



Energy Transition in Poland

2023 Edition

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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

- 2022 was a year of an energy crisis triggered by Russia's aggression against Ukraine and a decline in electricity generation in Europe from hydro and nuclear sources. Combined with fluctuations in supply, demand, and commodity prices caused by the COVID-19 pandemic, EU wholesale markets witnessed a steep rise in energy prices of up to 400 EUR/MWh.
- In Europe, including Poland, imports of energy raw materials from Russia have been radically reduced, which was and is important for cutting the Kremlin's revenues, which are used to finance the invasion of Ukraine. However, imports of raw materials from other directions have increased.
- Poland's dependence on energy imports is growing and hit a record of 43% in 2021 (10 years earlier, it was 31%). The cost of fossil fuel imports in 2022 reached a record high of PLN 193 billion (PLN 102 billion in 2021).
- As a result of the decline in domestic steam coal production, imports of steam coal reached a record high of 16.9 million tonnes. Supply constraints on coal, its rising price and high operating cost, as well as the declining availability of coal-fired power plants, resulted in a 4.7 TWh (-6% y/y) decline in coal-fired power generation.
- Unprecedented gas prices also forced a cut in the production of gas-fired power plants by 4 TWh (-25% y/y). The reduced output of conventional power plants was also due to an increase in output from renewable energy sources – from photovoltaics by 4 TWh (+102% y/y) and wind farms by 3 TWh (+19% y/y).
- Energy system security is deteriorating year after year. In 2022, the lowest capacity of centrally dispatched generation units (JWCDS) in more than a decade and the highest capacity losses were recorded, which translated into the lowest capacity reserve in 7 years at 1.4 GW (about 6%).
- Last year, Poland's greenhouse gas emissions (GHGs) increased by 0.3% from 2021. The country now ranks 7th in the world in terms of specific emissions of the entire economy (2.84 tonnes of CO₂/toe).
- Specific emissions of electricity generation amounted to 750 kg CO₂/MWh in 2021, placing Poland in penultimate place in the EU. The decrease in the sector's emissions between 2005 and 2022 is only 12%.

Chapter 1.

Energy in Poland



85%

energy in Poland comes from fossil fuels (45% coal, 23% oil, 17% natural gas).



PLN 193 billion

in 2022 was the bill for fossil fuel imports. Since 2013 the amount has been PLN 964 billion (of which PLN 594 billion went to Russia).



2%

of the energy consumed in Poland is covered by wind, solar, geothermal and ambient energy.



43%

of Poland's primary energy comes from imports. This is 12 p.p. increase in 10 years ago.



-0.7%

only that much are reductions in greenhouse gas emissions in Poland since 2005.



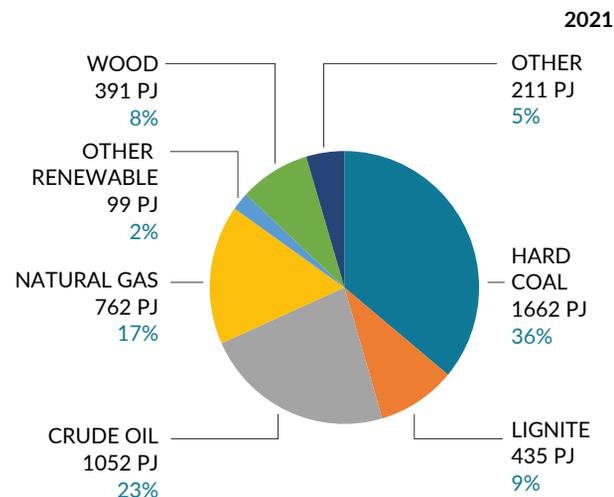
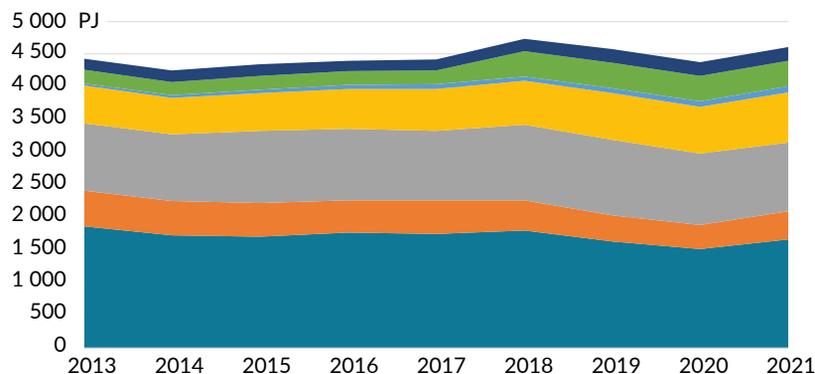
19%

of the coal consumed in 2022 came from imports. In case of natural gas it was 78%.

