

Energy Transition in Poland

2024 Edition

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PUBLICATION DATE:

June 2024

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The mission of Forum Energii is to initiate dialogue, propose knowledge-based solutions, and inspire action for a just and efficient energy transition that leads to climate neutrality.

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Main conclusions

- The year 2023 brought significant changes to Poland's generation mix. For the first time ever, coal's share of power generation fell to 60.5%, which is down as much as 9.9 percentage points (pp) from the previous year.
- It was mainly renewable sources that replaced coal-fired power generation, accounting for a record 27% of generation. Due to the return of lower natural gas prices and higher flexibility, electricity generation from this fuel increased by as much as 41%.
- However, in terms of the carbon footprint of the electricity sector, Poland ranks last in the EU (with a score of 666 g CO₂/kWh against an EU average of 251 g CO₂/kWh).
- The level of capacity reserves remains low, the share of available capacity is falling, and the flexibility of sources is not increasing, so the security of the national power system is not improving.
- Decarbonisation of the electric power industry is progressing, but changes in other sectors of the economy are much slower.
- Wood remains the main renewable source. Other RES account for less than 5% of the energy consumed in Poland. Fossil fuels dominate (87%), which is why the country has the world's third-highest emitting economy (previously seventh).
- Heaps of mined steam coal are growing. Consumption of this raw material fell by 8 million tonnes, while extraction fell by a mere 4 million tonnes. Imports remained at a very high level, down only 2 million tonnes from the record year of 2022.
- Poland still spends a great deal on fuel imports, with PLN 138 billion in 2023 alone. Since 2014, taking inflation into account, it has been PLN 1.2 trillion.
- In 2023, the diversification of supplies of energy resources accelerated significantly. Russia is no longer the main supplier (except for certain fuels like LPG). Despite this, imports are growing, and Poland's dependence on imported raw materials remains high at 43%.
- The country's energy transition has an uneven pace – it is visible in the electricity sector, but not in other sectors. There is no comprehensive strategy for the country's decarbonisation adequate to the scale of the challenge of achieving climate neutrality, while maintaining energy security and the competitiveness of the economy.

Chapter 1.

Energy in Poland



87%

Poland's primary energy comes from fossil fuels (45% coal, 26% oil, 15% gas).



PLN 1.2 trillion

amount of the bill for imports of fossil raw materials and fuels since 2014 (in 2023, PLN 139 billion, of which to Russia PLN 4.7 billion).



4.7%

of the energy consumed in Poland is covered by renewable energy (other than wood).



43%

is Poland's dependence on primary energy imports. This is 15 p.p. more than 10 years earlier.



0%

of natural gas and coal consumed in 2023 came from Russia. In 2014, it was 53% and 9%, respectively.



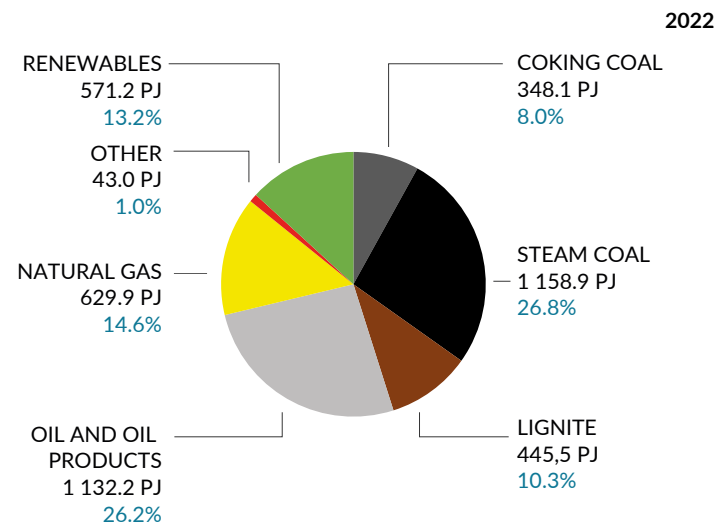
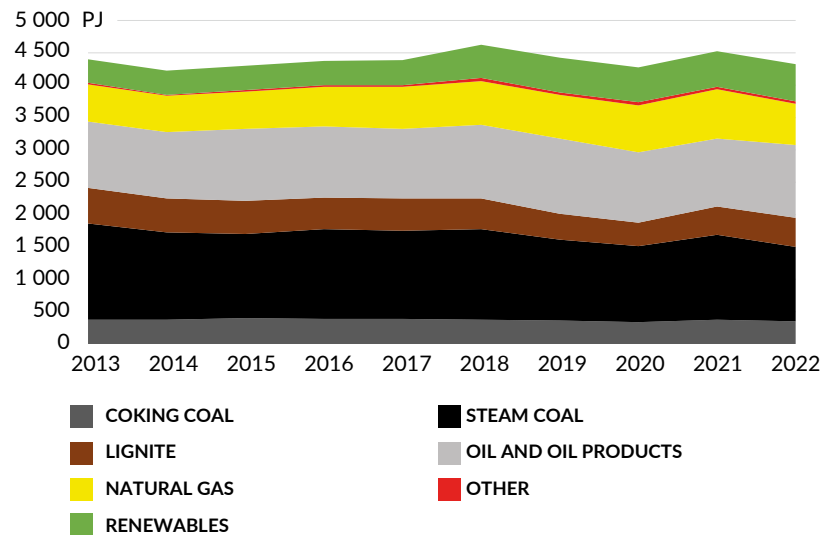
-33%

is how much the consumption of coal has fallen since joining the EU. Over the same period, oil consumption has increased by 47% and natural gas by 30%.

The energy transition has accelerated, and independence from raw material imports from Russia is almost complete. Nevertheless, the energy transition and the shift of the entire economy away from fossil fuels are still barely visible, and dependence on fossil fuel imports is growing. Poland's import bill remains very high.

Structure of primary energy consumption (2022)

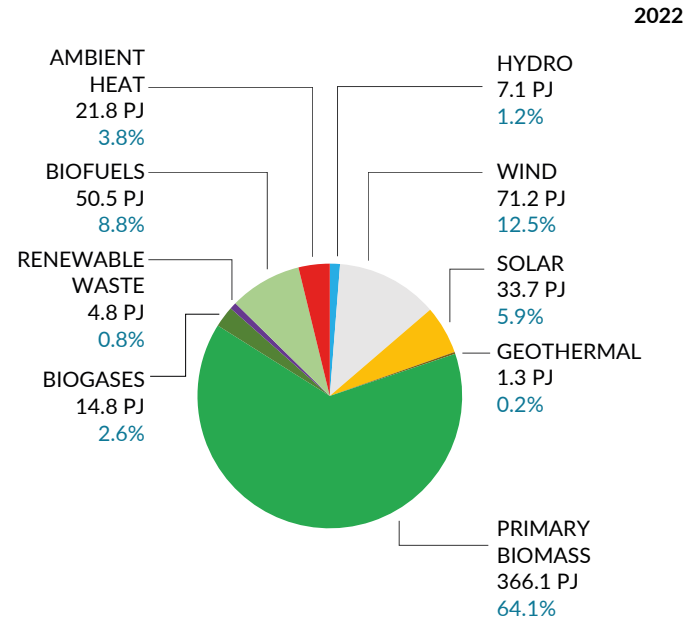
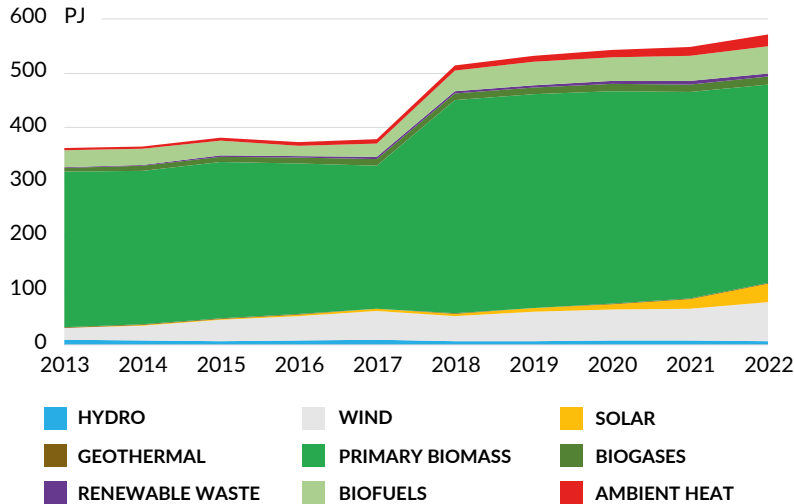
- Consumption of primary energy, i.e., energy obtained directly from natural resources, has remained at a similar level for years (it fell by 1.7% over the last decade).
- However, the structure of consumption is slowly changing – a smaller and smaller share is accounted for by coal (-10 p.p. over the decade), and an increasing share by RES (+5 p.p.).
- At the same time, in 2022, 86.8% of primary energy consumption in Poland was covered by fossil fuels, 45% of which was coal.



Source: own elaboration based on Eurostat data.

Structure of renewable primary energy consumption (2022)

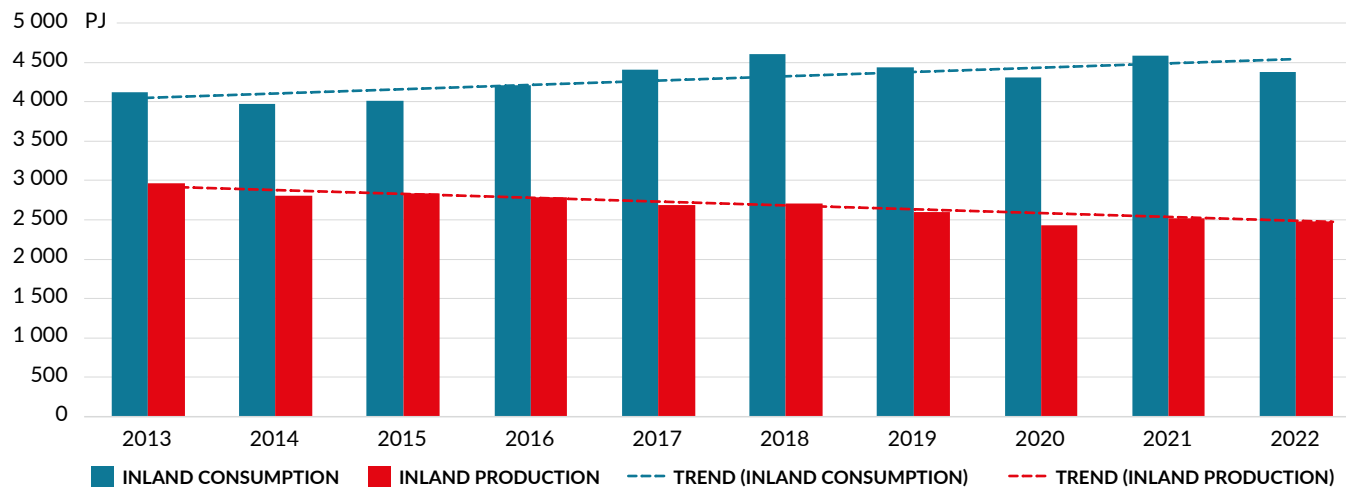
- Renewable sources accounted for 13.2% of primary energy consumed in 2022 (used in all sectors of the economy). The vast majority (nearly 2/3) was primary biomass, namely wood.
- Although the use of wind, solar and ambient energy (including via heat pumps) has clearly accelerated over the past decade, these sources still account for less than 3% of primary energy consumption.



Source: own elaboration based on Eurostat data.

Import wedge – demand and supply of total energy (2022)

- Although primary energy consumption has remained at a similar level for years (or is declining gently), total energy consumption in the Polish economy is increasing. This is due to imports of processed products, such as fuels (diesel, LPG).
- Over the 2013-2022 period, domestic energy consumption increased by 6.3% (258 PJ), with a 16.1% decrease in supply (-477 PJ). The decrease was mainly due to the decline in the mining of energy resources and the too-slow development of RES, which is unable to replace the losses in obtaining coal, among other things.
- This results in the growing dependence of the Polish economy on energy imports from abroad.

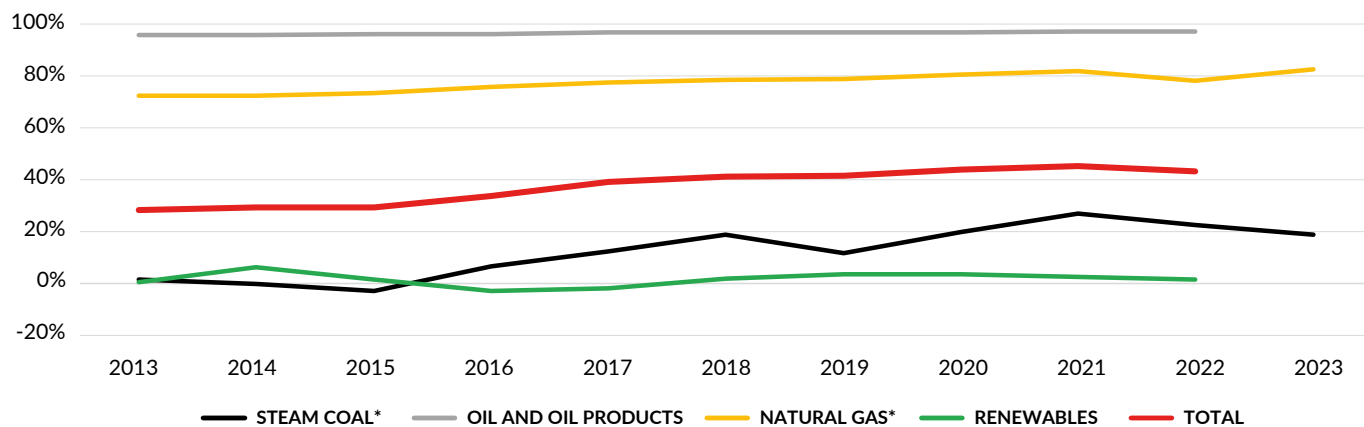


Source: own elaboration based on Eurostat data.

Primary energy comes directly from fossil fuels (natural gas, coal, oil), while total energy also takes into account processed energy carriers such as electricity, gasoline, etc.

Poland's import dependence

- Import dependence is the ratio of imported energy to energy consumed domestically.
- The Polish economy's dependence on energy imports increased from 28% to 43% between 2013 and 2022.
- For years, the largest import dependency was for oil. As much as 96-97% of the oil consumed in Poland comes from abroad.
- In 2023, the estimated import dependence on natural gas was 83%, which is 5 p.p. more than 2022 and 11 p.p. more than 10 years ago.
- Steam hard coal imports in 2023 covered 19% of domestic consumption. The decrease in the ratio compared to 2022 is due to the fact that while domestic output was falling, the rate of decline in coal consumption was even faster. However, over the decade, dependence on imported steam coal increased by 19 p.p.
- Dependence on renewable energy imports (mainly biofuels and biomass) hovers around zero.

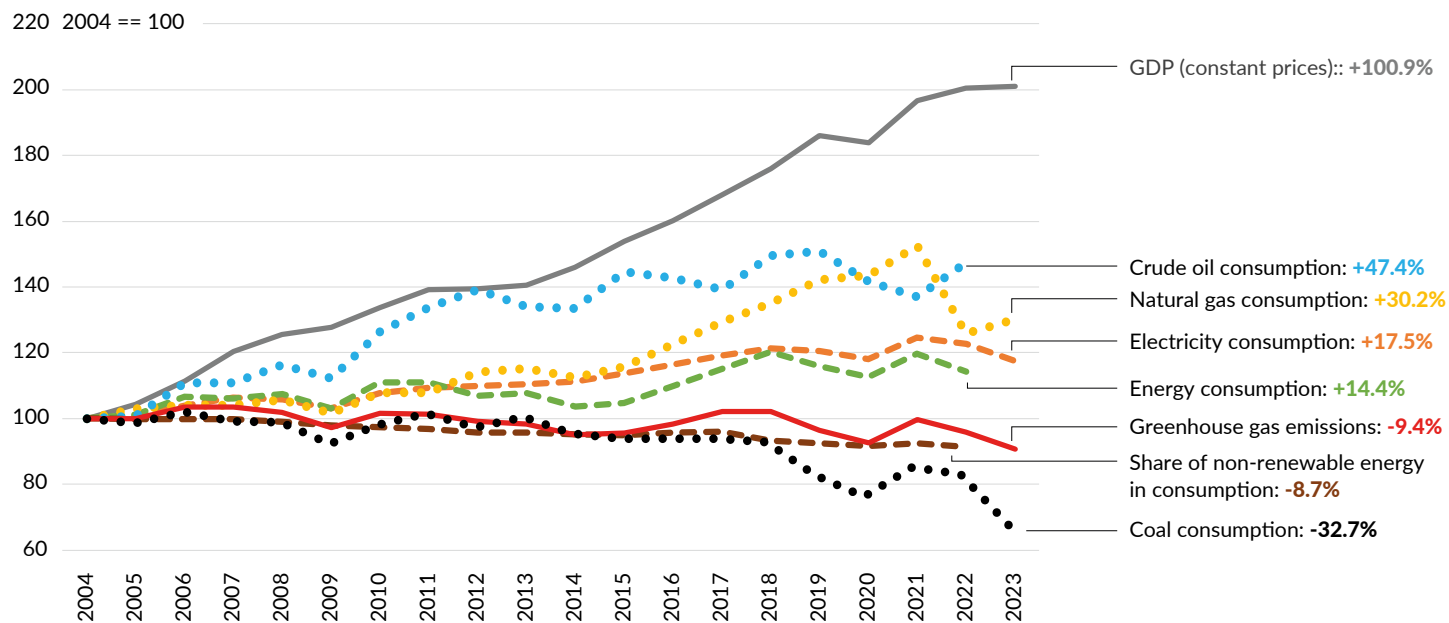


Source: own elaboration based on ARE, GUS, ARP, ENTSOG and Eurostat data.

* Estimated values for 2023. For the purposes of the estimates for hard coal, heating values unchanged from 2022 were assumed.

Energy transition indicators in 2023 (since 2004)

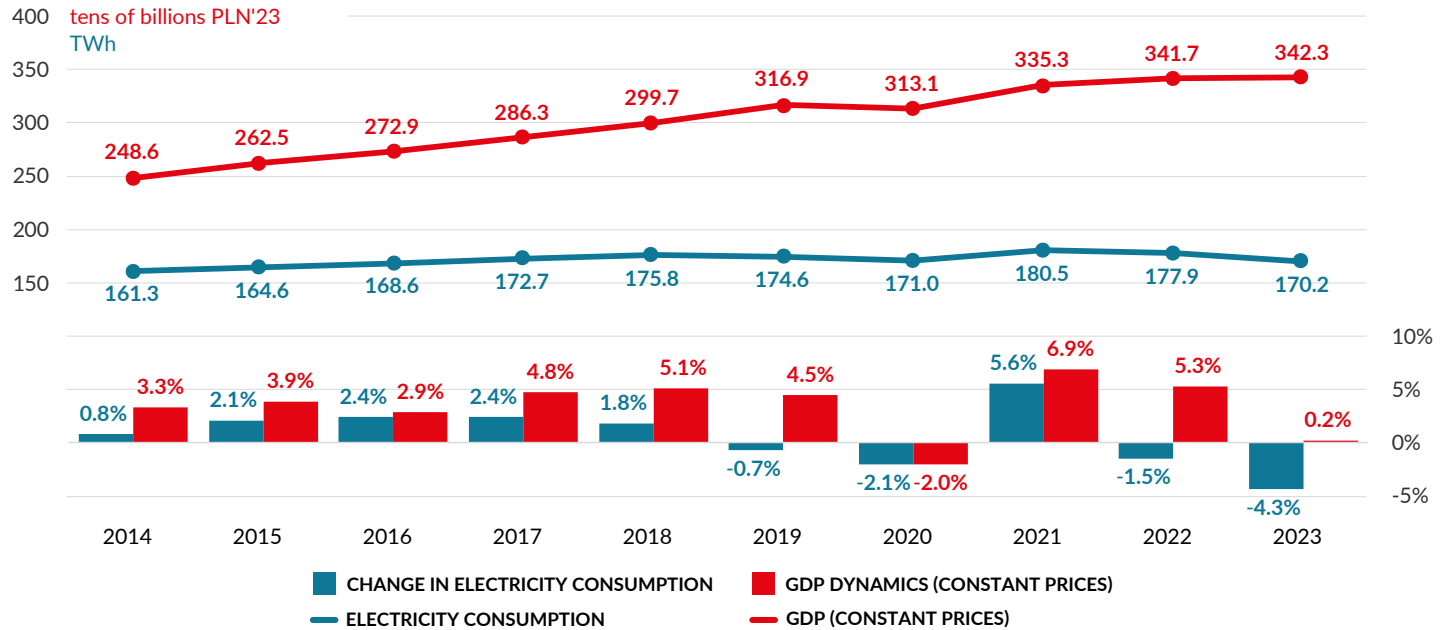
- Poland has achieved the third-highest GDP growth since 2004 (behind Ireland and Malta).
- The consumption of energy and fuels (especially for transport) in the Polish economy continues to grow, but the role of coal is clearly declining. Combined with an increase in the use of RES, Poland is beginning to reduce greenhouse gas emissions.



Source: own elaboration based on ARE, GUS, EEA, ARP, ENTSOG, KOBiZE and Eurostat data.

