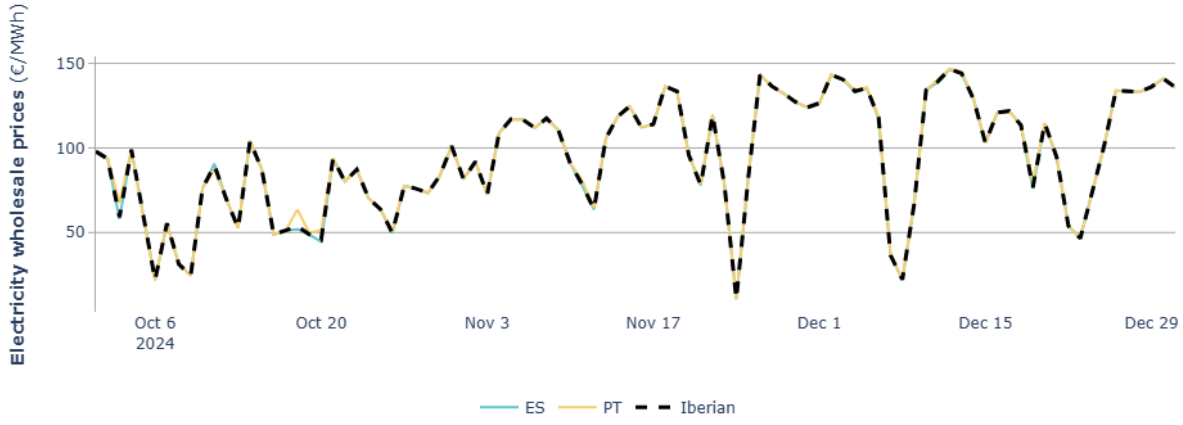
2.9 Iberian Peninsula (Spain and Portugal)

Figure 37 – Monthly electricity exchange traded volumes and average day-ahead prices in the Iberian Peninsula



Source: S&P Global Platts, OMEL, DGEG

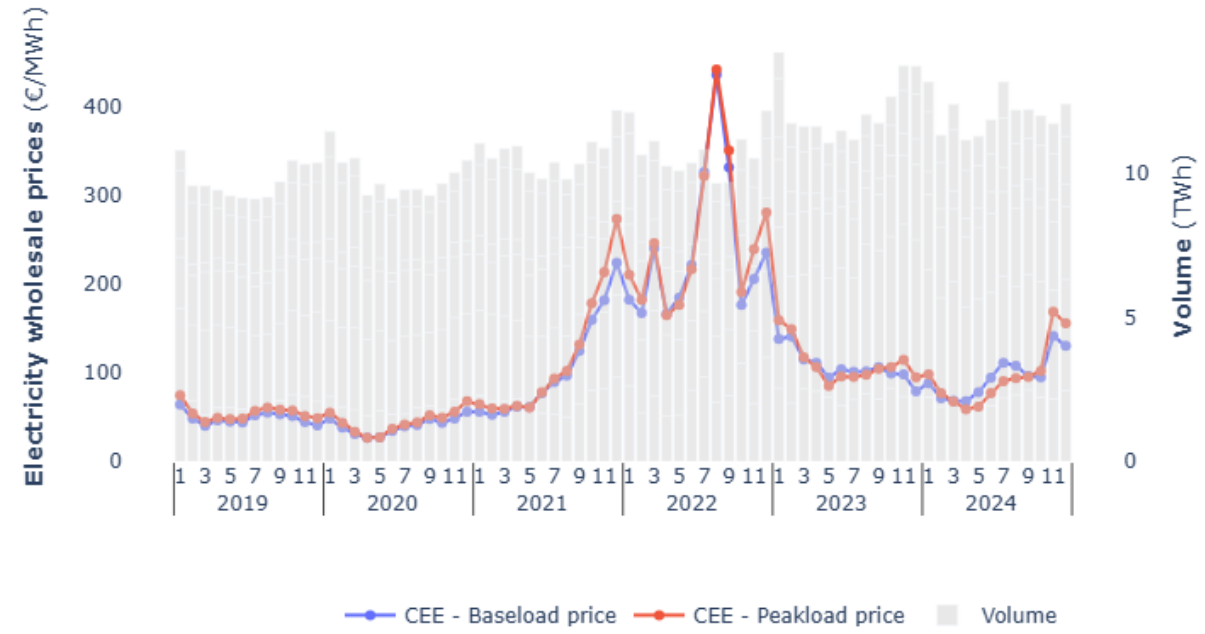
Figure 38 – Daily average electricity prices on the day-ahead market in the Iberian Peninsula