Change in electricity demand vs. GDP

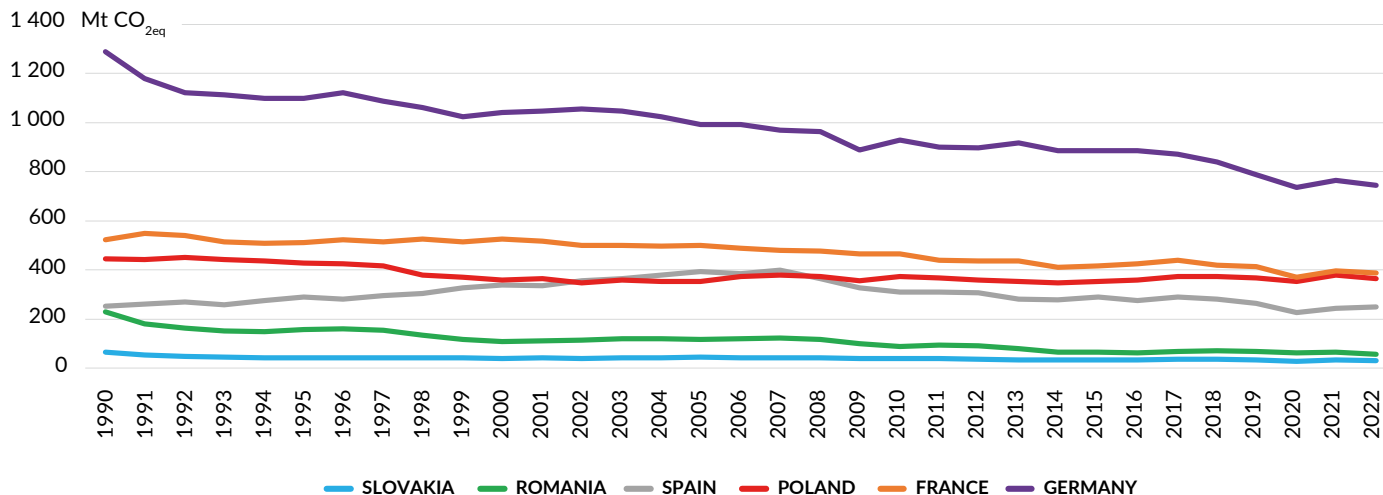
- Economic growth has always been correlated with an increase in demand for electricity. However, this has changed in recent years.
- Despite the large cumulative increase in Poland's GDP (by 37.7% at constant prices) over the decade, demand for electricity grew by only 5.5% during this period.



Source: own elaboration based on ARE and GUS data.

Change in greenhouse gas emissions compared to other EU countries (2022)

- Since 1990, net reductions in greenhouse gas emissions in Poland have amounted to 18.3% (32.5% in the EU as a whole). However, they have increased by 3.2% since 2005 (the year the ETS was launched). According to estimates, the first declines in Poland's emissions appear in 2023, but no official figures for that year have been provided.
- Among countries that emitted more than 50 million tonnes of CO_{2eq} in 1990, Romania (-75.1%) and Slovakia (-53.7%) are the leaders of the reduction.
- If the current trend continues, in the coming years Poland will have higher emissions than France, whose economy is four times larger than Poland's.

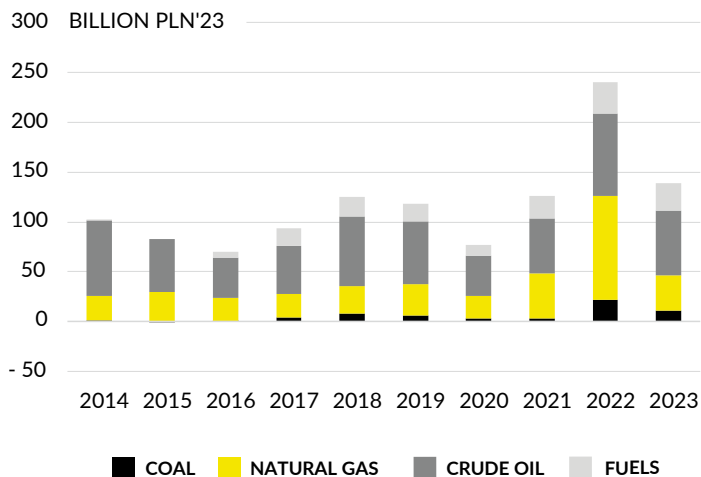


Source: own elaboration based on EEA data.

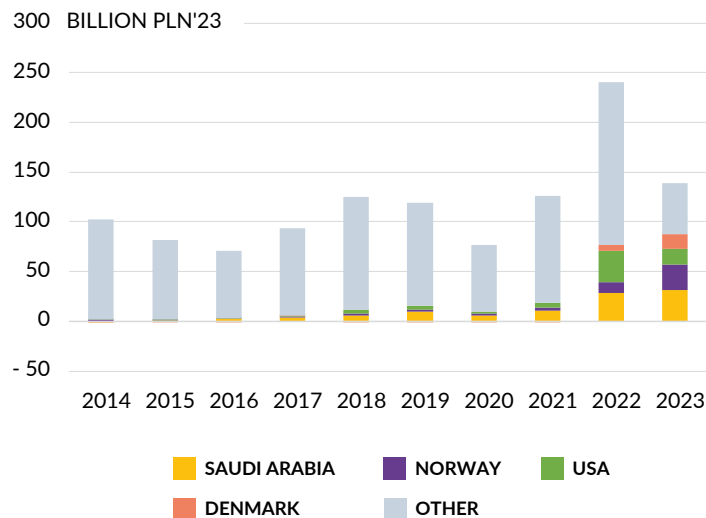
The cost of importing fuels and raw energy materials

- In 2023, the value of energy and fuel imports to Poland was an estimated PLN 139 billion. In 2022, after accounting for inflation, it was the equivalent of PLN 241 billion, and in 2014 the equivalent of PLN 102 billion.
- Nearly half of this amount (46%) was oil imports (PLN 64 billion), 26% natural gas (PLN 36 billion), and 8% coal (PLN 11 billion).
- After eliminating fuel supplies from Russia, Saudi Arabia became the biggest beneficiary of Poland's import dependence. In 2023, it earned PLN 31.5 billion from supplies to Poland. Second place went to Norway and third to Denmark.

COST OF NET IMPORTS, BY RAW MATERIAL AND FUEL

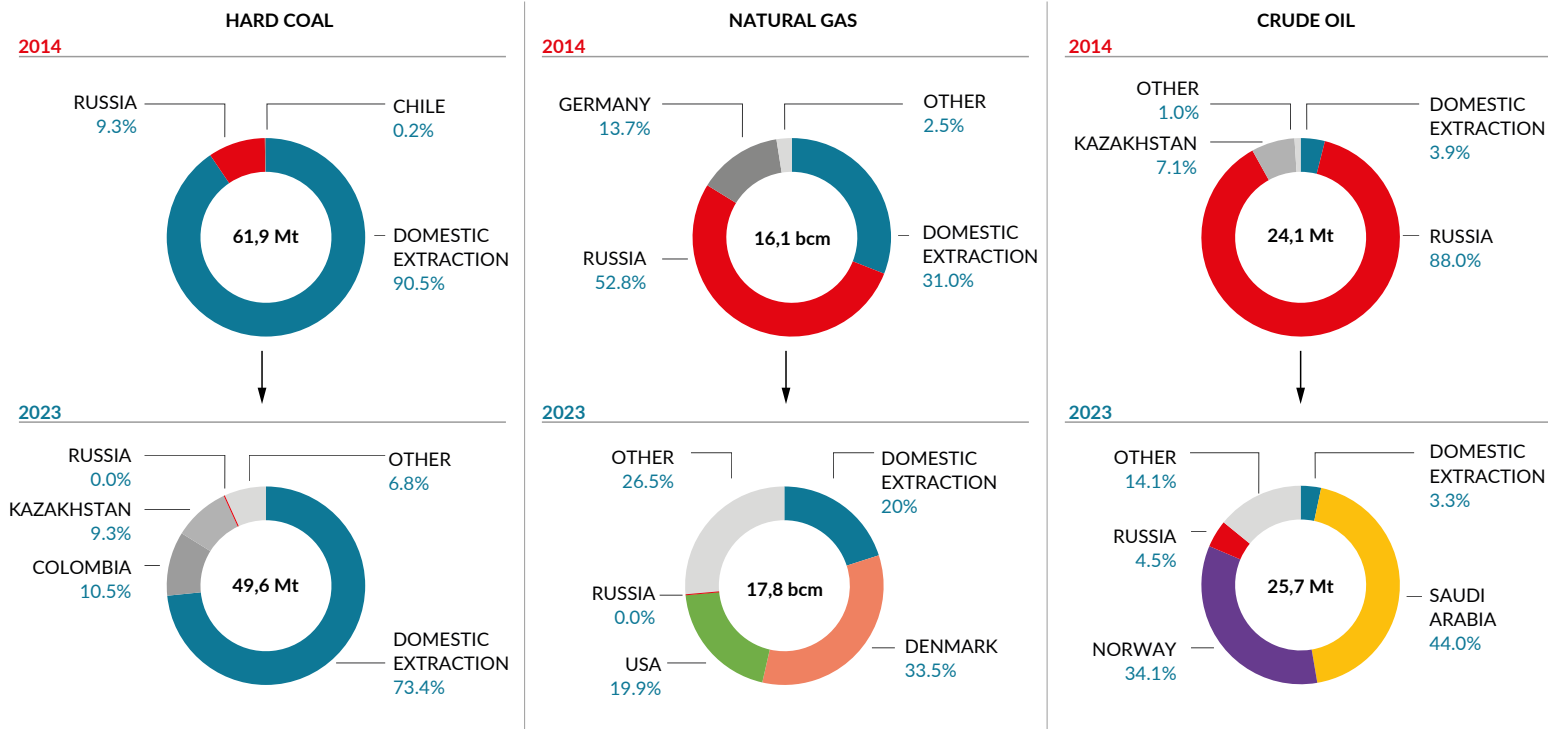


COST OF NET IMPORTS, BY PARTNER COUNTRY



Source: own elaboration based on GUS, Eurostat and NBP data.

Diversification of energy sources in the last decade



Source: own elaboration based on GUS, ARP and ENTSOG data.

Extraction by a Polish company outside the country (e.g., on the Norwegian shelf) is not domestic extraction.

The values in the centre are the sum of net imports and domestic output. If net imports were negative, they are not shown on the graph, but are included in the value shown inside the donut.

Chapter 2.

National Power System



27.1%

was the share of RES in Poland's electricity production. Coal's share is 60.5% – 9.9 p.p. lower than in 2022.



3.74 TWh

was the net import of electricity. After last year's exception, Poland returned to the role of importer due to higher electricity production costs.



4.1%

of domestic electricity production was fed into the grid by prosumers. Estimated self-consumption is 1.4% of domestic consumption.



-20%

was the amount of reduction in coal-fired generation, with a 41% increase in gas-fired generation due to, among others, the higher flexibility needed with a higher share of RES.



74.4 GWh

was the estimated amount of reduction in electricity production from RES. This is equivalent to the annual consumption of about 30,000 households or the production of about 1,600 tonnes of green hydrogen.



1.4 GW

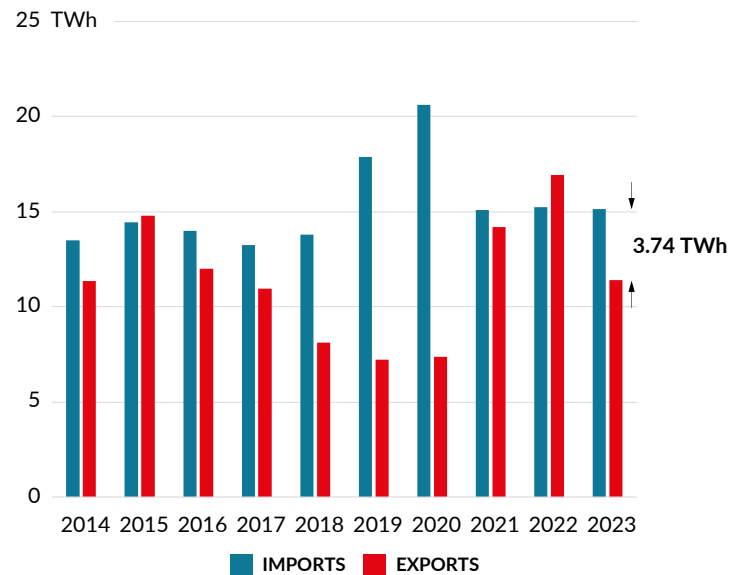
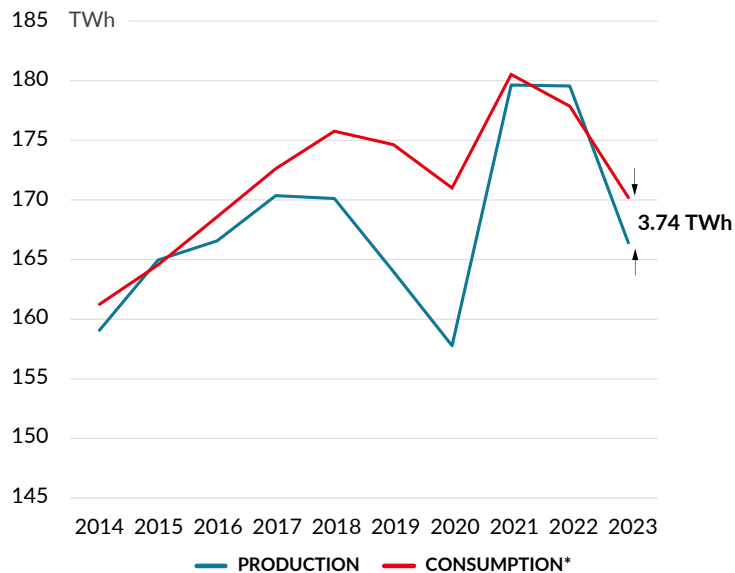
was the minimum reserve of power in the NPS. This means there was no improvement over the previous year, which was the lowest recorded reserve in seven years.

The rapid growth of RES (average annual and hourly), driven largely by prosumers, leaves less and less market space for coal-fired capacity. Because of RES inflexibility, the amount of curtailed electricity generation is growing dynamically. At the same time, dispatchable capacity is declining, raising the risk of system imbalances. The role of new sources of demand is growing, although sales of heat pumps have slowed.

National balance

Balance of domestic electricity production and consumption

- Electricity consumption in Poland has begun to decline in recent years. In 2023, it stood at 166.4 TWh. However, its domestic production is falling even faster.
- During the energy crisis, Poland briefly became a net exporter of electricity. However, in 2023 it returned to the role of a net importer, at 3.74 TWh (imports of 15.14 TWh, exports of 11.40 TWh). The main reason was lower electricity prices in neighbouring countries after the effects of the gas price surge in 2022 expired.
- Electricity imports remain at levels similar to both the last two years and a decade ago.

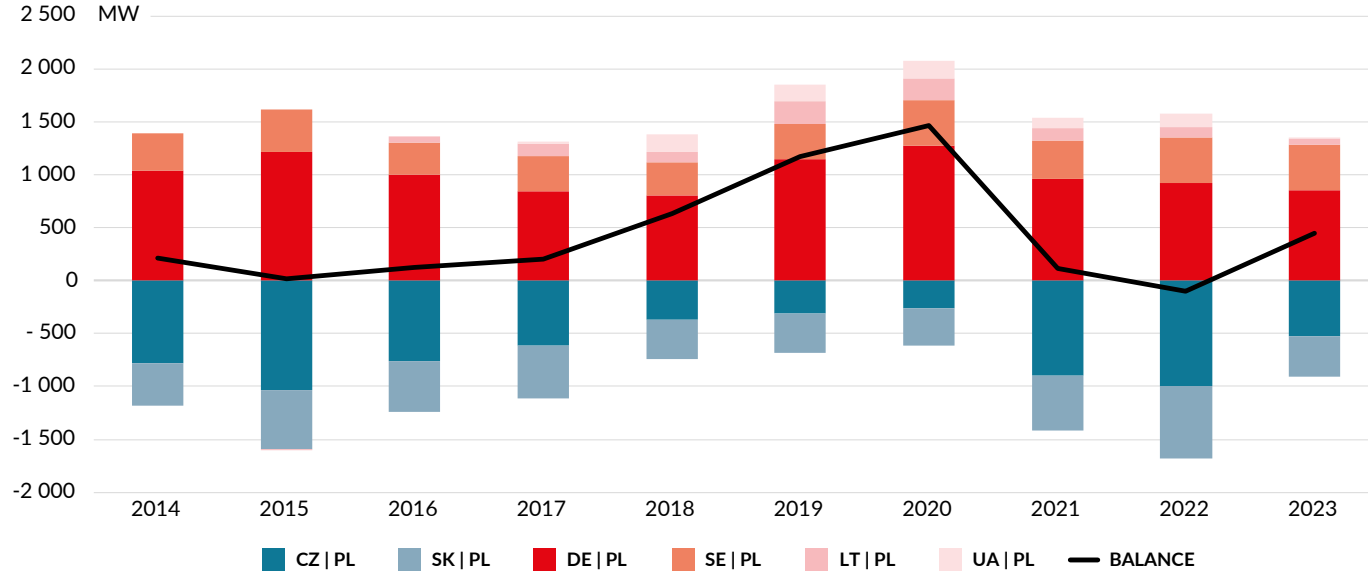


Source: own elaboration based on ARE data.

* Gross consumption (including power plants' own needs) is shown.

Average cross-border electricity exchange capacity

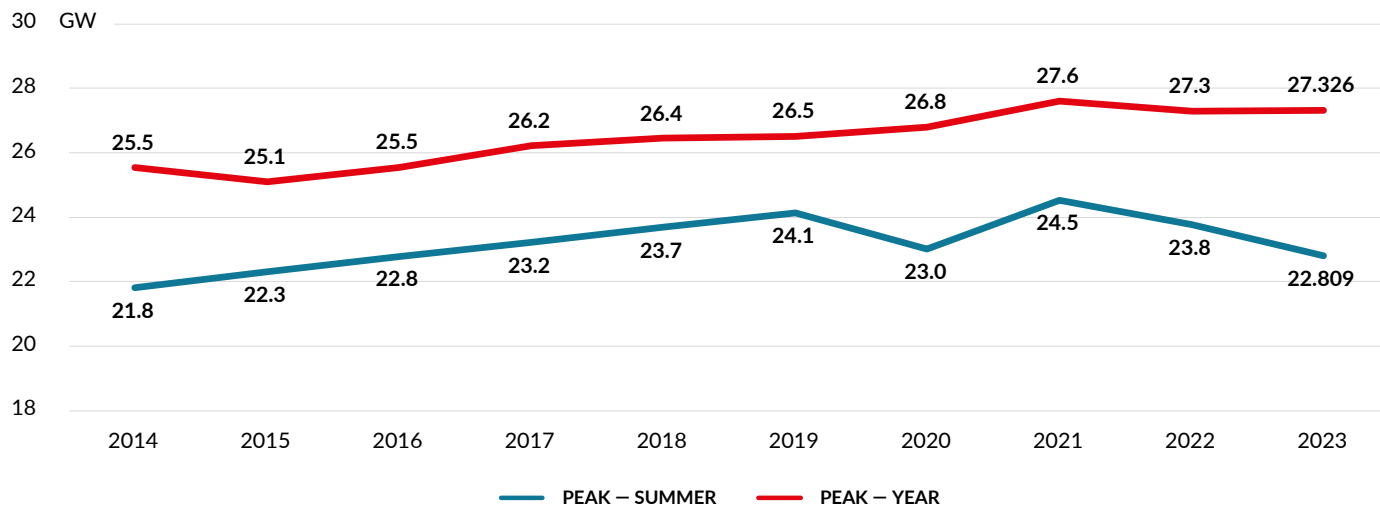
- For years, Poland has been importing electricity mainly from Germany and Sweden, while exporting south to Czechia and Slovakia.
- Through DC links (with Sweden and Lithuania), an average of 400-600 MW has been imported for years.
- The annual average import capacity in 2023 was 443 MW, equivalent to the continuous operation of two 200 MW units.
- The highest average capacity of electricity imports in recent years was observed in 2020 and amounted to 1,466 MW. This value is equivalent to the operation of about 1.5 times the newest unit of the Koźienice Power Plant.



Source: own elaboration based on ENTSO-E data.

Change in peak power demand

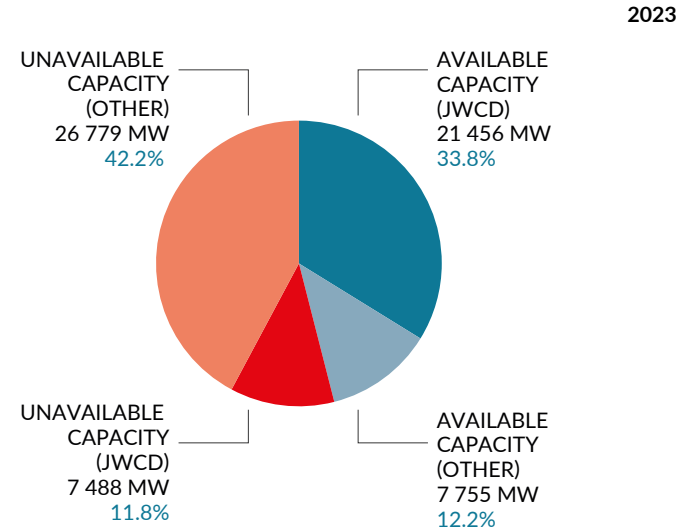
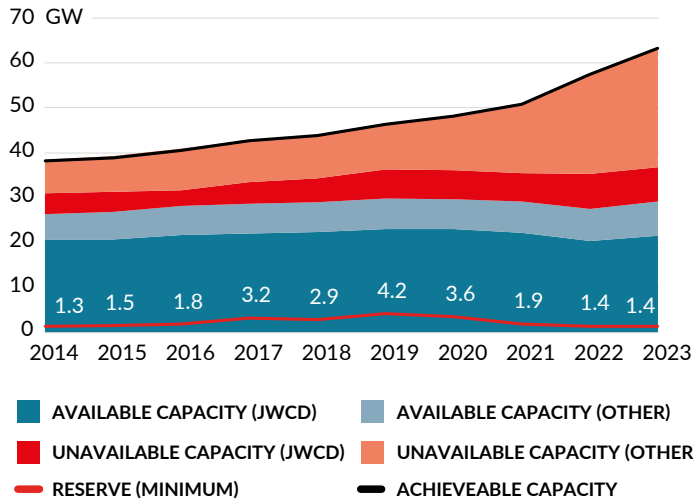
- Winter power demand in 2023 was 27.3 GW – only 30 MW more than in 2022. In contrast, summer power demand is declining for another year in a row, to 22.8 GW (down 1 GW from 2022).
- The lack of growth in peak demand in winter, despite the increase in heat pumps and electric cars, can be explained in part by consumers saving electricity and a warming climate.
- The reason for the decrease in demand in summer, despite the steady increase in the number of air conditioners, is the development of domestic photovoltaics, followed by the growing self-consumption of prosumers.
- The values shown in the chart are the sum of PSE's measured power demand and the operator's estimated self-consumption. Peak power consumption can therefore be higher, especially in summer, if prosumer consumption is underestimated.