Source: S&P Global Platts, OMEL, DGEG

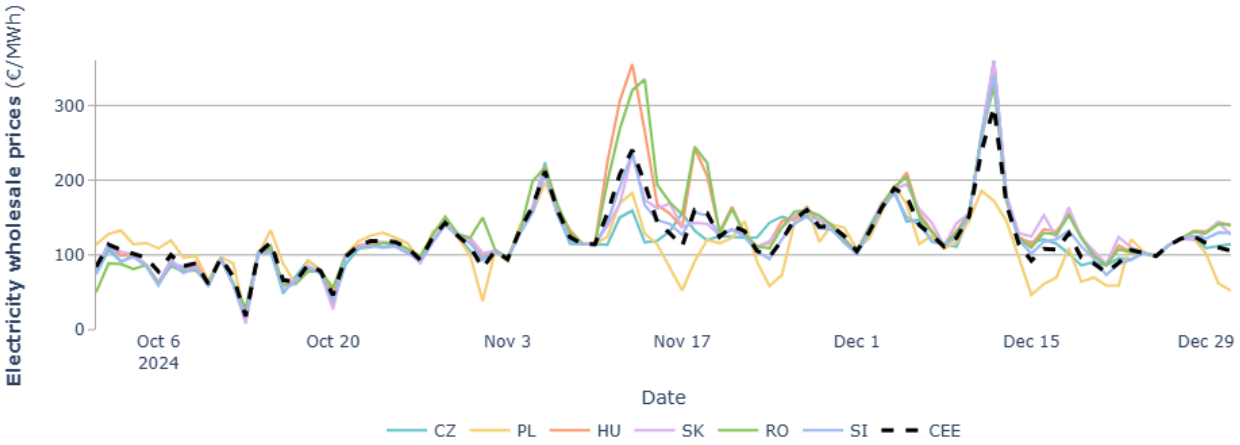
2.10 Central Eastern Europe (Czechia, Hungary, Poland, Romania, Slovakia, Slovenia)

Figure 39 – Monthly electricity exchange traded volumes and average day-ahead prices in Central Eastern Europe (CEE)



Source: Regional power exchanges, Central and Eastern Europe (CEE), CEE: CZ, HU, RO, PL, SK, SI

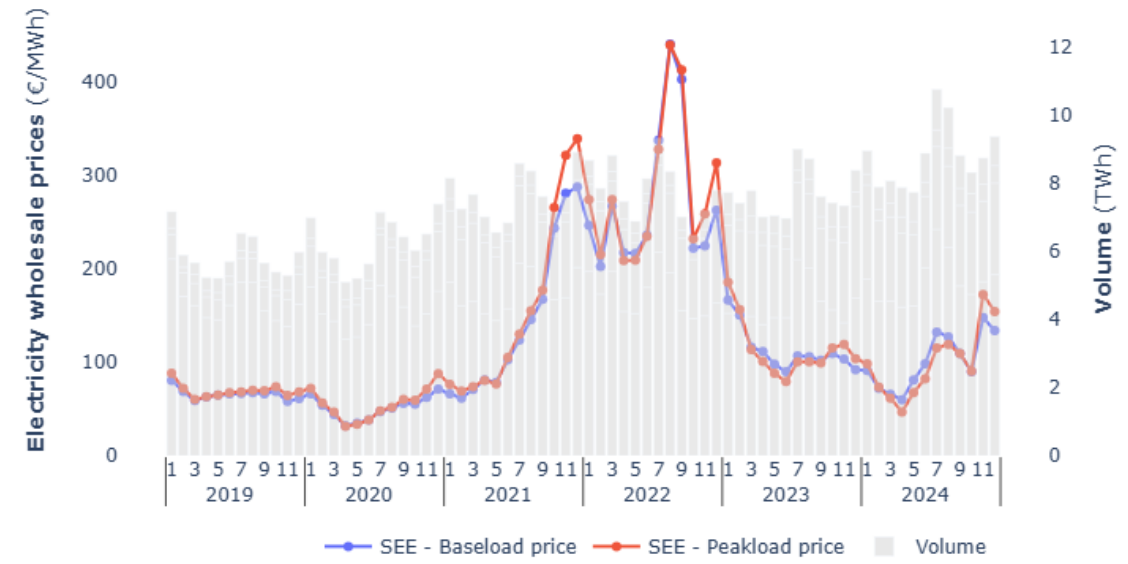
Figure 40 – Daily average power prices on the day-ahead market in the CEE region