Source: own elaboration based on PSE data.

Reserve and unavailable capacity

- At the end of 2023, the system's available capacity increased to 65.2 GW. On average, it amounted to 63.1 GW.
- The level of power reserves in Poland is low. In 2022, it amounted to 1.4 GW, indicating no improvement from the record low in 2022.
- On average, unavailable capacity accounted for 54% of the achievable capacity – 11.8% was unavailable centrally dispatched generation units (JWCDS), while the remaining 42.2% was unavailable non-JWCDS and non-working RES.
- The average annual available capacity of non-JWCDS was 21.5 GW, up 1 GW from 2022. This is largely due to the stable operation of the repaired supercritical unit in Jaworzno (910 MW).
- The share of JWCDS' available capacity (in achievable capacity in Poland) fell from 54% in 2014 to just under 34% in 2023.



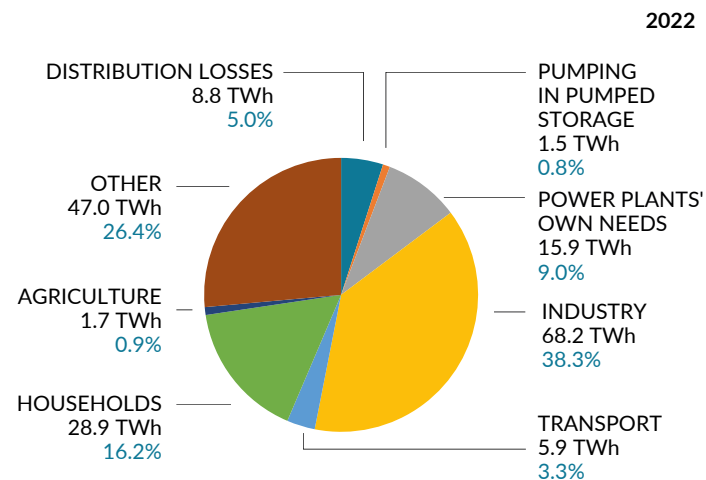
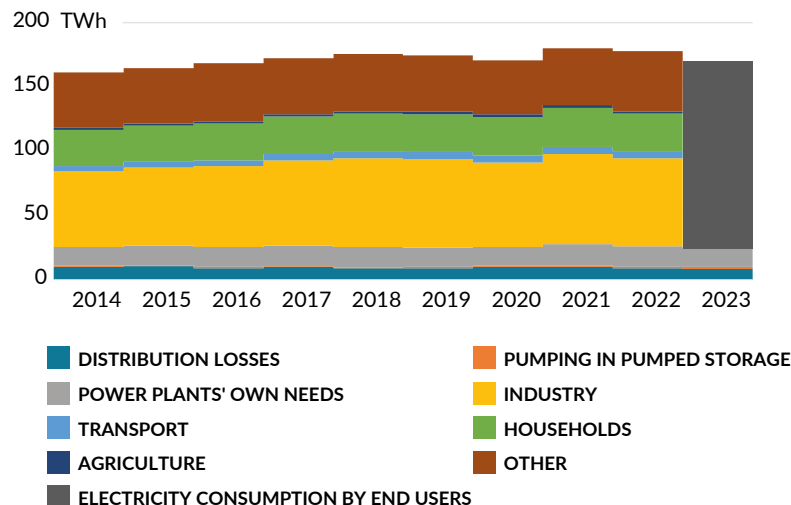
Source: own elaboration based on PSE data.

JWCDS - centrally dispatched generation units (power plants directly controlled by the transmission grid operator - PSE).

The nJWCD units can be disposed of by the operator to a limited extent.

Structure of electricity consumption

- Gross electricity consumption amounted in 2023 to 170.2 TWh. End-user consumption accounted for 85.7% (145.9 TWh), and the remaining 14.3% (24.3 TWh) included consumption for CHPs' and power plants' own needs, as well as losses in transmission and distribution networks.
- Pumped storage power plants required 1.9 TWh of electricity in 2023 – that's 1.1% of gross domestic consumption. These units produced 1.3 TWh, so the efficiency of this energy storage type was 71.6%.
- In 2022 (the latest data), the largest end-user of electricity was industry (68 TWh). Households consumed 29 TWh.
- The dominance of production from coal results in high consumption for power plants' own needs – it accounts for 9% of Poland's gross consumption.

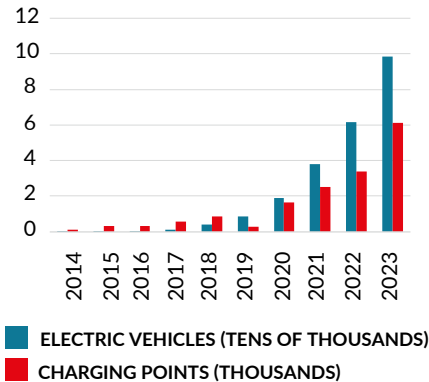


Source: own elaboration based on ARE and GUS data.

Electricity consumption – demand increasing factors

- The increase in electricity consumption (related to the electrification of sectors) will, on the one hand, put increasing pressure on the electric power system, but, on the other hand, will reduce total energy consumption across the economy due to higher efficiency.
- In 2023, sales of heat pumps were lower than in the record year of 2022, at more than 124,000 units. At the end of 2023, there were about 657,000 of them. 37,000 electric cars (BEVs and PHEVs) also arrived, totaling more than 98,000 at the end of 2023.
- According to Forum Energii estimates, the share of air-conditioned household space is also growing. In 2021, it amounted to about 1.8%, while in 2012, less than 0.5% of household space was air-conditioned.

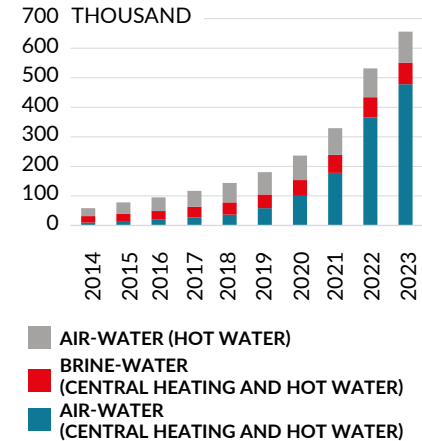
NUMBER OF EVS AND CHARGING POINTS



ESTIMATED SHARE OF AIR-CONDITIONED HOUSEHOLD SPACE*



CUMULATIVE NUMBER OF SOLD HEAT PUMPS SINCE 2010

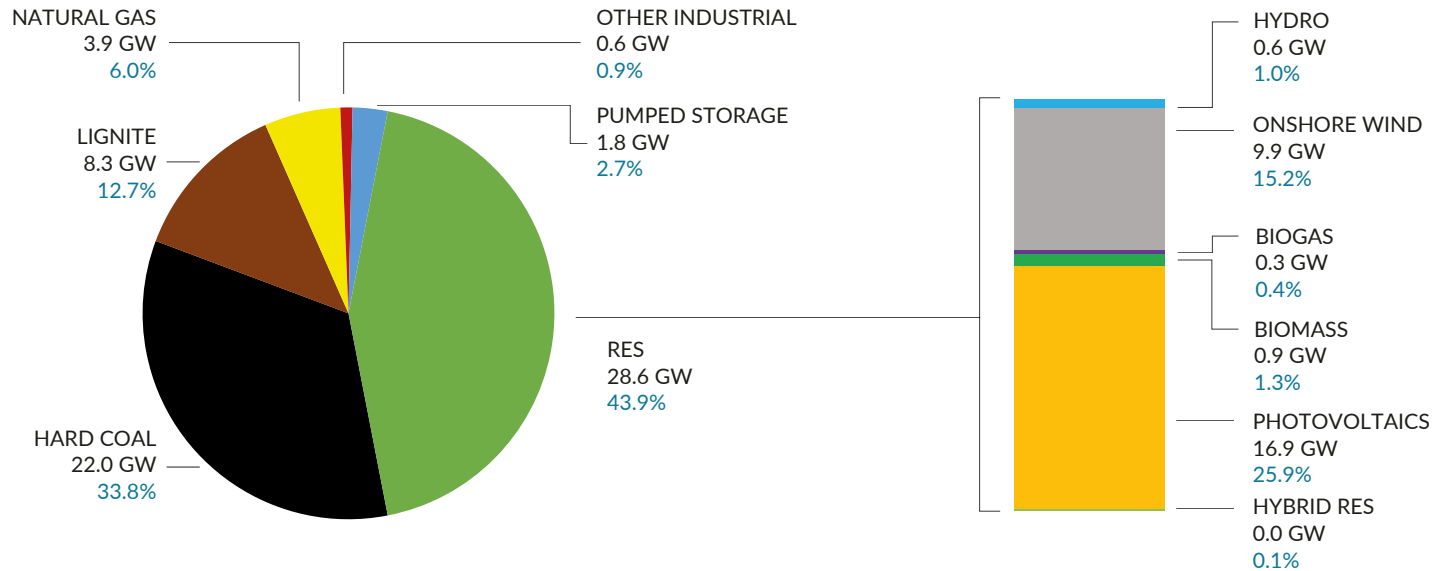


Source: own elaboration based on PSPA, EAFO, GUS and PORT PC data. The decrease in the number of charging points in 2019 was due to a change in methodology.
 * No data for 2013 and 2014, light blue bars are interpolated values between 2012 and 2015.

Generation capacity

Achievable capacity in 2023

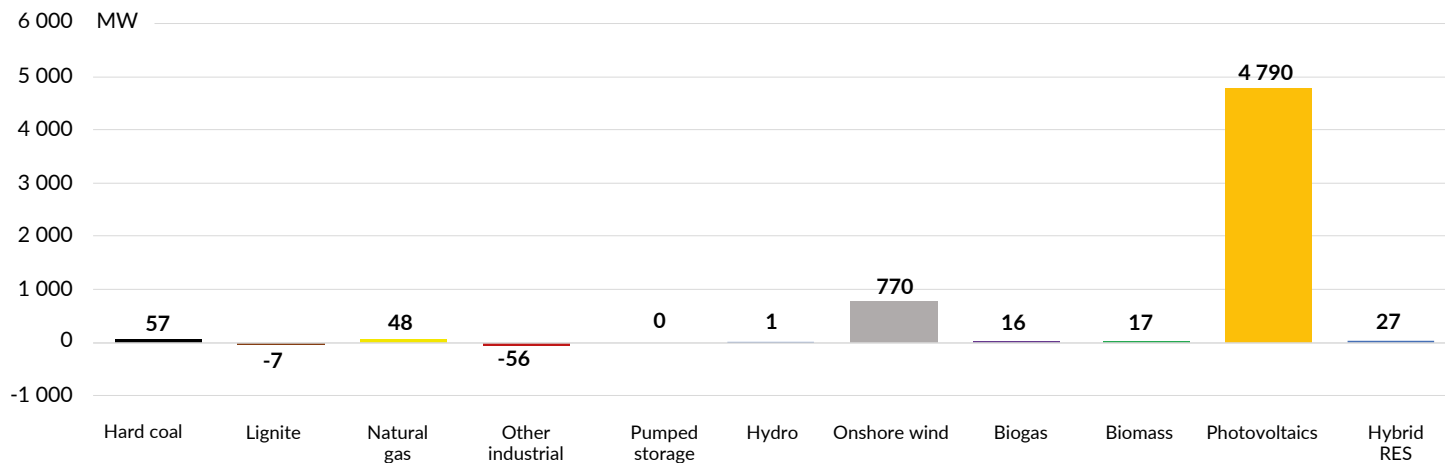
- 65.2 GW was the achievable capacity at the end of 2023, 5.6 GW more than a year earlier.
- The share of RES capacity increased to 43.9% (from 38.6%).
- At the end of 2023, the capacity of wind sources exceeded that of lignite power plants.
- Photovoltaics (16.9 GW) are responsible for almost 60% of RES capacity. Wind power accounts for just over 1/3 of RES capacity (9.9 GW).



Source: own elaboration based on ARE data.

Changes in achievable capacity in 2023 as compared to 2022

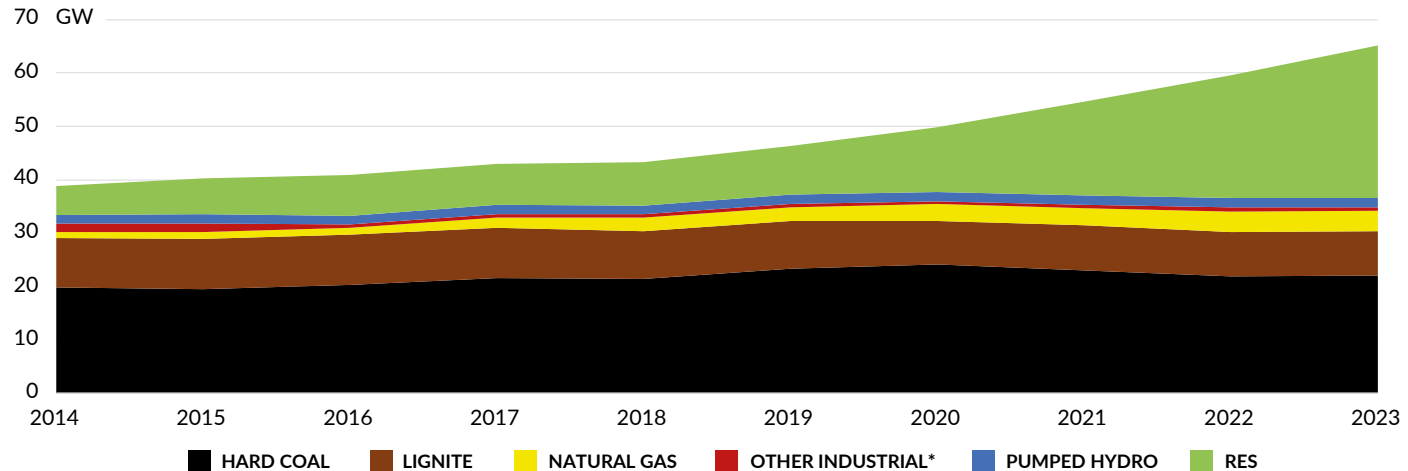
- There were no significant changes in fossil fuel-fired capacity in 2023.
- The only significant changes were in renewables, which added 5.6 GW.
- Photovoltaics (4.8 GW) were responsible for most of the increase in renewable capacity, of which 1.9 GW was prosumer solar PV.
- There was also an increase of 0.8 GW of wind capacity, which is mostly the result of investments made in RES auctions in earlier years.



Source: own elaboration based on ARE data.

Changes in achievable capacity over the last decade

- Conventional sources' achievable capacity has fluctuated in the 32-35 GW range for years, with last year's increase a mere 41 MW, to 34.8 GW.
- Over 10 years, total achievable capacity increased to 65.2 GW – up by 26.3 GW, or 68%.
- The capacity of conventional units increased by 3.1 GW (+9.7%), hard coal by 2.3 GW (+11.5%), and natural gas by 2.7 GW (+229.9%). Lignite capacity decreased by 1 GW (-11.1%).
- RES capacity more than quadrupled over the decade, from 5.5 GW to 28.6 GW.

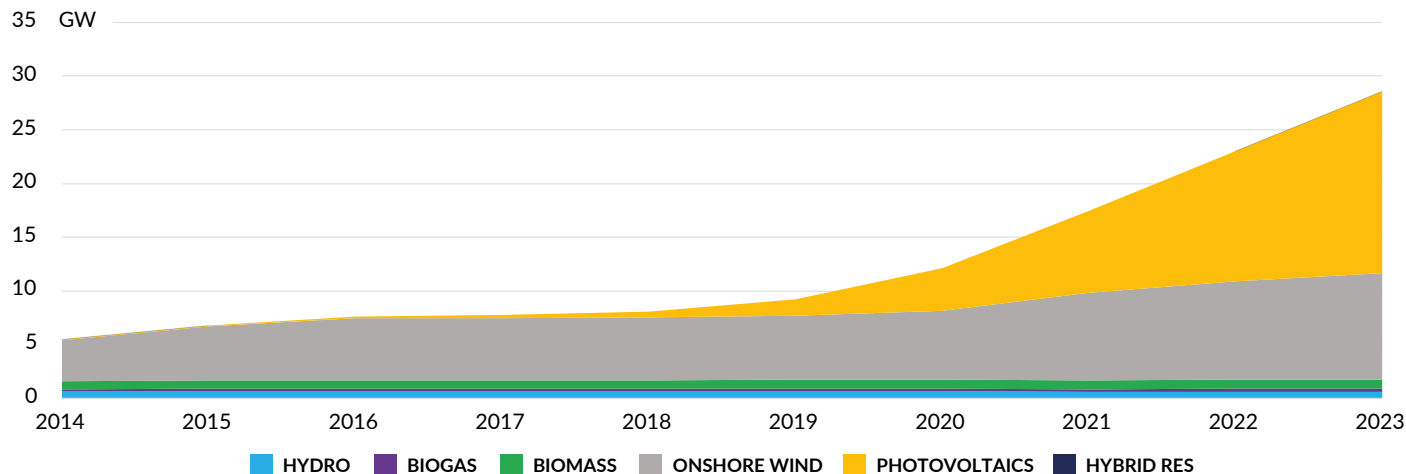


Source: own elaboration based on ARE data.

* Until 2016, the "other industrial" category also includes capacity in natural gas and hard coal.

Changes in achievable renewable capacity over the last decade

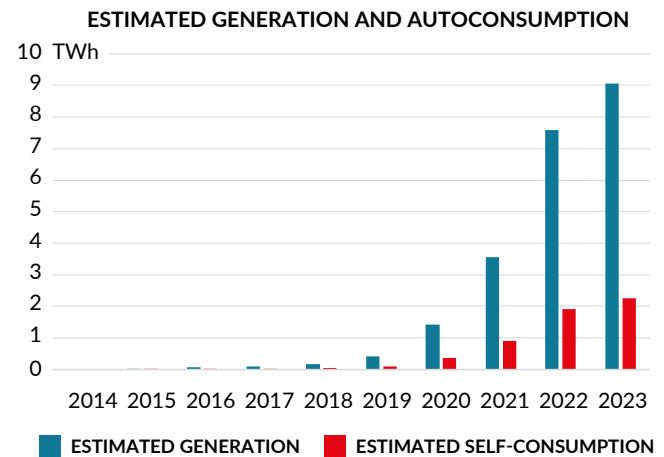
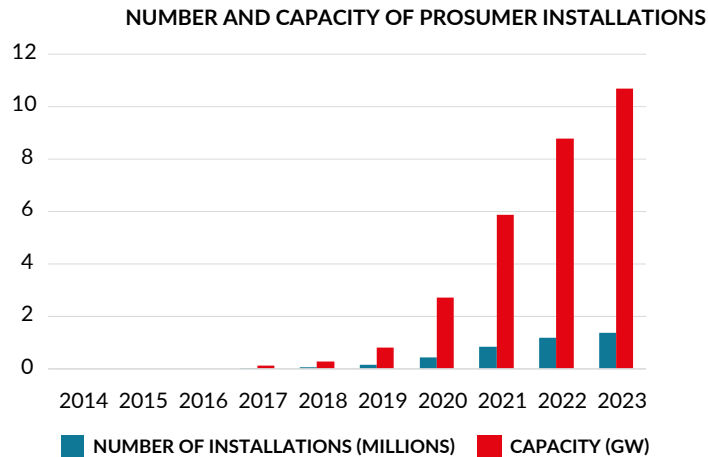
- At the end of 2023, there was 28.6 GW of RES installed, an increase of 5.6 GW (+24.5%).
- Photovoltaic capacity increased by 4.8 GW (+39.6%), reaching 16.9 GW. A decade ago, the first photovoltaic installations appeared, with an installed capacity of 0.028 GW at the end of 2014.
- Wind power increased by 0.8 GW over the year (+8.5%). There was an increase of 6 GW (+156%) over 10 years.
- RES development is almost entirely driven by wind and photovoltaic investments. Hydropower, biogas, biomass, and hybrid capacities added 0.3 GW over the decade.



Source: own elaboration based on ARE data.

Electricity prosumers

- At the end of 2023, prosumer installation capacity reached 10.7 GW. This represents an increase of 21% (1.9 GW) over the year.
- This capacity consists of nearly 1.4 million prosumer installations (+16% year-on-year). Photovoltaic installations account for 99.97% of them.
- Estimated total prosumer electricity production is about 9.1 TWh. Estimated self-consumption was about 2.3 TWh, which means that about 1.4% of domestic consumption did not have to be sent through the NPS.
- Prosumers fed 6.8 TWh of electricity into the grid. This corresponds to 4.1% of national generation.

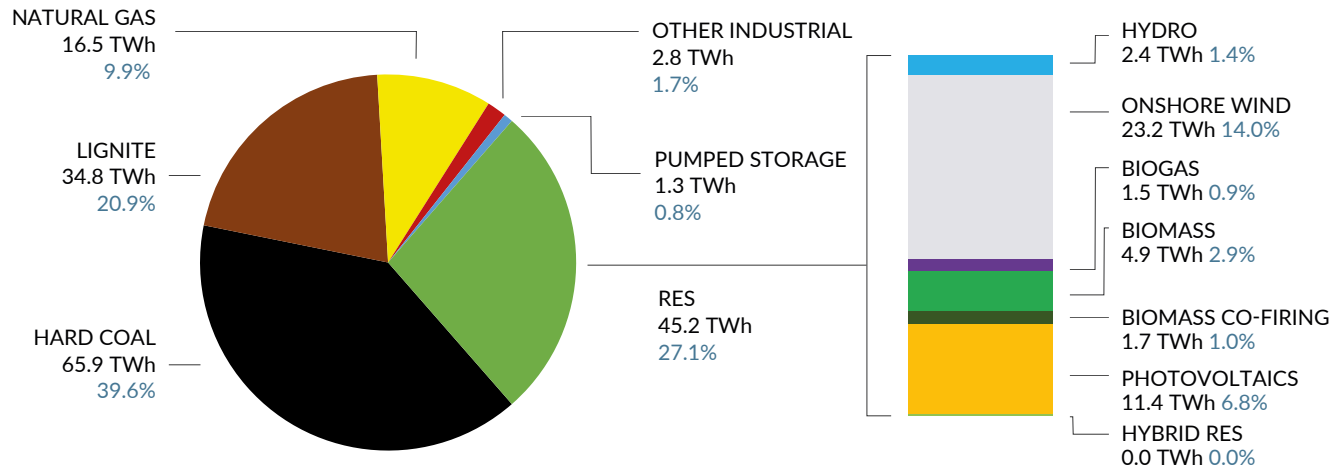


Source: own elaboration based on PTPIREE and ARE data. Self-consumption of 25% was assumed for the calculations.

Electricity generation

Electricity generation in 2023

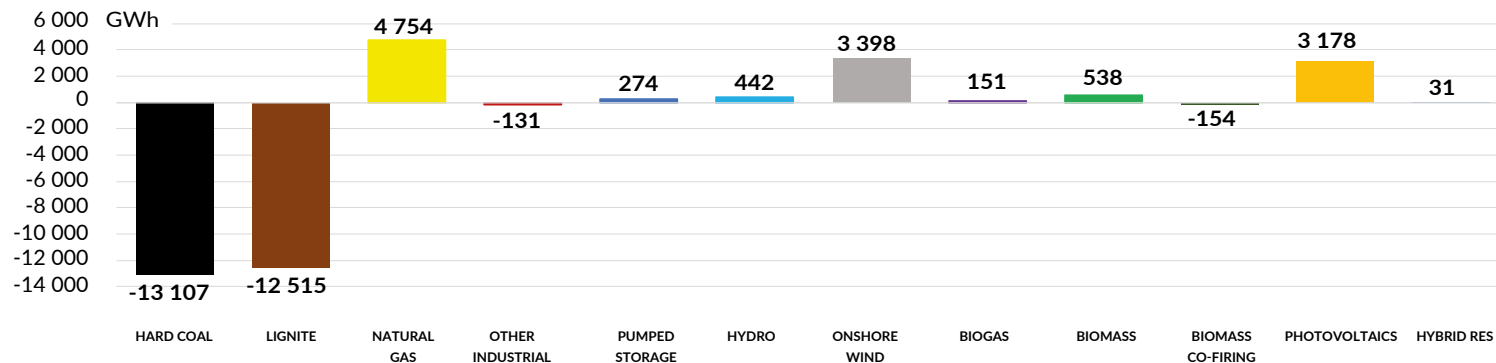
- 60.5% was coal's share of gross electricity production in 2023 (9.9 p.p. less than in 2022).
- Production from RES was 27.1%, 6.2 p.p. more than in 2022. A record 45.2 TWh from renewables made them the second-largest producer of electricity in 2023, overtaking lignite. This was possible thanks in part to reduced demand for electricity (down 4.3% y/y).
- For the first time, production from wind exceeded 20 TWh, reaching 23.2 TWh (14%).
- Electricity production from natural gas reached its highest level ever, at 16.5 TWh (9.9% of electricity production).
- Coal units recorded the lowest capacity factors ever. Values for coal approached those for high wind turbines.



Source: own elaboration based on ARE data.

Changes in electricity generation in 2023 as compared to 2022

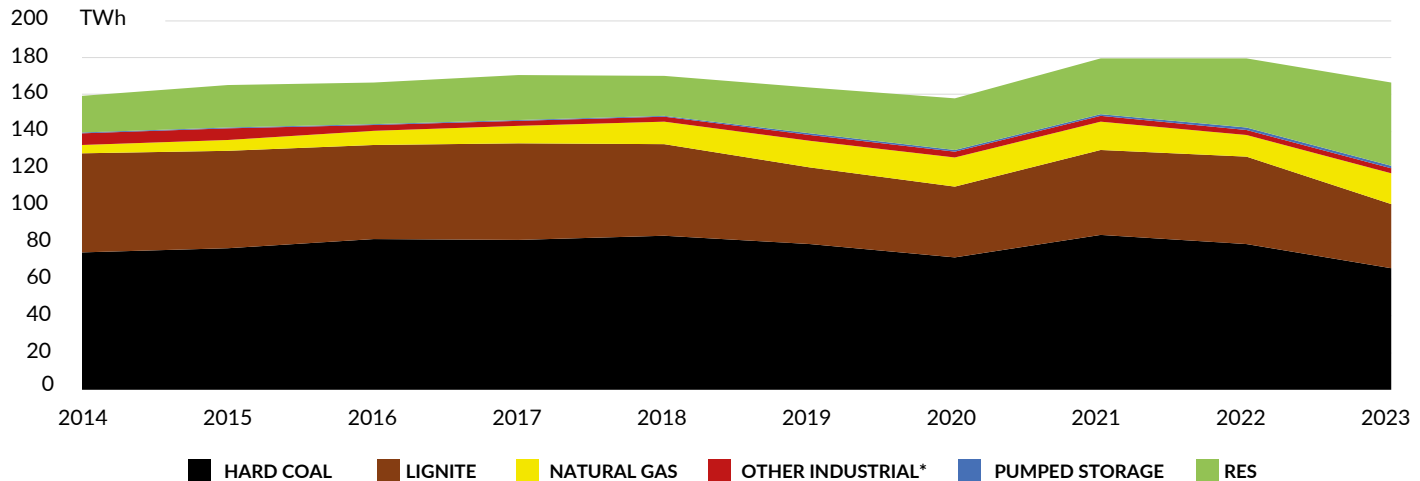
- Production from coal fell by 25.6 TWh (-20% y/y): from hard coal by 13.1 TWh (-17% y/y), from lignite by 12.5 TWh (-26% y/y).
- This is a result of very high prices for hard coal and CO₂ emission allowances, as well as the low flexibility of coal sources, for which there is less and less room in the system with the rapidly growing production from RES.
- Production from natural gas increased by 4.8 TWh (+41% y/y) primarily due to the decline in natural gas prices, which have become competitive with high coal prices, and the higher flexibility of these sources, which work better with the variables of RES.
- Among RES, production from photovoltaics (+39% y/y, +3.2 TWh) and wind (+17% y/y, +3.4 TWh) grew most rapidly. The only decline was in biomass co-firing (-8% y/y, -0.2 TWh).
- Pumped storage plants, the system's only significant energy storage, were once again utilized at record levels for the second year in a row – 26% more than in 2022.



Source: own elaboration based on ARE data.

Changes in electricity generation over the last decade

- Domestic gross electricity production amounted to 166.4 TWh. This is 7.3% (-13.1 TWh) less than a year ago.
- Over 10 years, electricity generation increased by 4.6% (from 159.1 TWh in 2014).
- Production from conventional sources fell by 14%, from 138.7 TWh in 2014 to 119.9 TWh in 2023. Declines in production were recorded in hard coal (-8.7 TWh, or -12%) and lignite (-18.7 TWh, or -35%), while production from gas sources increased (by 11.9 TWh, or 263%).
- Generation from RES increased by 128% (from 19.8 TWh in 2014 to 45.1 TWh in 2023).

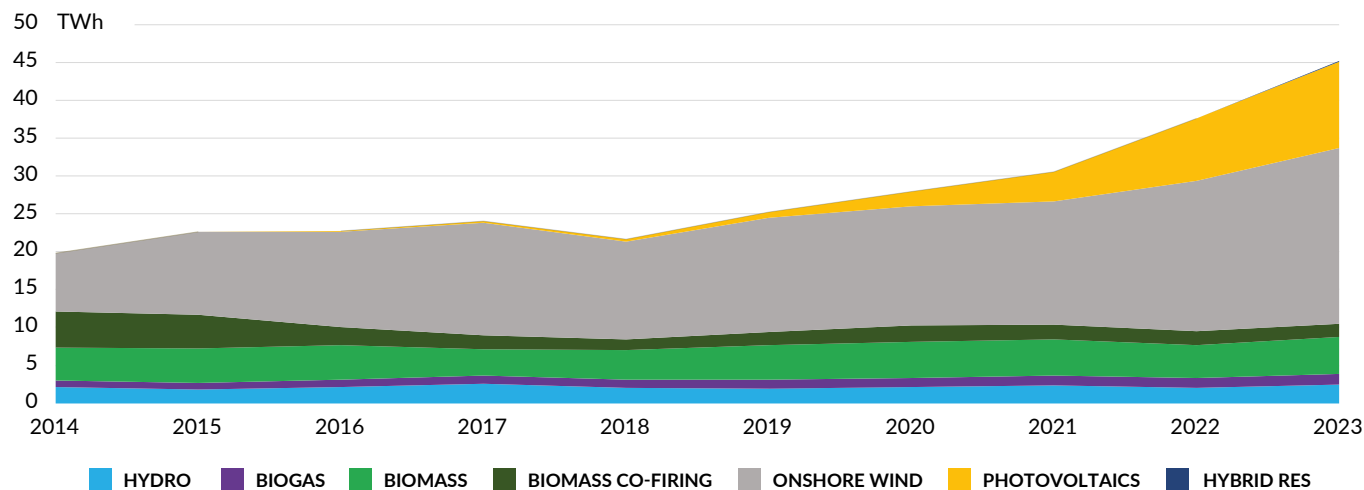


Source: own elaboration based on ARE data.

* Until 2016, the "other industrial" category also includes capacity in natural gas and hard coal.

Changes in renewable electricity generation over the last decade

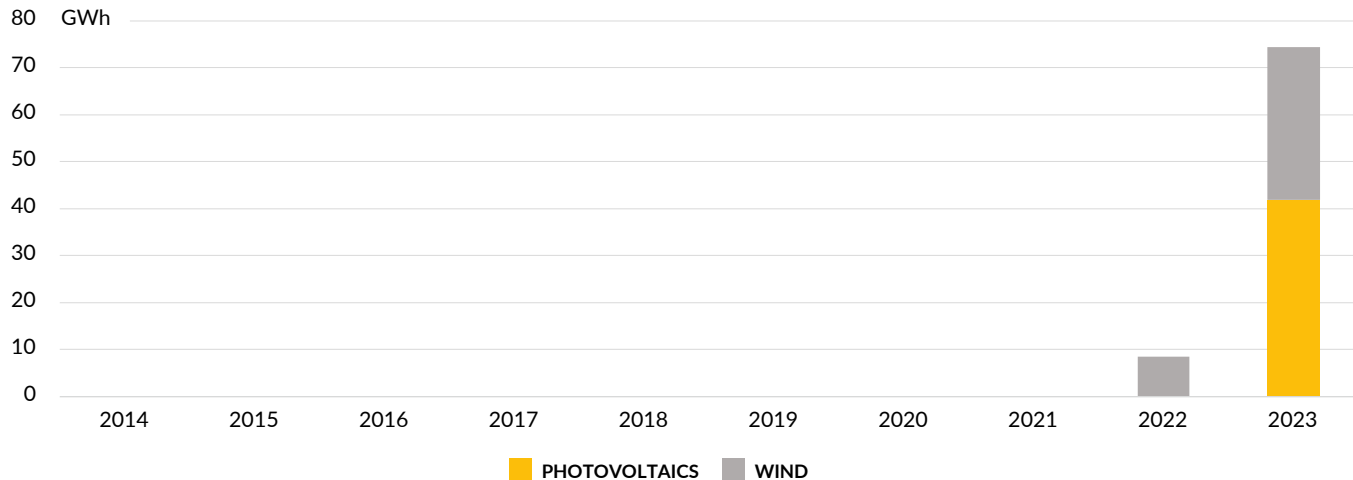
- In 2023, 45.1 TWh of electricity was produced from RES – another year with a 20% increase.
- Wind power was responsible for more than half of the production from RES (51%) in 2023, the share of photovoltaics was 25%, and biomass 18%.
- Over the 10-year period, the largest increase, aside from photovoltaics, was in generation from wind power, which was up 203% (+15.6 TWh). Generation from biogas also increased, by 95% (+0.7 TWh), and water, by 11% (+0.2 TWh).
- The largest decline was in biomass co-firing, by 64% (-3 TWh).



Source: own elaboration based on ARE data.

Curtailment of renewable energy sources

- An estimated 74.4 GWh of electricity was subjected to non-market redispatch (curtailment) in 2023. This is an amount comparable to the annual demand of 30,000 households.
- 56% of this value was related to the curtailment of photovoltaic (non-prosumer) installations, while the remaining 44% was curtailment of wind farm production. In 2022, only wind farm generation was curtailed (8.4 GWh).
- In earlier years, non-market redispatch did not occur because RES capacity was too low. Currently, there are 26.8 GW of non-controllable RES installed, while the minimum system demand amounts to 11 GW.
- Non-market redispatch is a tool for maintaining system stability and regulation, used as a last resort by the TSO. The main reason is the low flexibility of the system (primarily conventional power plants) combined with the high capacity of RES.

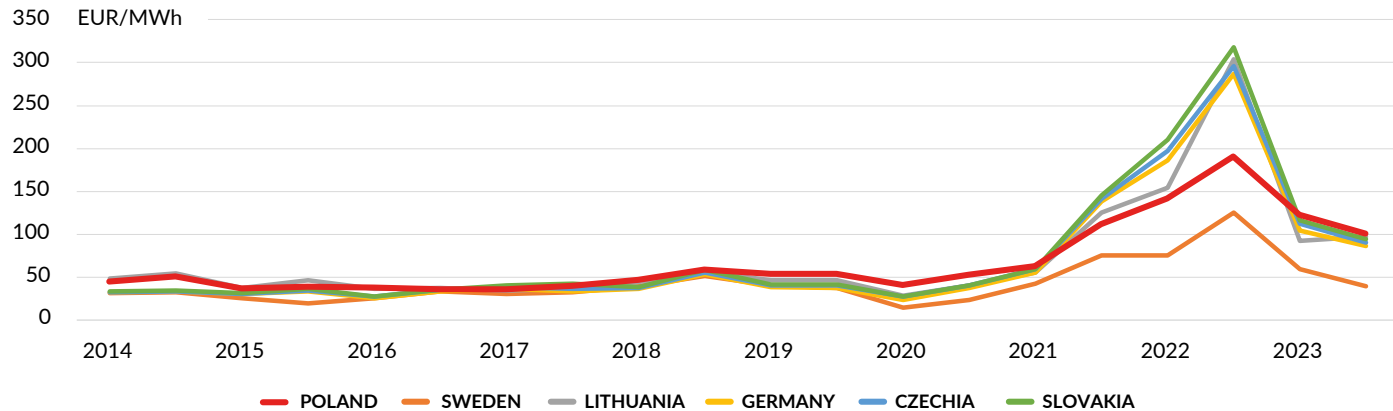


Source: own elaboration based on PSE data.

Electricity and gas prices

Comparison of spot electricity prices in neighbouring markets

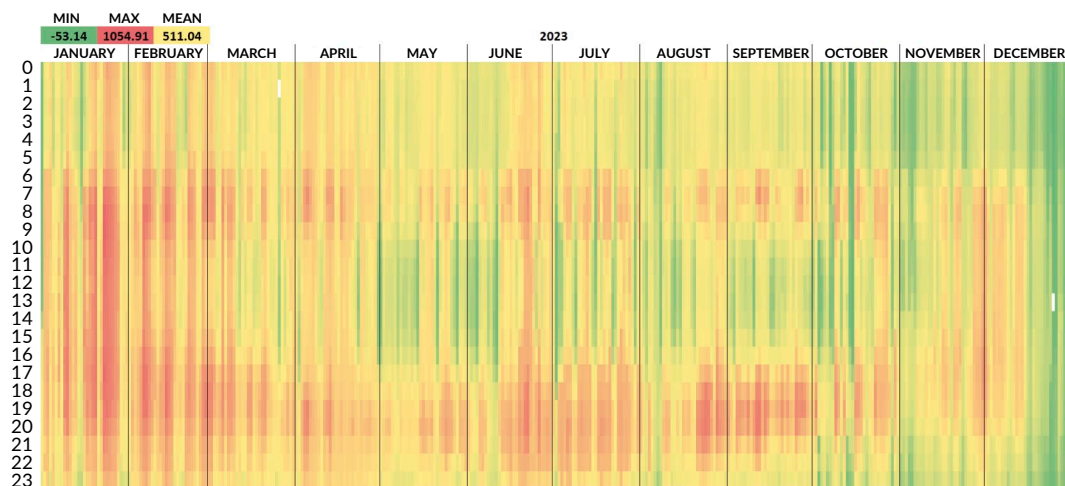
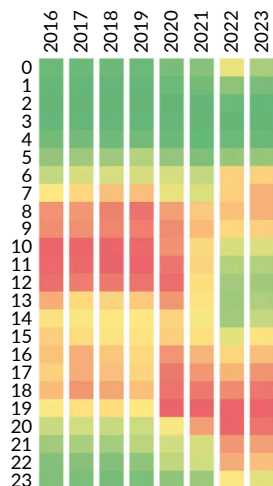
- In 2023, electricity prices on the markets fell relative to those quoted in the crisis year of 2022. At that time, the increases were influenced by, among other things, very high natural gas prices (which shape electricity prices in most markets), as well as maintenance (and drought-induced) shutdowns of French nuclear reactors.
- Despite declines in 2023, prices have not returned to pre-crisis levels. In the second half of 2023, they were 62% higher in Poland than in the first half of 2021, at €101/MWh.
- As in pre-crisis years, spot electricity prices in Poland were higher than in neighbouring markets due to the highest “carbonisation” of the energy mix (expensive coal and very high prices for CO₂ emission allowances).
- At the end of 2023, prices in Germany were 14% lower, in Czechia 11% lower, in Slovakia 7% lower, and in Lithuania 4% lower than in Poland. In Sweden, it was 61% cheaper, primarily because its energy mix (mainly based on nuclear and hydroelectric sources) does not require the purchase of emission rights and is immune to energy commodity price shocks.



Source: own elaboration based on European Commission and ENTSO-E data.

Electricity prices on the spot market

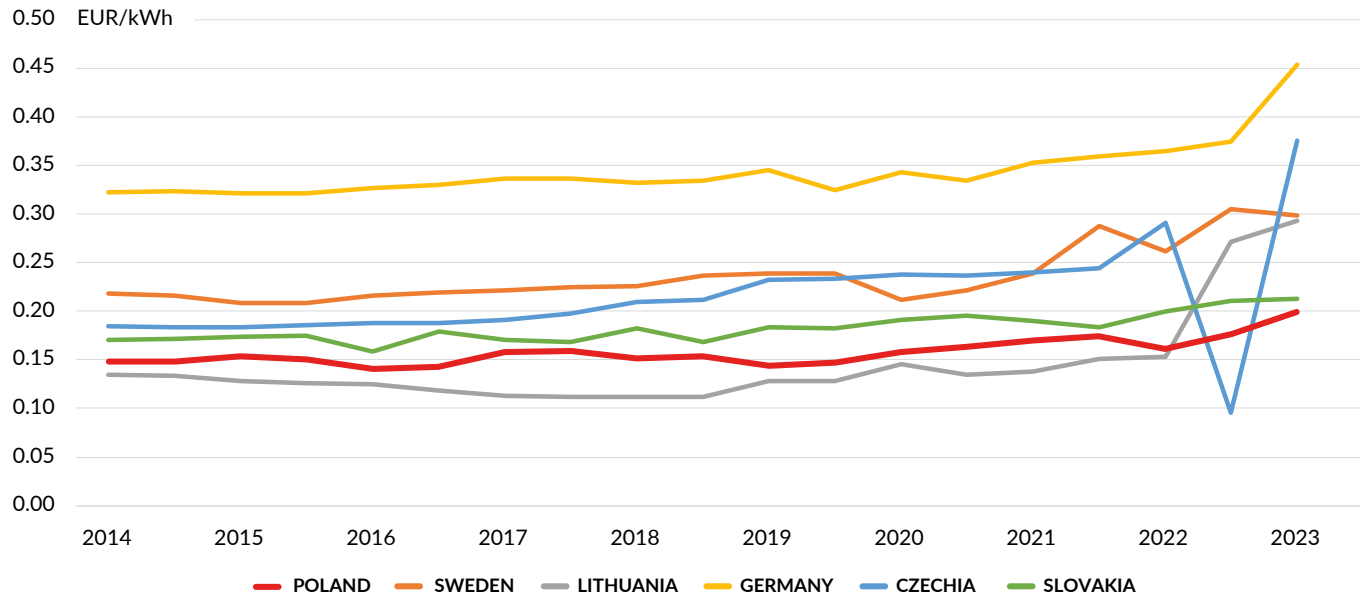
- The heatmap on the right shows the price of electricity at a given hour in 2023 on the spot market (green is the lowest price, red the highest).
- In 2023, the average price on the DAM was 511 PLN/MWh, the lowest 53 PLN/MWh, and the highest 1,054 PLN/MWh.
- The price of electricity is higher when electricity supply over demand is lower. The lowest level of reserves occurred throughout the year during the hours of 6:00-9:00 (morning peak) and 6:00-21:00/23:00 (evening peak in the off-summer/summer). The largest supply reserve occurred during the day in summer (due to photovoltaics) and at the end of the year during the holiday season (good wind conditions and low demand).
- A change can be seen over the years: the pre- and early afternoon hours used to be the most expensive, while due to the expansion of photovoltaics, the midday zone is now one of the cheapest hours. The evening hours are the most expensive.