Source: Regional power exchanges

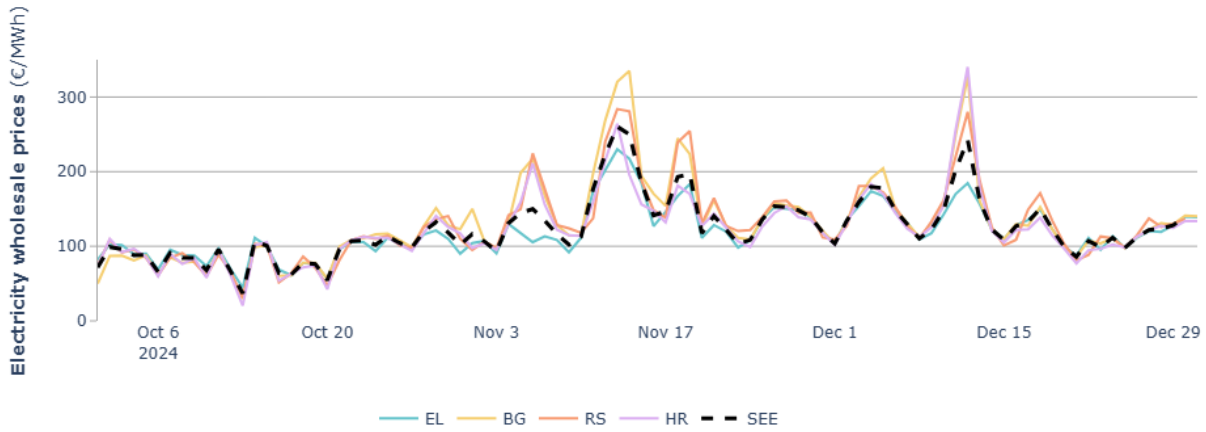
2.11 South-Eastern Europe (Bulgaria, Croatia, Greece and Serbia)

Figure 41 – Monthly traded volumes and baseload prices in South-Eastern Europe (SEE)



Source: ENTSO-E, IBEX, LAGIE, CROPEX, SEEPEX

Figure 42 – Daily average power prices on the day-ahead market in Bulgaria, Croatia, Greece and Serbia