Source: own elaboration based on TGE data.

Comparison of electricity prices in neighbouring markets (for households)

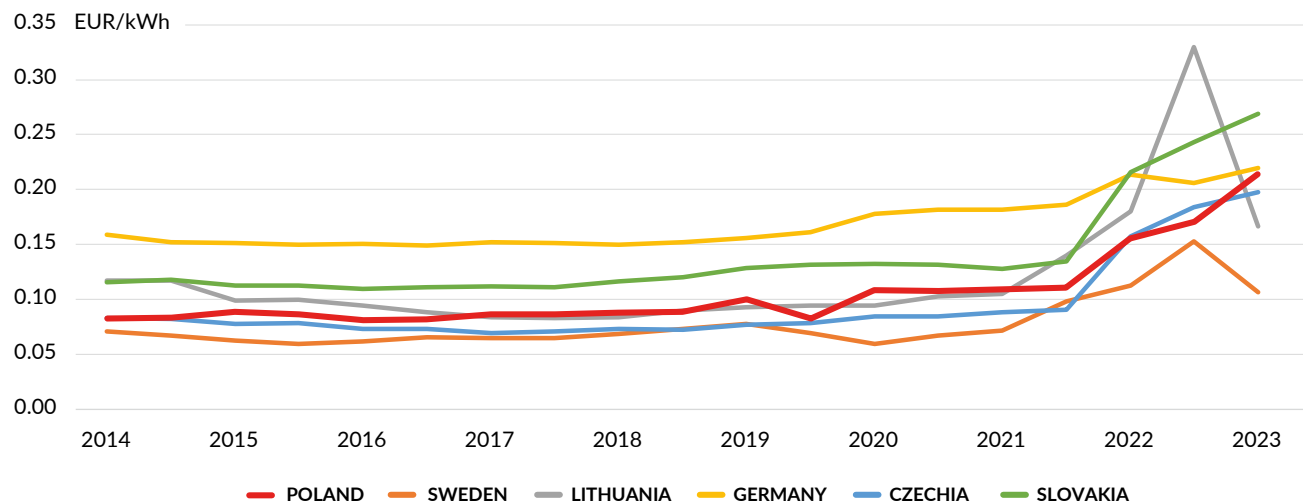
- For years, electricity prices for households in Poland have been among the lowest (nominally) among neighbouring countries.
- Taking into account all taxes and levies, in H1 2023, the price of electricity in Poland was 19.9 eurocents/kWh, that's 56% less than in Germany, 47% less than in the Czech Republic, 1/3 less than in Lithuania and Sweden, and 7% less than in Slovakia.
- Electricity prices for households are largely shaped by a country's tax and regulatory policies. It is not a simple reflection of wholesale energy prices on the exchange.



Source: own elaboration based on Eurostat data.

Comparison of electricity prices in neighbouring markets (for industry)

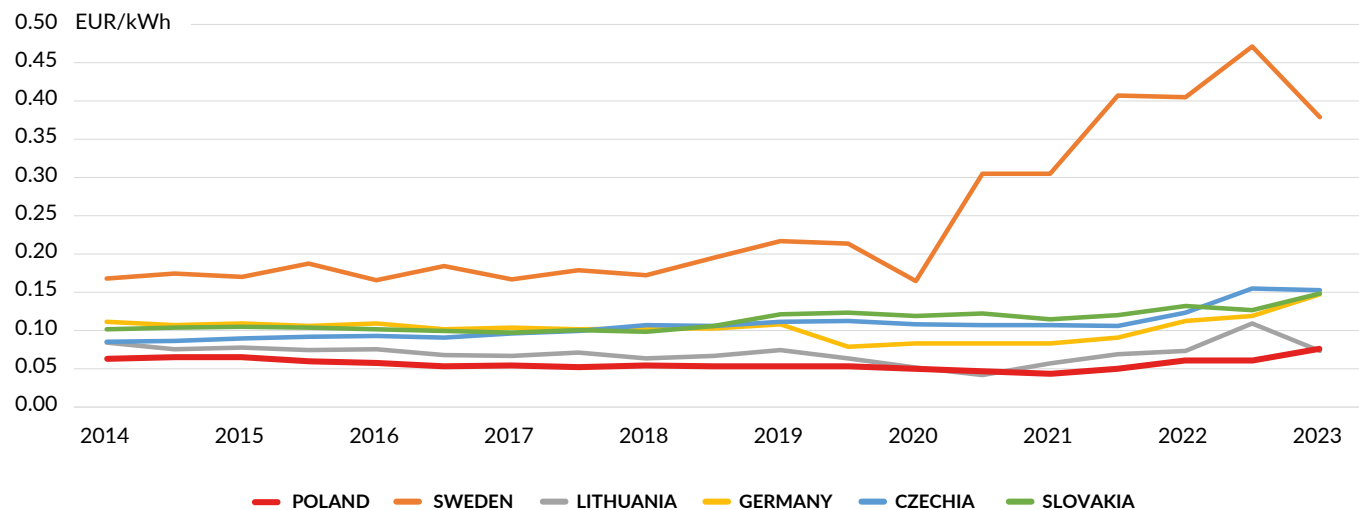
- After deducting VAT and all recoverable taxes and levies, the average price of electricity for industry in Poland was 21.35 eurocents/kWh, 7% higher than for households.
- Historically, Polish energy prices for industry have been low compared to its neighbours, but since the second half of 2021, they have been rising faster than in most neighbouring countries. During this time, prices have risen by 96%, compared to 21% in the Czech Republic and 121% in Slovakia.
- Electricity prices for industry are more dependent on the energy exchange than prices for households. Their level translates into the competitiveness of the economy internationally and the prices of locally consumed products.



Source: own elaboration based on Eurostat data.

Comparison of natural gas prices in neighbouring markets (for households)

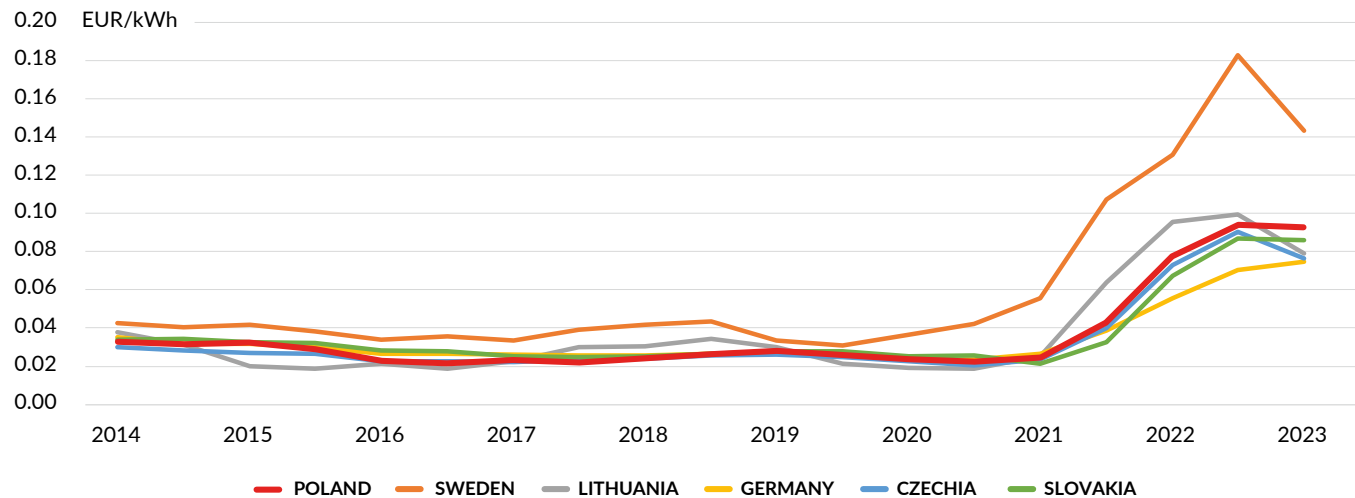
- Taking into account all taxes and levies, the price of natural gas for households in Poland in H1 2023 was 7.56 eurocents/kWh. This is 80% less than in Sweden, about 50% less than in the Czech Republic, Germany and Slovakia, and 4% more than in Lithuania.
- As in the electricity market, gas prices for households largely depend on state tax policy and are not a direct reflection of the situation on the stock market.



Source: own elaboration based on Eurostat data.

Comparison of natural gas prices in neighbouring markets (for industry)

- After deducting VAT and all recoverable taxes and levies, the average price of natural gas for industry in Poland was 9.27 eurocents/kWh, 23% higher than for households.
- Historically, Polish gas prices for industry have been low compared to its neighbors, but since the second half of 2021 they have been rising at a faster rate than in most neighboring countries. During this time, prices in Poland have increased by 280% (in Sweden by 157% and in Slovakia by 305%).
- Natural gas prices for industry are more closely correlated with the power exchange than prices for households. Their level is reflected in the competitiveness of the economy internationally and in the prices of locally consumed products.



Source: own elaboration based on Eurostat data.

Chapter 3.
Energy raw materials



733%

is the increase (by 12 million tonnes) in net imports relative to 2014 of hard coal due to the decline in domestic mining.



27%

is how much the consumption of lignite in Poland has fallen since 2022. Compared to 2014, the decrease is 37% (23 million tonnes).



-8 million tonnes

(12%) is the decrease in estimated domestic consumption of steam hard coal compared to 2022 (and mining by 4 million tonnes). Over 10 years, the decline in consumption is 17 million tonnes.



5%

of crude oil imports came from Russia (47% in 2022). In 2023, Poland did not import natural gas or coal from Russia.



82%

of imported natural gas came from the Baltic Pipe (40%) and LNG Terminal (42%; mainly from the US and Qatar).



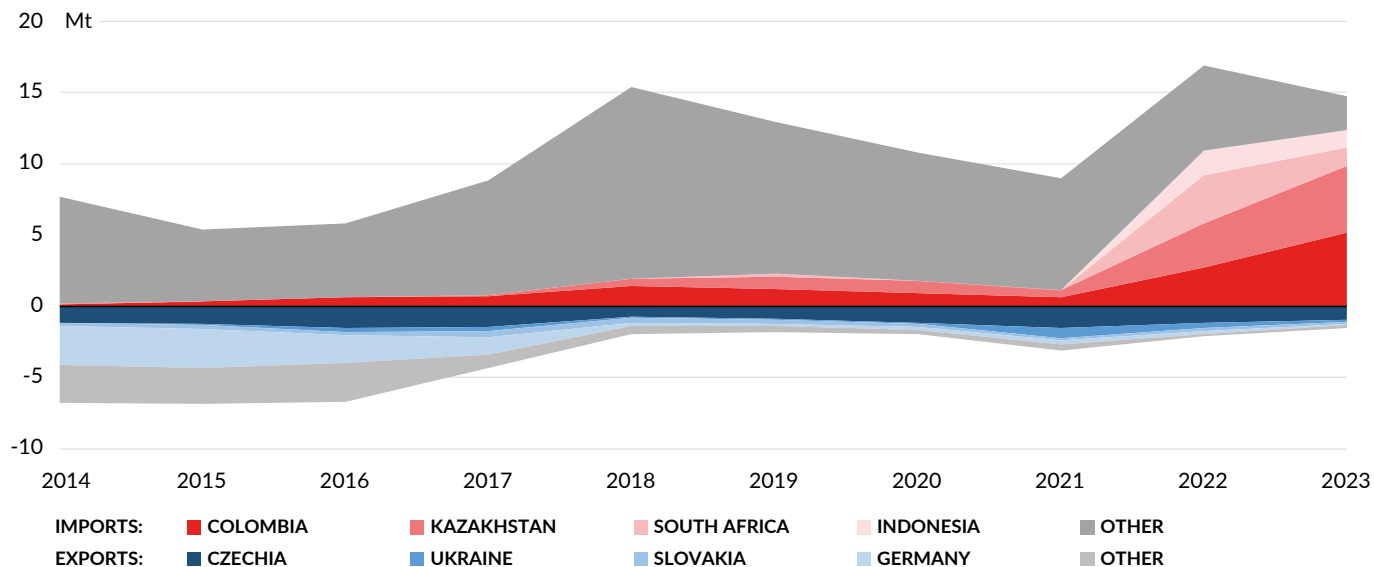
-13%

is how much domestic natural gas production has fallen over the past 10 years.

Fossil fuel imports remain at very high levels, but the directions of imports have been diversified. Imports of coal and gas from Russia fell to zero, while only a small stream of oil flowed in. The only visible dependence on Russia remained fuel imports (mainly LPG).

Trade balance of steam hard coal

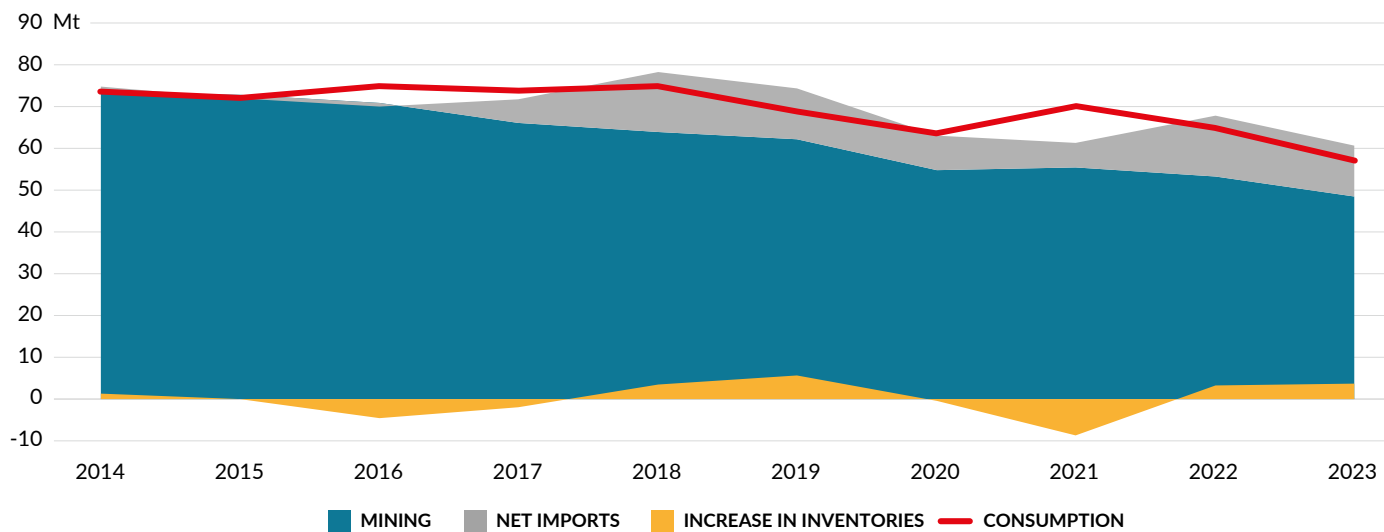
- In 2023, Poland's steam hard coal imports amounted to 14.7 million tonnes – 2.2 million tonnes (-13%) less than in 2022 and 7 million tonnes (+91%) more than in 2014.
- 35% of imported coal came from Colombia, 32% from Kazakhstan, 9% from South Africa, 8% from Indonesia, and 16% from other countries. Poland did not import a single tonne from Russia.
- In 2023, 1.5 million tonnes of steam coal were exported, which was 0.6 million tonnes (-29%) less than in 2022 and 5.3 million tonnes (-78%) less than in 2014. The main customers for Polish steam coal were the Czech Republic (62%), Ukraine (13%), Slovakia (9%), and Germany (5%).



Source: own elaboration based on GUS data.

Hard coal balance in Poland

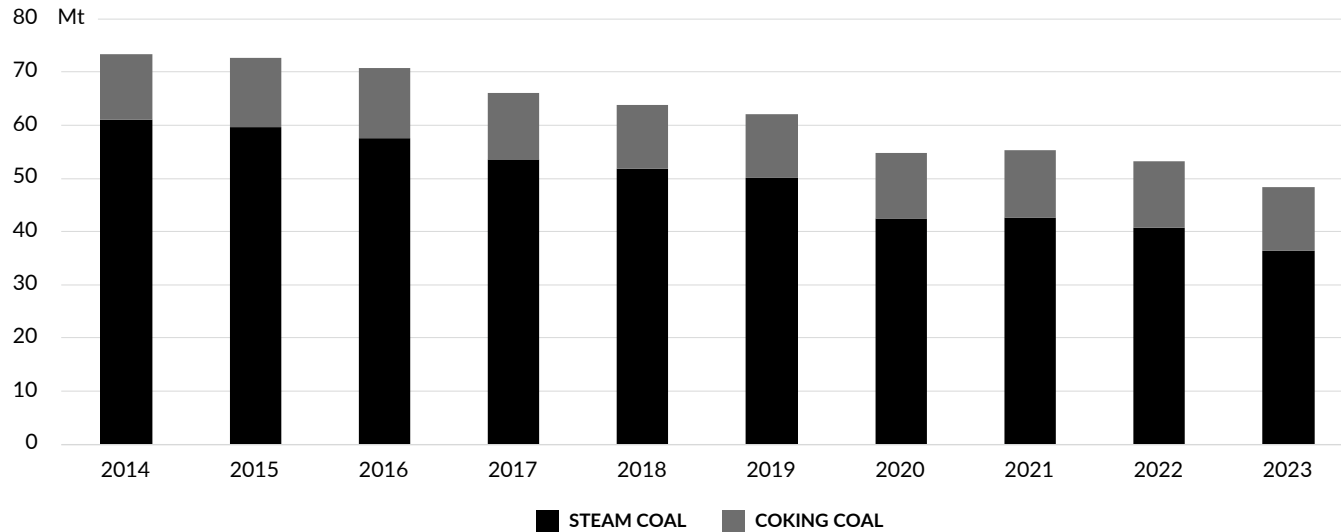
- According to Forum Energii estimates, hard coal consumption in 2023 was about 57 million tonnes, down from 2022 by about 8 million tonnes (-12% y/y).
- Net imports fell by 2.5 million tonnes (by 17%, to 12 million tonnes). Mining fell by 4.8 million tonnes (by 9%, to 48.4 million tonnes). According to estimates, about 4 million tonnes of coal were put on the heap, increasing inventories.
- Over the 10-year period, hard coal consumption fell by about 17 million tonnes (-23%), mining fell by 24.9 million tonnes (-34%), and net imports increased by 10.7 million tonnes (+733%).



Source: own elaboration based on GUS, ARE, ARP and Eurostat data.

Domestic hard coal production

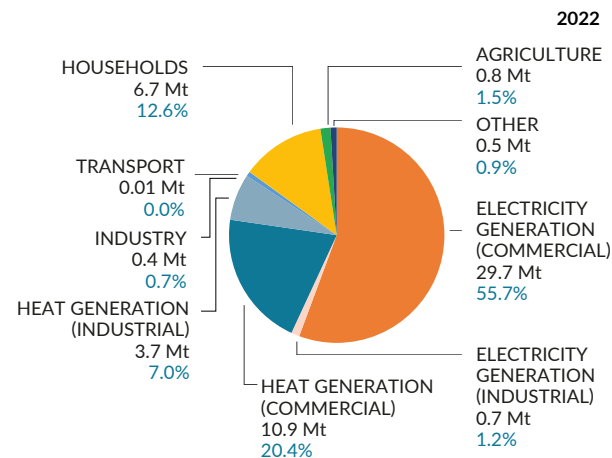
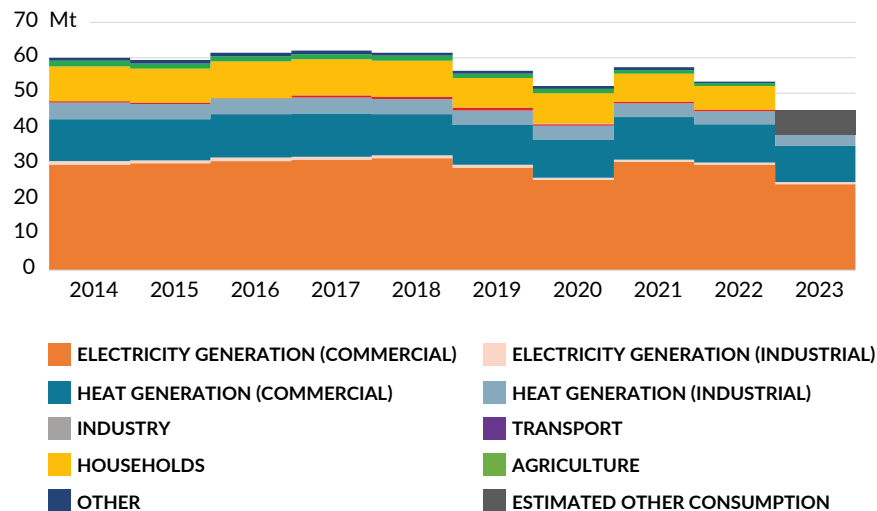
- In 2023, 48.4 million tonnes of hard coal were mined in Poland. Steam hard coal accounted for 75% (36.4 million tonnes) and coking coal for 25% (11.9 million tonnes).
- Total production fell by 4.8 million tonnes (-9%) during the year, with steam coal mining down by 4.4 million tonnes (-11%) and coking coal output down by 0.4 million tonnes (-4%).
- Over the decade, total hard coal production decreased by nearly 25 million tonnes (-34%), of which steam coal output decreased by 24.6 million tonnes (-40%) and coking coal mining decreased by 0.4 million tonnes (-3%).



Source: own elaboration based on GUS and ARP data.

Structure of steam hard coal consumption

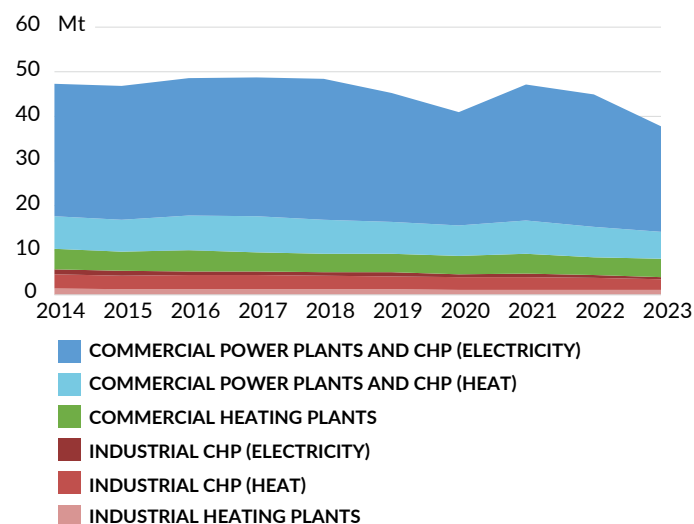
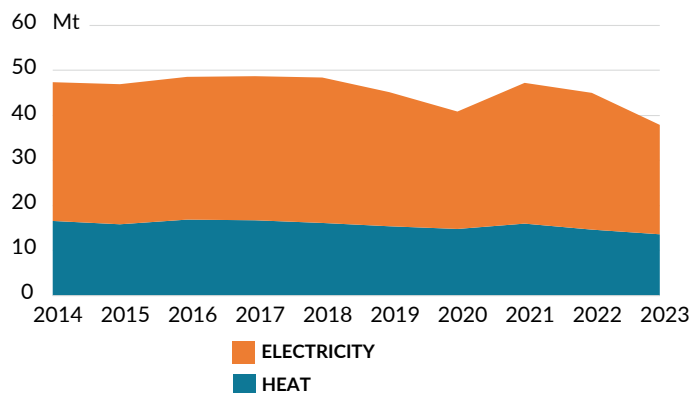
- Estimated consumption of steam hard coal fell by 16% (-8.3 million tonnes) year-on-year in 2023, to about 45 million tonnes.
- In 2023, 85% of steam coal (38.4 million tonnes) was used for electricity and heat production (in power plants, district heating plants, and CHPs). The remaining 15% (6.6 million tonnes) is the total consumption of other industries.
- Consumption for electricity generation is declining the most, with almost all of the decline relative to 2014 occurring in 2023.
- In 2022 (the latest data available), households consumed 6.7 million tonnes of steam coal (12.6% at the time), that's 1.3 million tonnes less y/y (-16%) and 4.4 million tonnes (-40%) less over the previous 10 years.



Source: own elaboration based on GUS, ARE, ARP and Eurostat data.

Structure of steam hard coal consumption – power and heat industry

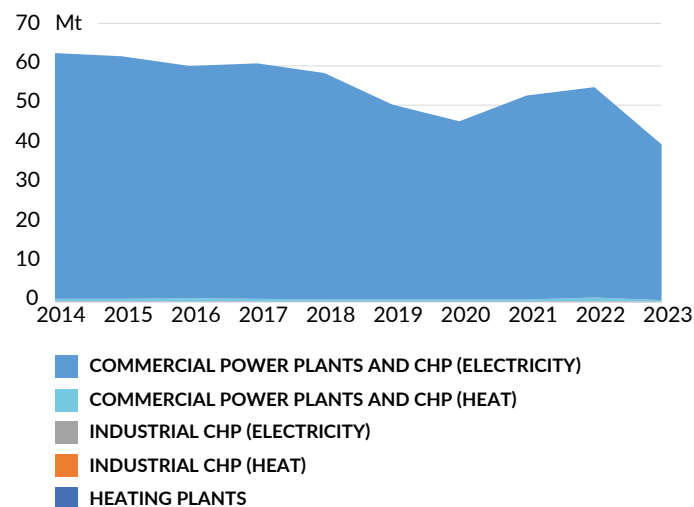
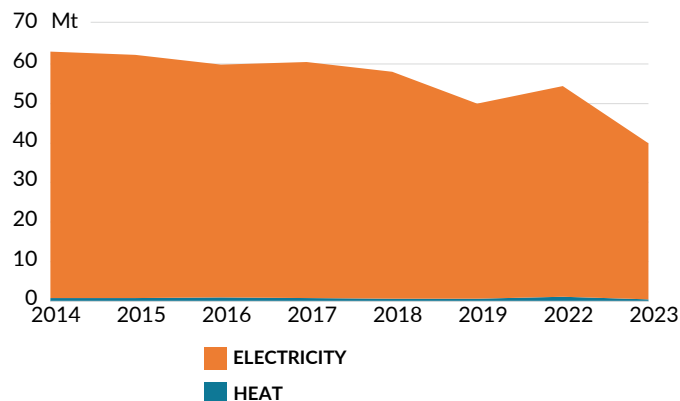
- Hard coal consumption in the power and heat industry in 2023 was 38.4 million tonnes. About two-thirds of this (24.9 million tonnes) was used for electricity generation, and about one-third (13.5 million tonnes) for heat production.
- Commercial electric power generation was responsible for 78% of consumption (29.8 million tonnes, of which 23.7 million tonnes was for heat). District heating plants were responsible for 11% of consumption (4.1 million tonnes), while industrial CHP and heating plants accounted for about 10% (4 million tonnes, of which 3.4 million tonnes was for heat).
- Coal consumption for heat production continues to decline slightly (-7% y/y, -18% relative to 2014). On the other hand, consumption for electricity generation has declined dynamically in 2023 (-20% y/y, -21% relative to 2014).
- Commercial power generation is almost entirely responsible for the net decline in coal consumption for electricity generation, while for heat production, equally responsible are commercial and industrial units (in the latter, the relative decline is much larger).



Source: own elaboration based on ARE and GUS data.

Structure of lignite consumption – power and heat industry

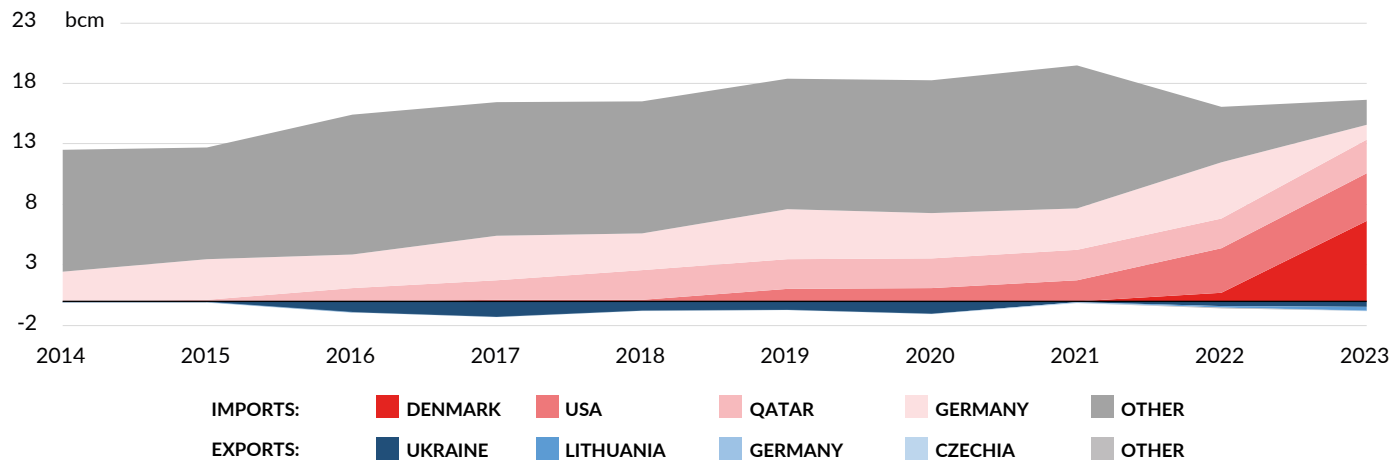
- Lignite is used almost exclusively in the energy sector (more than 99%). In 2023, 54.4 million tonnes of this raw material were consumed. It is not used in heating plants or industry.
- Almost the only purpose of lignite combustion is the production of electricity (98-99%) in the commercial electric power industry. Consumption in 2023 was 39.6 million tonnes.
- Consumption of lignite decreased relative to 2022 by 27% (14.4 million tonnes), and over 10 years by 37% (23.2 million tonnes).



Source: own elaboration based on ARE and GUS data.

Trade balance of natural gas

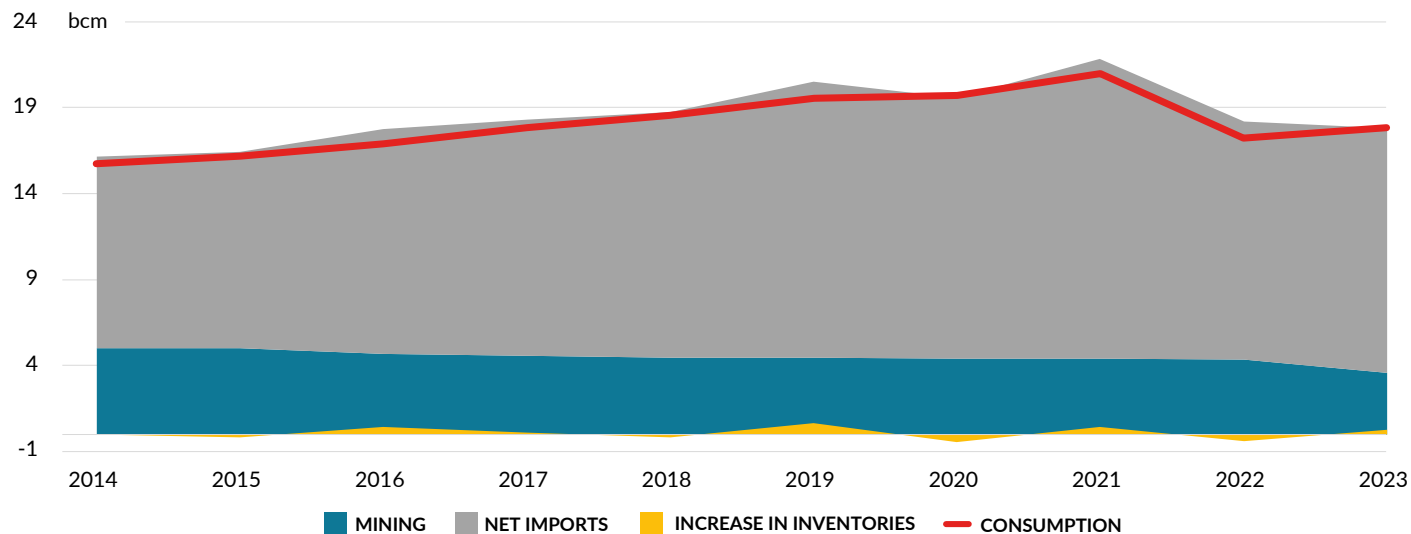
- Poland's natural gas supply diversified in 2023 after imports from Russia ended (they fell from 8.5 bcm in 2014 to zero in 2023).
- In 2023, 40% of imported natural gas came from Denmark (Baltic Pipe). The US (24%), Qatar (23%), and Germany (7%) are also important suppliers. Other directions accounted for 12% of imported gas.
- In total, natural gas imports (both by pipeline and LNG) in 2023 amounted to 16.7 bcm, 0.6 bcm (4% y/y) more than in the previous year and 4.1 bcm (+33%) more than 10 years ago.
- In 2023, 0.8 bcm of natural gas was exported – 61% flowed to Ukraine, 37% to Lithuania, and the remaining 2% mainly to the Czech Republic and Germany.
- LNG imports accounted for a record 42% (7.1 bcm after regasification) of natural gas imports.



Source: own elaboration based on GUS data.

Natural gas balance in Poland

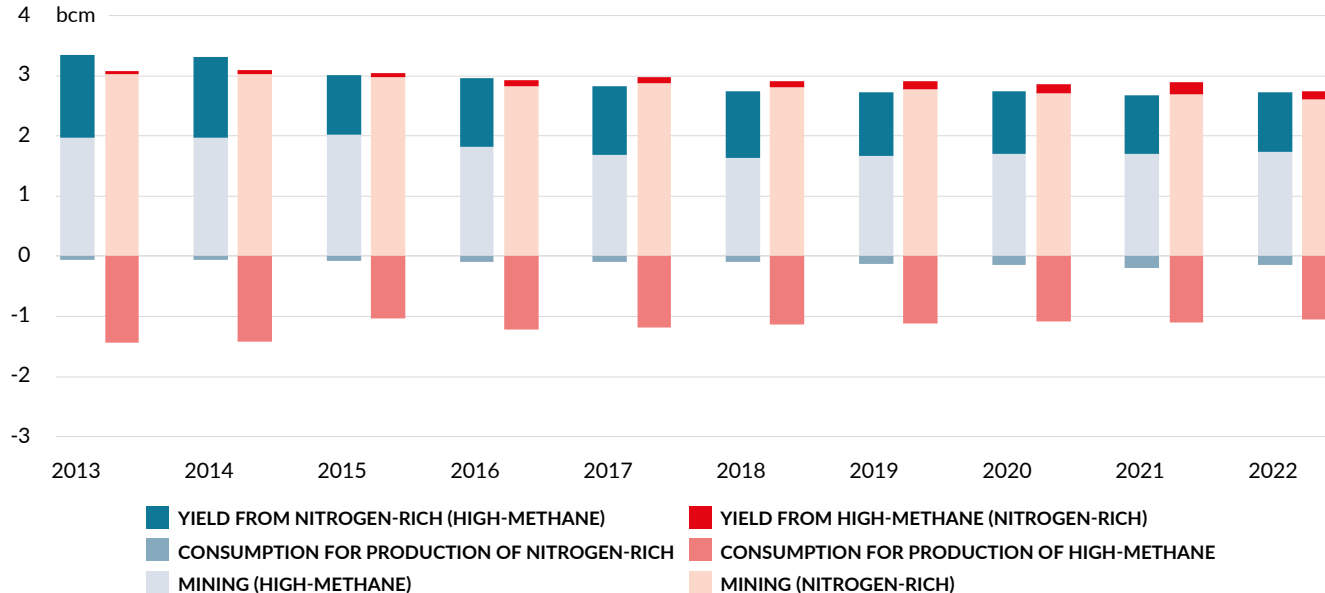
- In 2023, natural gas consumption increased by an estimated 0.6 bcm (+3%) over the previous year to 17.8 bcm of high-methane gas equivalent.
- Net imports increased by 0.4 bcm (+3% y/y, to 14.2 bcm). Domestic production is estimated to have declined by 0.8 bcm (-18% y/y, to 3.6 bcm), and inventories by 0.2 bcm. At the end of 2023, storage fill was 95.4%.
- Over the decade, natural gas consumption increased by 2.1 bcm (+13%), while domestic production fell by 1.4 bcm (-29%). Net imports increased by 3.1 bcm (+28%).



Source: own elaboration based on ARE, GUS, ENTSOG and Eurostat data. Production and consumption of nitrogen-rich natural gas is converted to the equivalent of high-methane natural gas.

Domestic natural gas production (2022)

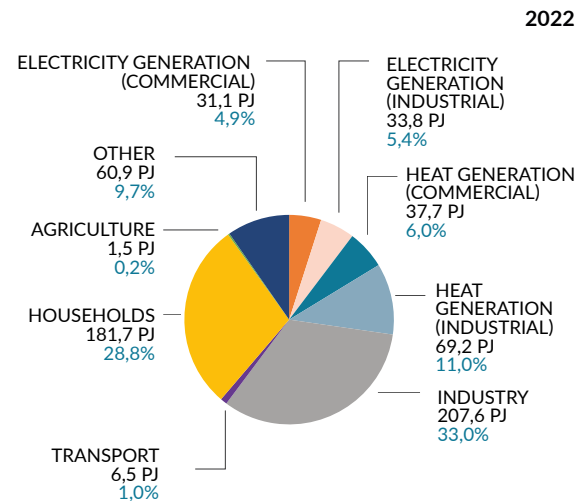
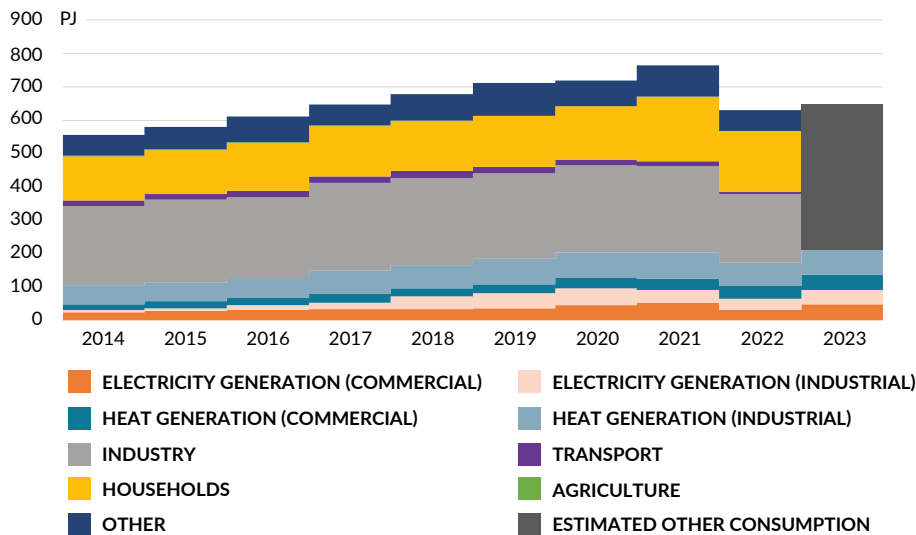
- Domestic production of high-methane natural gas is declining slightly. In 2022 (the latest available data), net production was 2.6 bcm, consisting of 1.7 bcm of gas from mining, 1 bcm from conversion (at the denitrification plant) of nitrogen-rich natural gas, and consumption of 0.1 bcm for the production of nitrogen-rich natural gas.
- In 2022, domestic production of nitrogen-rich natural gas did not deviate significantly from the long-term trend. A net 1.7 bcm was obtained, consisting of 2.6 bcm from mining, 0.1 bcm from conversion (at the blending plant) of high-methane gas, and consumption of 1 bcm for high-methane gas production.



Source: own elaboration based on ARE and GUS data. Volume of nitrogen-rich natural gas is converted to high-methane gas equivalent.

Structure of natural gas consumption

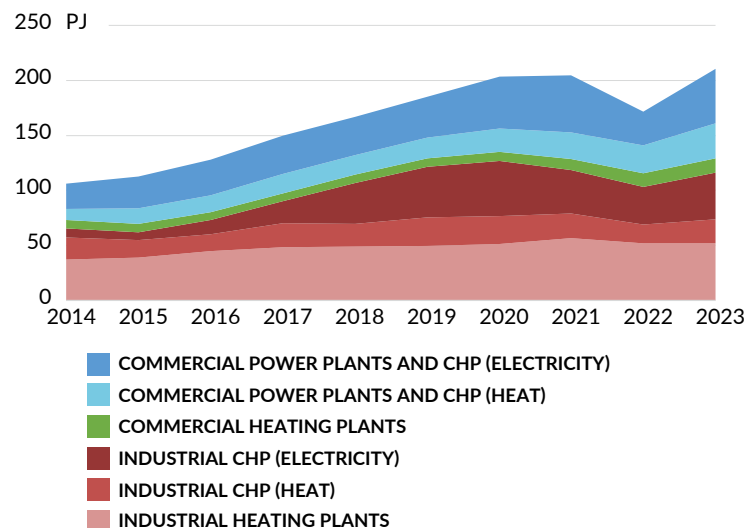
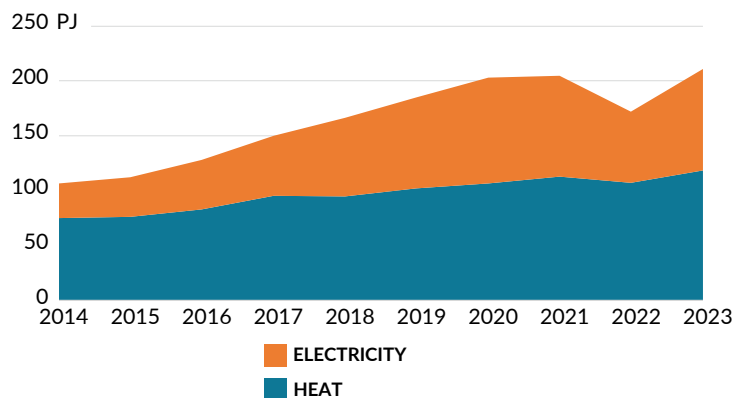
- In 2023, one-third of natural gas (210.7 PJ) was consumed for electricity and heat production. Total consumption in other industries was 67% (437 PJ).
- The largest consumer of natural gas in Poland is industry, which in 2022 (the latest data) accounted for 33% of domestic consumption (207.6 PJ). This represents a decline of 19% y/y and 9% over the decade.
- The second-largest consumer of gas in Poland are households, which in 2022 were responsible for 29% of consumption (181.7 PJ). This represents a decrease of 5% y/y, but an increase of 27% over the decade.