Source: ENTSO-E, IBEX, LAGIE, SEEPEX, CROPEX

2.12 **Electricity generation**

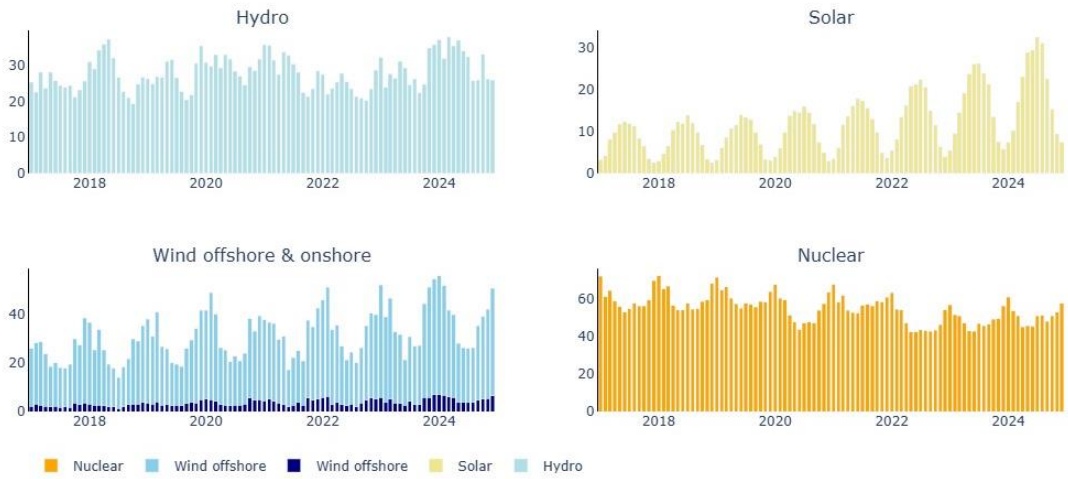
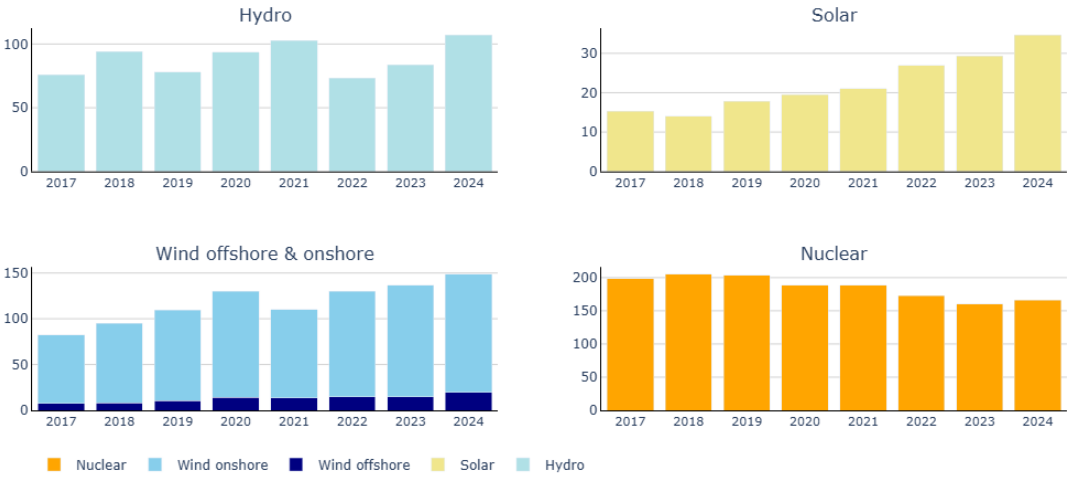


Figure 43 - Monthly renewable generation in the EU (TWh)

Source: ENTSO-E. Data represent net generation

Figure 44 - Yearly renewable generation in the EU (TWh)



Source: ENTSO-E. Data represent net generation

Glossary

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

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.

Emission allowances' spot prices are defined as prices for an allowance traded on the secondary market and with a date of delivery in the nearest December.

European Power Benchmark (EPB9) is a replacement of the former Platt's PEP index discontinued at the end of 2016, computed as weighted average of nine representative European markets' (Belgium, Czechia, France, Italy, Germany, Netherlands, Spain, the United Kingdom and the Nord Pool system price) day-ahead contracts.

EP5 is a consumption-weighted baseload benchmark of five most advanced markets offering a 3-year visibility into the future Markets included in the benchmark are France, Germany, the Netherlands, Spain and Nord Pool. Prices are weighted according to the consumption levels in individual markets. Forward prices are rolled over towards the end of each year, meaning that the year-ahead benchmark in 2021 shows the price for 2022; and the year-ahead curve in 2022, in turn, shows baseload prices for delivery in 2023.

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.

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.

Retail prices paid by households include all taxes, levies, fees and charges. Prices paid by industrial customers exclude VAT and recoverable taxes. Monthly retail electricity prices are estimated by using Harmonised Consumer Price Indices (HICP) based on bi-annual retail energy price data from Eurostat.

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.