Source: own elaboration based on ARE, GUS and ENTSOG data.

Structure of natural gas consumption – power and heat industry

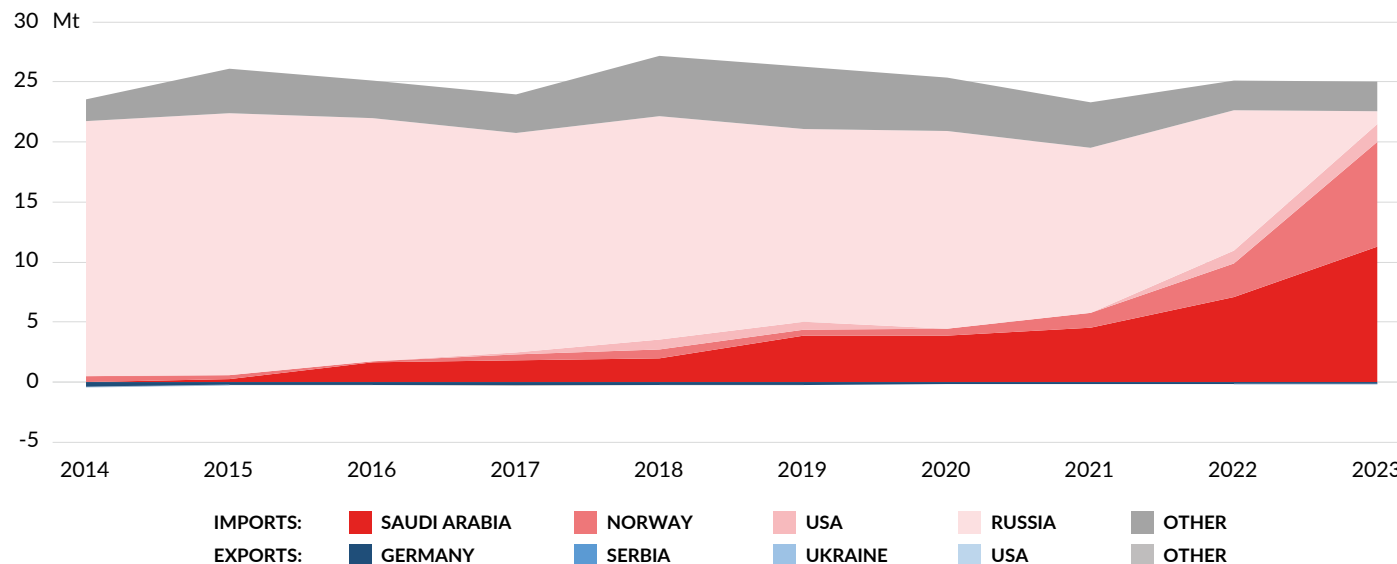
- In 2023, 211 PJ of natural gas was consumed in the power and heat industry, of which 56% (119 PJ) was used for heat production and 44% (92 PJ) for electricity production.
- Industrial CHP and heating plants were responsible for 55% of consumption (116 PJ, including 74 PJ for heat), district heating plants accounted for 6% (13 PJ), and commercial CHP for 39% (82 PJ, including 32 PJ for heat).
- Both natural gas consumption for heat production (+11% y/y, +58% relative to 2014) and electricity (+42% y/y, +194% relative to 2014) are growing.
- Industrial CHP is mainly responsible for the long-term increase in gas consumption for electricity production. In the case of heat production, it is commercial CHP and, to a lesser extent, industrial CHP.



Source: own elaboration based on ARE and GUS data.

Trade balance of crude oil

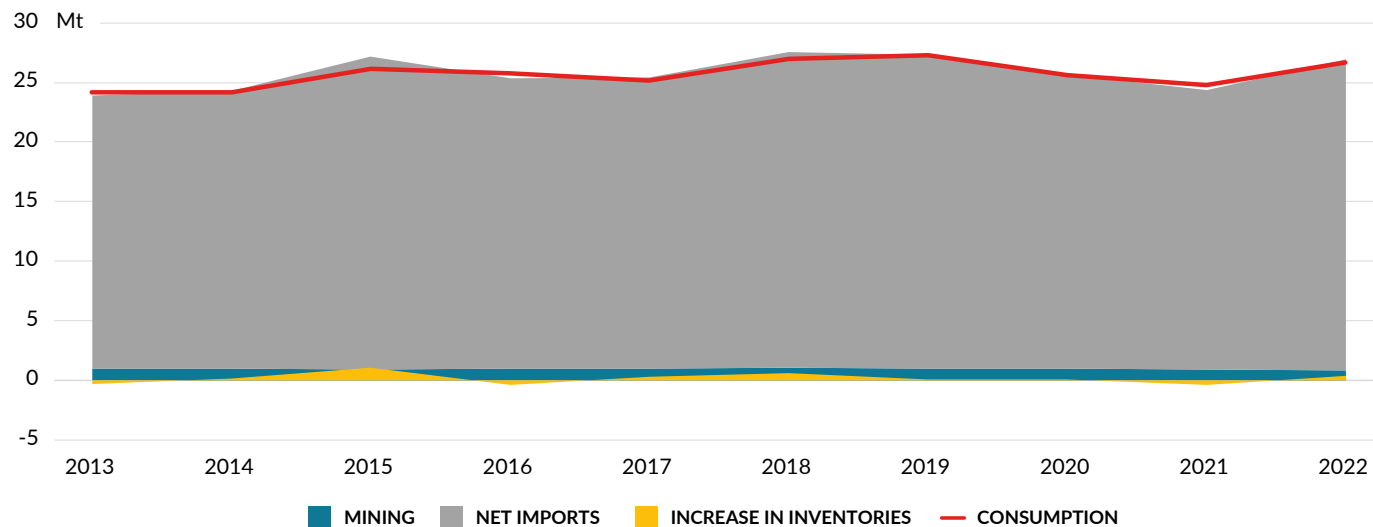
- In 2023, there was a diversification of the directions of crude oil supplies to Poland – after a significant reduction in imports, only 5% of that year's imports (1 million tonnes) came from Russia. In 2014, it was 90% (21 million tonnes), and in 2022 47% (12 million tonnes).
- Russia's place in crude oil supplies to Poland was taken by Saudi Arabia (45% of imports, 11 million tonnes) and Norway (35%, 9 million tonnes). The U.S. brought 6% of it (1 million tonnes), and from other directions 10% (2 million tonnes).
- In total, Poland's crude oil imports amounted to 25 million tonnes, the same as in 2022.
- Poland exports almost no crude oil. The only, insignificant, stream (0.18 million tonnes) flowed, as every year, to Germany.



Source: own elaboration based on GUS data.

Crude oil balance in Poland (2022)

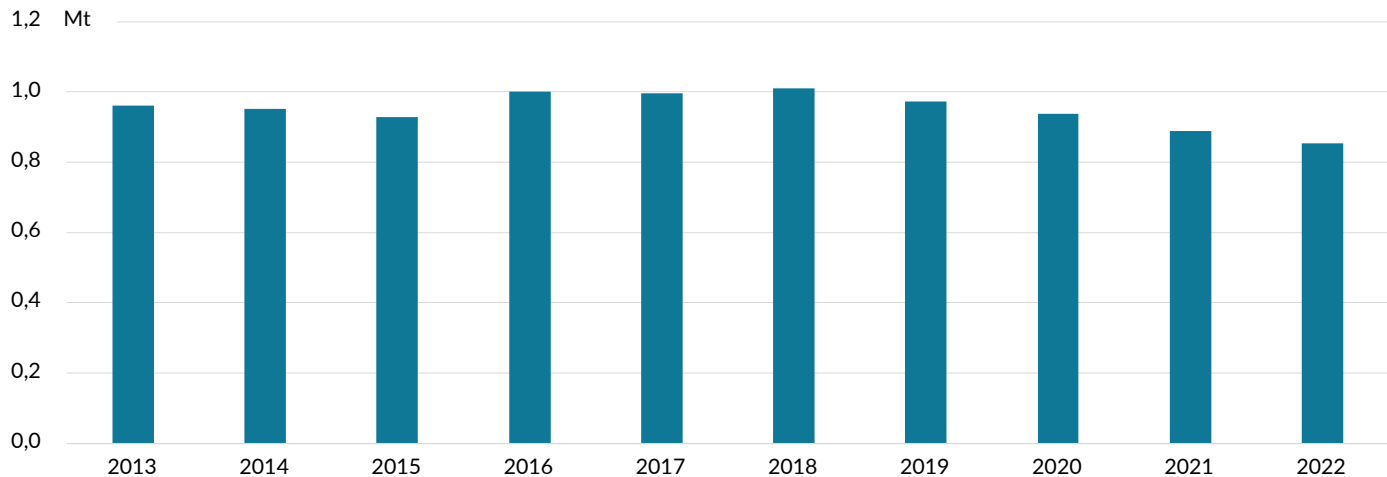
- After two years of declines, crude oil consumption rose to 26.6 million tonnes in 2022, up 1.9 million tonnes y/y (+8%) (latest available data).
- Net imports increased by 2.7 million tonnes (up 11%, to 26.1 million tonnes), while domestic production fell by 4% (to 0.9 million tonnes). Inventories increased by 0.3 million tonnes.
- In 2013-2022, crude oil consumption increased by 2.4 million tonnes (+10%), domestic extraction decreased by 0.1 million tonnes (-11%), and net imports increased by 3.2 million tonnes (+14%).



Source: own elaboration based on GUS data.

Domestic crude oil production (2022)

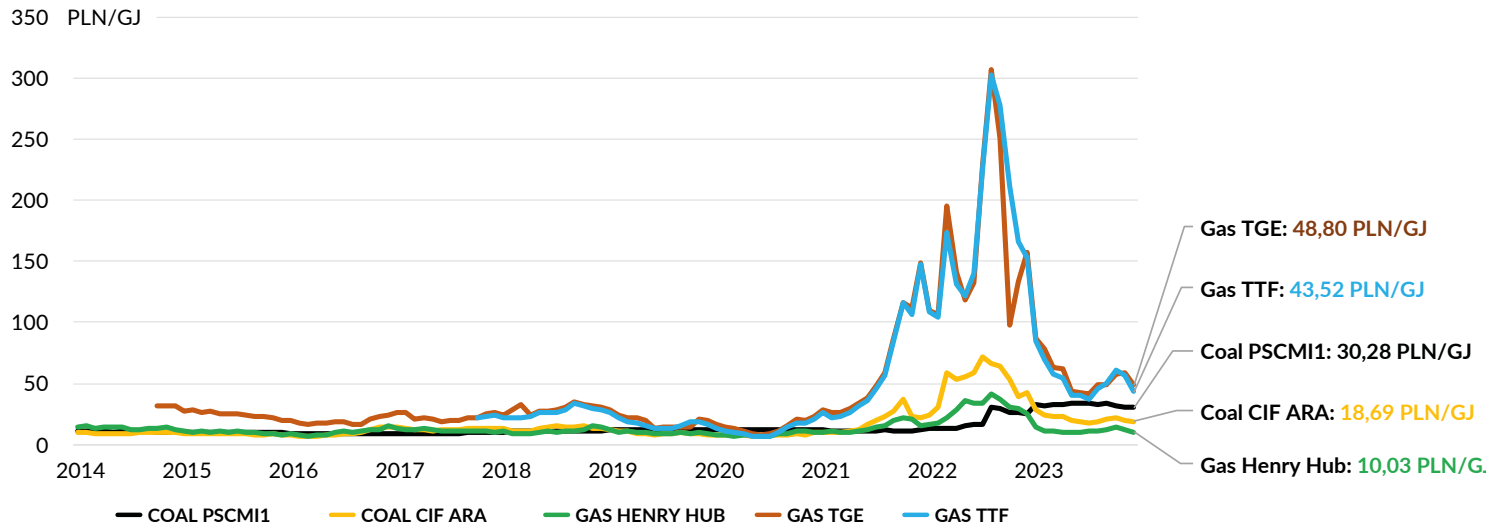
- Domestic oil production has been declining every year for the past four years by about 0.04 million tonnes.
- In 2022, Poland's oil production was 0.85 million tonnes, down 4% year-on-year and 11% lower than in 2013.



Source: own elaboration based on GUS data.

Coal and natural gas prices

- In 2023, the prices of energy commodities traded on the international markets normalised. However, prices remained higher than before the outbreak of the energy crisis and Russian aggression against Ukraine.
- Natural gas recorded the largest price declines. On the European TTF exchange, declines are 72% y/y, on the Polish TGE, 69%, and on the US Henry Hub, 61%. Relative to 2019, however, these prices remain higher by, respectively, 158%, 150%, and 14%.
- Coal on the European ARA exchange was also cheaper, down 56% y/y, although relative to 2019 the price was 126% higher.
- The only raw material whose prices increased relative to 2022 was Polish coal (PSCMI1), which became 20% more expensive. Relative to the end of 2019, it was 150% more expensive.



Source: own elaboration based on monthly averages: ARP, TGE, NBP, Gas TTF – index Dutch TTF Gas Exend (TG.F), Coal CIF ARA – index Coal (API2), CIF ARA (ARGUS-McCloskey), Futures (MTFc1), Gas Henry Hub – index NYMEX (NG.F).

Chapter 4.

Impact on climate. Emissions



27th

is Poland's rank in the European Union (last) in terms of specific CO₂ emissions in electricity generation.



3rd

is Poland's rank in the world from the bottom (so, among the worst) in terms of specific greenhouse gas emissions associated with primary energy consumption.



PLN 24.7 bln

was gained by the Polish budget in 2023 from the sale of CO₂ emission allowances. Since 2014, the value, adjusted for inflation, is PLN 130 billion.



38%

is the percent of Poland's greenhouse gas emissions that come from electricity and heat production.



48%

of Polish emissions in 2022 were traded in the ETS (in power generation: 98%, in industry: 79%).



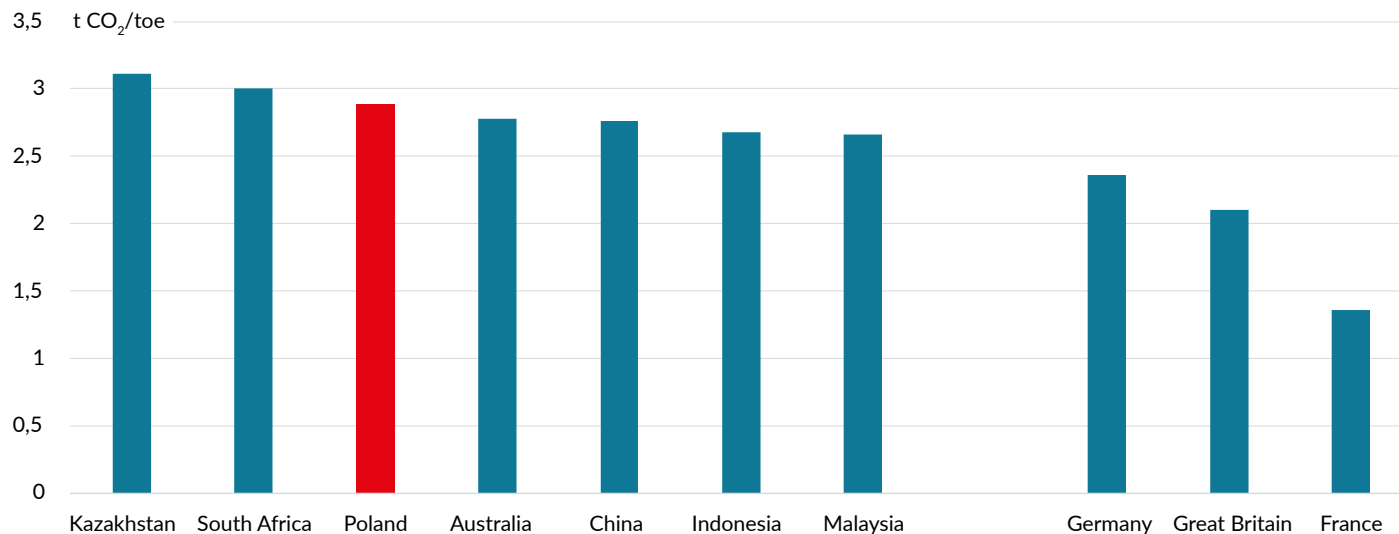
-27.6%

is the reduction in greenhouse gas emissions from the energy sector relative to 2005. Relative to 2022, it is -14.7%.

The rate of reduction in CO₂ emissions is much lower than that of other countries in the region and the EU. Although emissions in the power and heat industry dropped significantly for the first time, the rate of decline in other sectors of the economy is insufficient. This is especially true in transport, where emissions are increasing. The high level of emissions in the power sector translates into high energy prices, and in industry it translates into reduced competitiveness.

Specific emissions of primary energy consumption (2022)

- In 2022, Poland was ranked third in the world („up” four places y/y) in terms of the specific carbon intensity of primary energy consumption.
- Kazakhstan had the most carbon-intensive economy (3.11 t CO₂/toe). Poland, with a score of 2.89 t CO₂/toe (+0.05 y/y), ranked just behind South Africa (3 t CO₂/toe). By comparison, the economy of the United Kingdom emitted 27% less than Poland (2.1 t CO₂/toe), and the French economy emitted 53% less (1.36 t CO₂/toe).

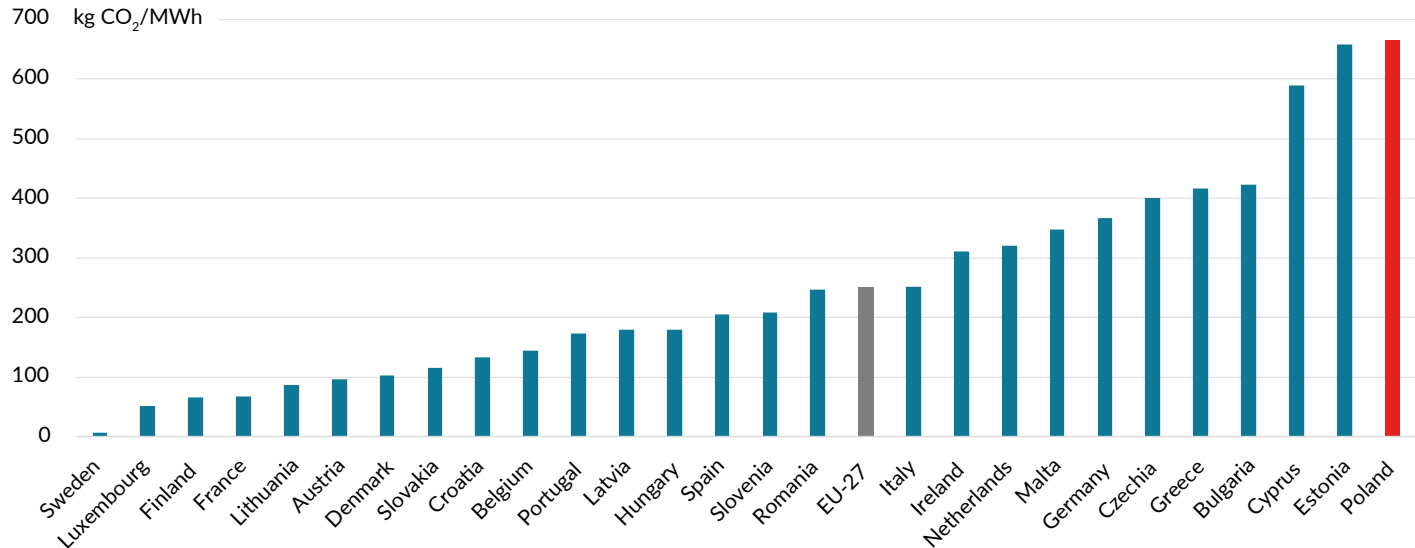


Source: own elaboration based on Enerdata data.

The specific carbon intensity of primary energy consumption tells how many tonnes of CO₂ were emitted on average when consuming 1 unit of primary energy (toe - tonnes of oil equivalent, 1 toe ≈ 41.9 GJ). In other words, it is the emission intensity of energy consumption, regardless of its form (heating, fuels, electricity, etc.).

Greenhouse gas emission intensity of electricity generation (2022)

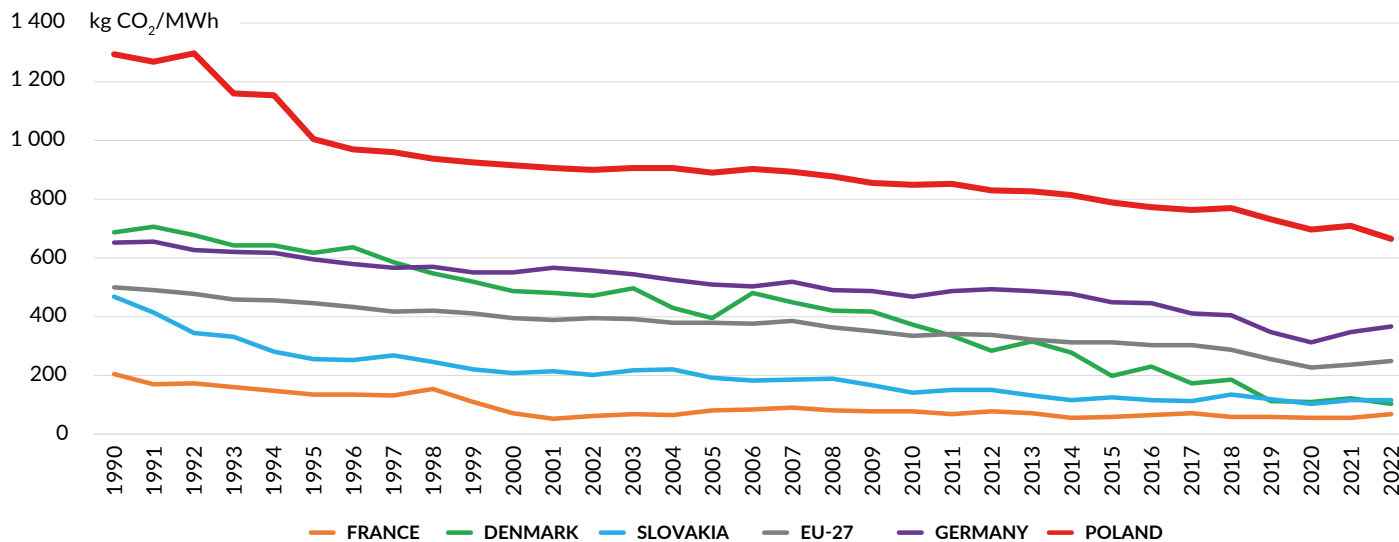
- Greenhouse gas emission intensity of electricity production in 2022 in Poland was 666 kg CO₂/MWh, the highest in the EU.
- Such a high intensity has and will continue to have an impact on industry, among others, due to the growing importance of the carbon footprint of industrial production, which must be reported. With high prices for CO₂ emission allowances, the cost of electricity generation also increases significantly, which translates into high prices on the wholesale market.



Source: own elaboration based on EEA data.

Change in GHG emission intensity of electricity generation over time (2022)

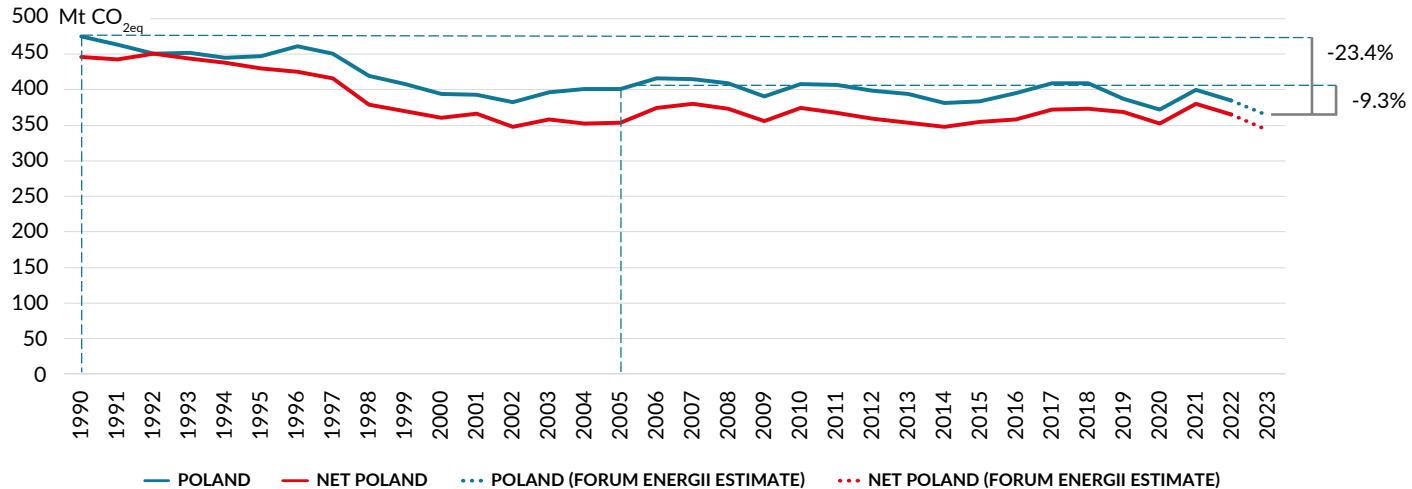
- Despite a 48.5% reduction in the carbon intensity of electricity production relative to 1990, Poland's power sector is (and always has been) one of the most carbon-intensive in the EU.
- The EU average reduction between 1990 and 2022 is 49.9%. Among countries with large power systems, Denmark has been the most successful, with reductions in greenhouse gas emissions from the power industry reaching 85%. However, it should be noted that due to its size, location, and connection to its neighbors, it is not a reference country to Poland.
- In the same period, Slovakia's carbon-intensity reductions were 75.4%, France's 66.8%, and Germany's 43.9%.



Source: own elaboration based on EEA data.

Changes in greenhouse gas emissions in Poland

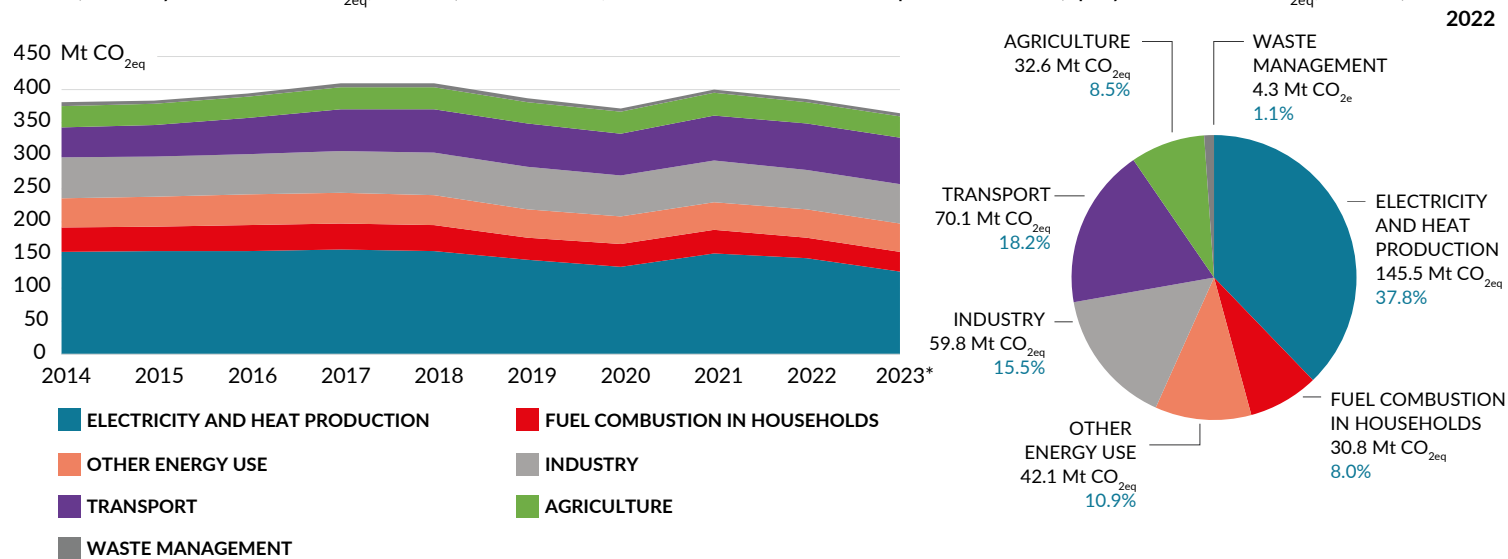
- According to Forum Energii estimates, Poland's gross emissions in 2023 fell by 5.5% from 2022, to about 364 million tonnes of CO_{2eq}.
- Land use, land use change and forestry (LULUCF) were responsible for absorbing about 20 million tonnes of CO₂-equivalent, reducing net emissions to about 345 million t CO_{2e}.
- Relative to 1990 (the reference year for the EU), Polish gross emissions fell by 23.4%.
- Relative to 2005 (the beginning of the emissions trading system), Polish gross emissions fell by 9.3%.



Source: own elaboration based on EEA, KOBiZE, ARE and GUS data. Greenhouse gases: CO₂, methane, nitrous oxide. Net greenhouse gas emission is lower than gross emission because it takes into account not only greenhouse gases released into the atmosphere but also those absorbed by trees, peatlands, or soil (LULUCF – Land Use, Land Use Change and Forestry).

Structure of greenhouse gas emissions in Poland (2022)

- In 2023, most GHG emissions came from electricity and heat production: 124 million t CO_{2eq}, or 34% of estimated total gross emissions. This represents a decrease relative to 2022 of 21.4 million t CO_{2eq} (-15% y/y).
- In 2022 (the latest official data), only emissions from the transport sector increased, by 3% y/y, to 70.1 million t CO_{2eq}.
- Emissions from household fuel combustion fell the most (by 13% y/y, to 30.8 million t CO_{2eq}), industry (by 5% y/y, to 59.8 million t CO_{2eq}), and agriculture (by 4% y/y, to 32.6 million t CO_{2eq}).
- Over the 10-year period, emissions from power generation (down by 29.9 million t CO_{2eq}, or 19%) and households (down by 9.9 million t CO_{2eq}, or 24%) fell the most, while emissions from transport increased (up by 25 million t CO_{2eq}, or 55%).

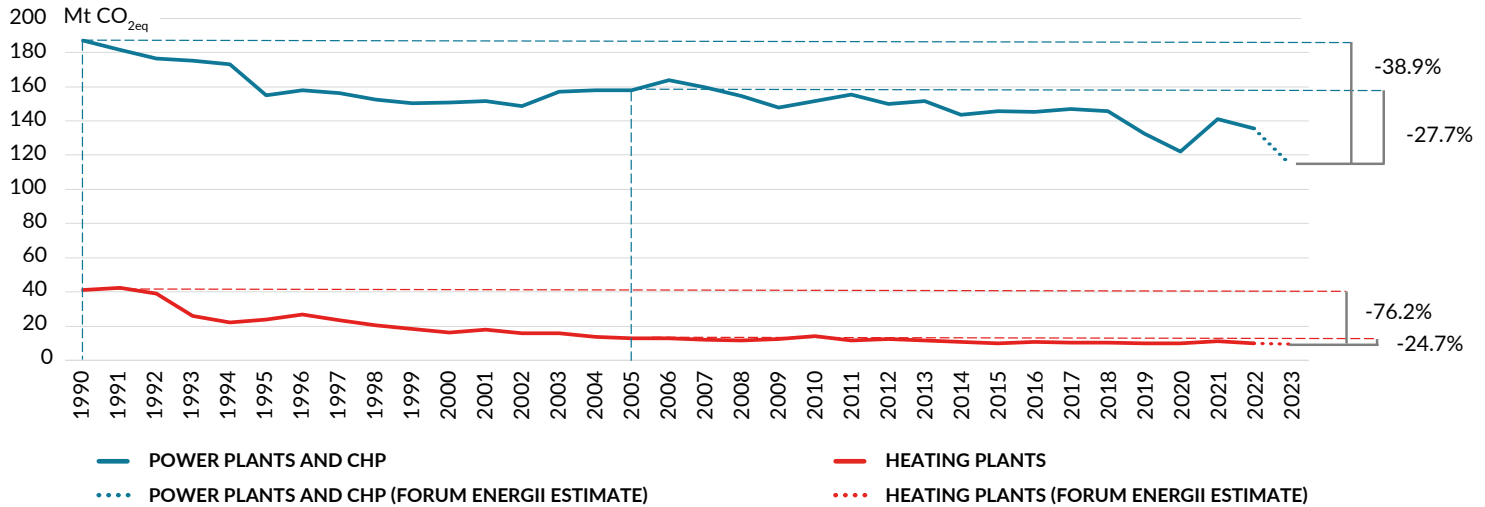


Source: own elaboration based on EEA, KOBiZE, ARE and GUS data.

* Estimated values.

Changes in greenhouse gas emissions from electricity and heat generation

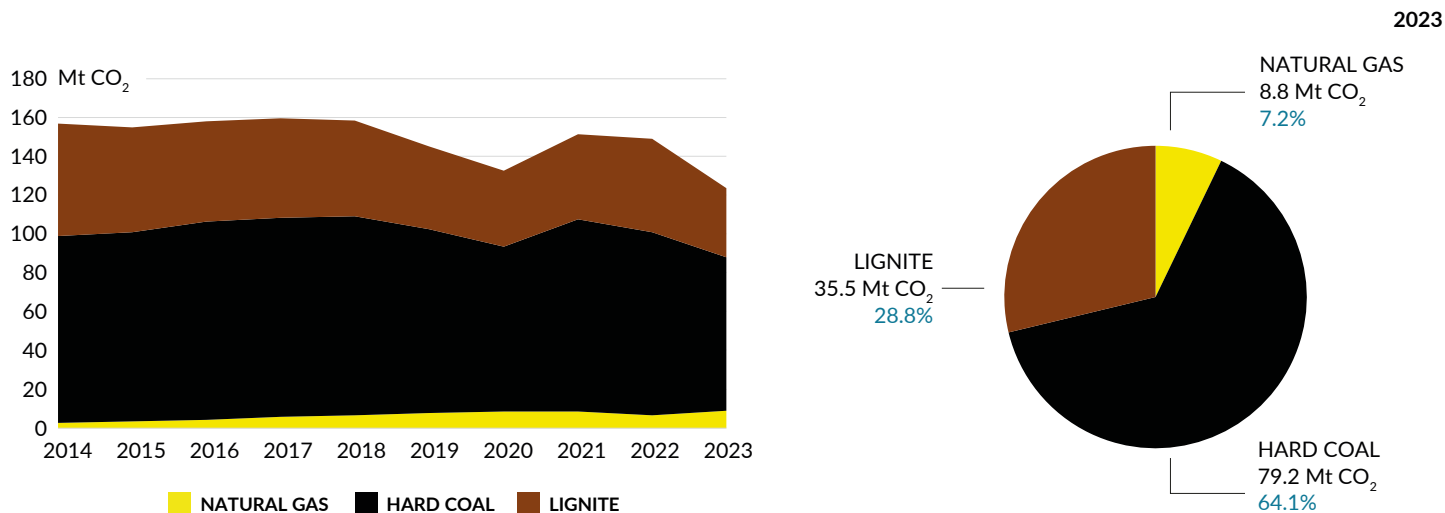
- According to Forum Energii estimates, emissions from power plants and CHP in Poland in 2023 fell by 15.6% against 2022, to 114 million t CO_{2eq}
- Greenhouse gas emissions from heating plants fell an estimated 2.5% y/y, to 9.8 million t CO_{2eq}.
- Relative to 1990, emissions from power plants and combined heat and power (CHP) plants fell by 38.9%, and from district heating plants by 76.2% (mainly due to a decline in industrial demand and modernized district heating systems).
- Relative to 2005, the emission reductions are, respectively, -27.7% and -24.7%.



Source: own elaboration based on EEA, KOBiZE, ARE and GUS data. Greenhouse gases: CO₂, methane, nitrous oxide.

Emissions from electricity and heat production, by fuel

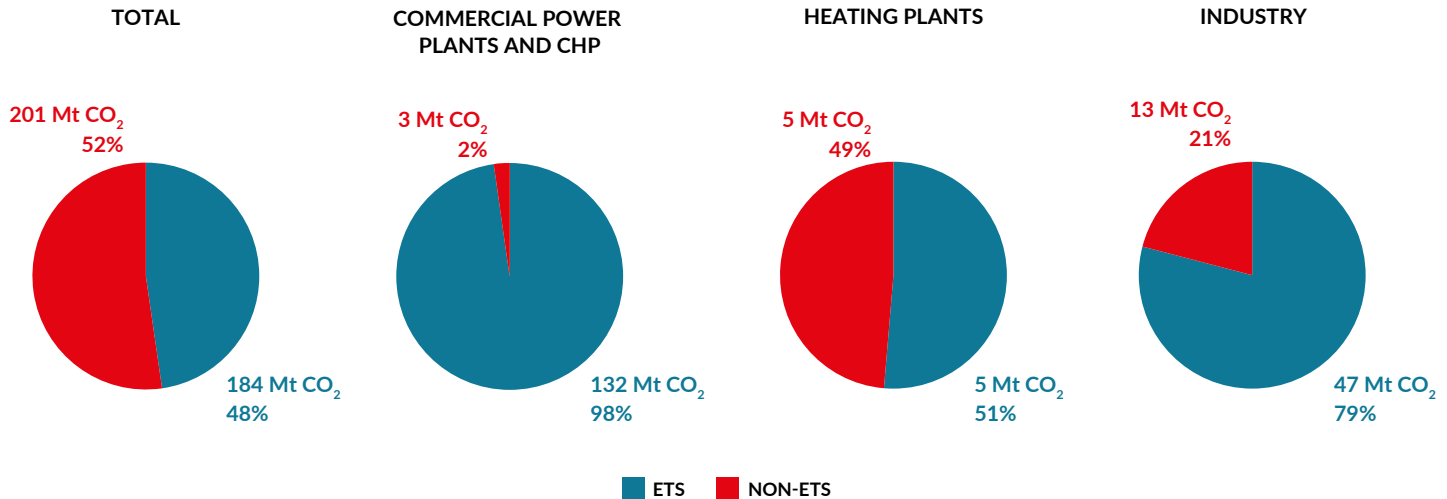
- Hard coal was responsible for 64% of CO₂ emissions from the power sector in 2023 (79.2 million t CO₂, -16% y/y).
- Lignite accounted for 29% of emissions (35.5 million t CO₂, -26% y/y).
- Production of electricity and heat from natural gas was associated with emissions of 8.8 million t CO₂ (+32% y/y), accounting for 7%.
- During the decade, emissions from lignite fell by 39% (-22.4 million t CO₂), and from hard coal by 18% (-16.8 million t CO₂). In contrast, emissions from natural gas increased by 224% (+6.1 million t CO₂).



Source: own elaboration based on KOBiZE, ARE and GUS data.

Carbon dioxide emissions covered by the Emissions Trading System (2022)

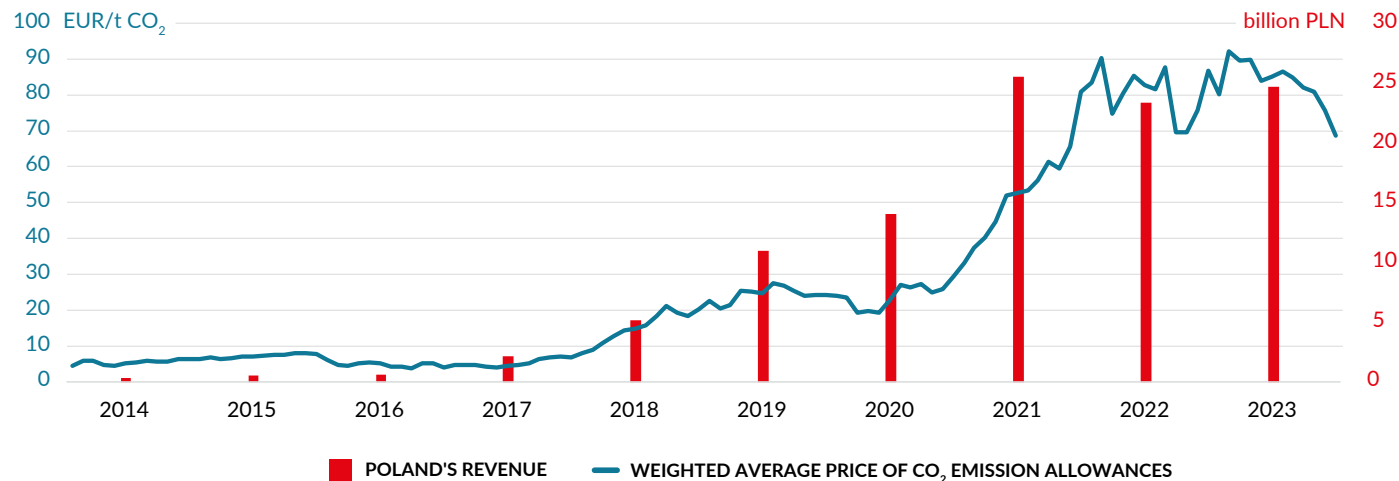
- Poland's total CO₂ emissions in 2022 amounted to 384.8 million tonnes, with 48% of them covered by the European Emissions Trading System (EU ETS).
- Among commercial power plants and combined heat and power plants, 132 million tonnes of CO₂ were covered by the ETS (98% of all emissions from this sector). For heat plants, the figure is 51%: 5 million t of CO₂ from Polish heat plants were subject to the ETS in 2022.
- For industrial GHG emissions, 79% of emissions, or 47 million t of CO₂, were covered by the ETS.



Source: own elaboration based on EEA and KOBiZE data.

CO₂ emission allowances prices and Poland's income from their sale

- At the end of 2023, the weighted average price of CO₂ emission allowances on the primary market (EEX) was 68.69 EUR/t CO₂.
- In February 2023, EUA prices exceeding 100 EUR/t CO₂ were recorded for the first time, but in the second half of the year price declines were observed.
- The volume of allowances sold by Poland amounted in 2023 to 65.1 million tonnes. This is 2.1 million tonnes more than in 2022.
- The country's budget gained PLN 24.67 billion from auctions of CO₂ emission allowances (EUA and EUAA). This is PLN 1.4 billion more than in 2022 and PLN 24.3 billion more than in 2014.
- PLN 107.4 billion in total in nominal terms was the budget's revenues over the 10 years of CO₂ allowance sales. Adjusted for inflation, it is PLN 129.8 billion.



Source: own elaboration based on EEX and NBP data.

Energy Transition
in Poland.
2024 Edition



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