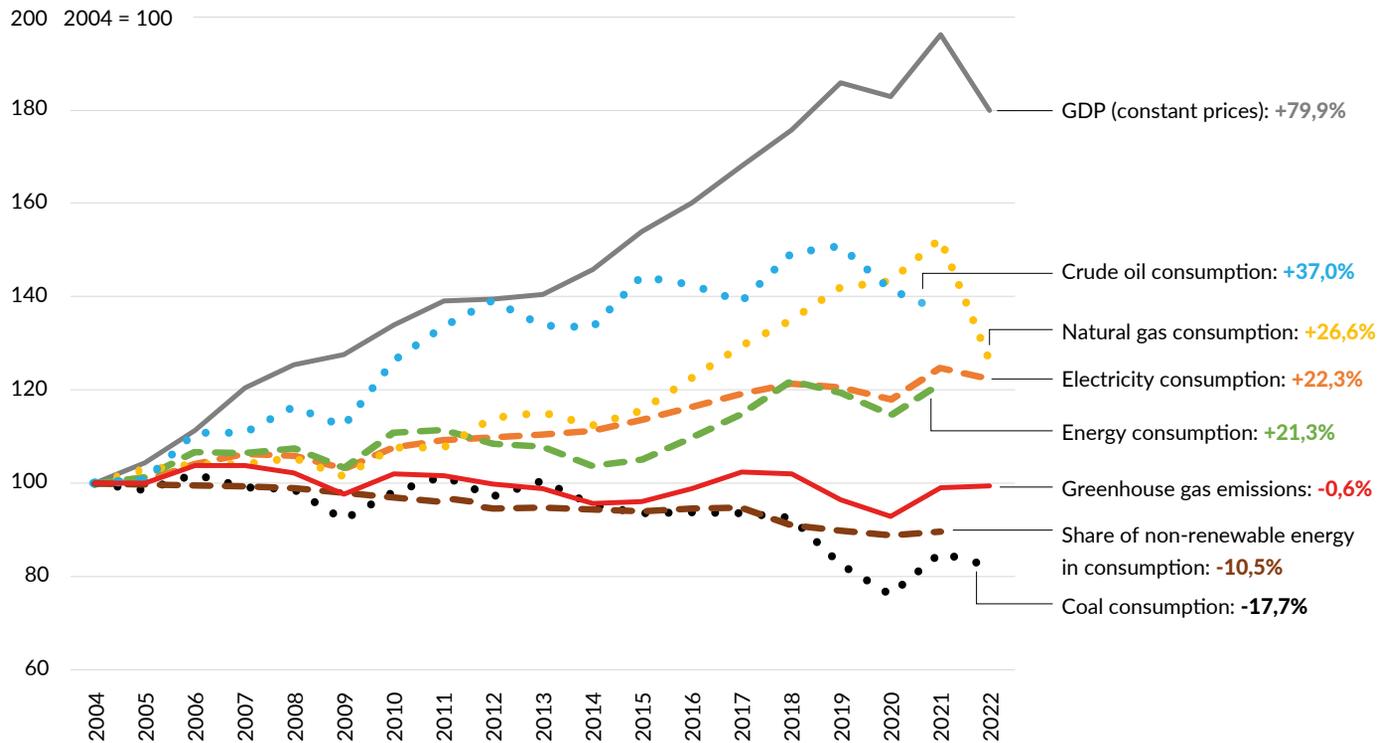
Although modernization of the electricity sector is slowly progressing, the energy transformation of the entire Polish economy is at a standstill, while fossil fuel import bills and the risk of system imbalance are on the rise.

Structure of primary energy consumption (2021)

- 85% of Poland's final energy consumption is covered by fossil fuels.
- 45% of the energy consumed comes from coal: 36% from hard coal and 9% from lignite.
- Renewable sources provided 10% of energy, with as much as 8% coming from biomass (wood). Waterpower, photovoltaics, and wind power; geothermal and ambient heat covered 2% of energy needs.
- Over the last decade, a decline in the share of coal (-8 p.p.) and crude oil (-2 p.p.) is observed, while the share of natural gas (+3 p.p.) and renewable energy (+6 p.p.) has increased.



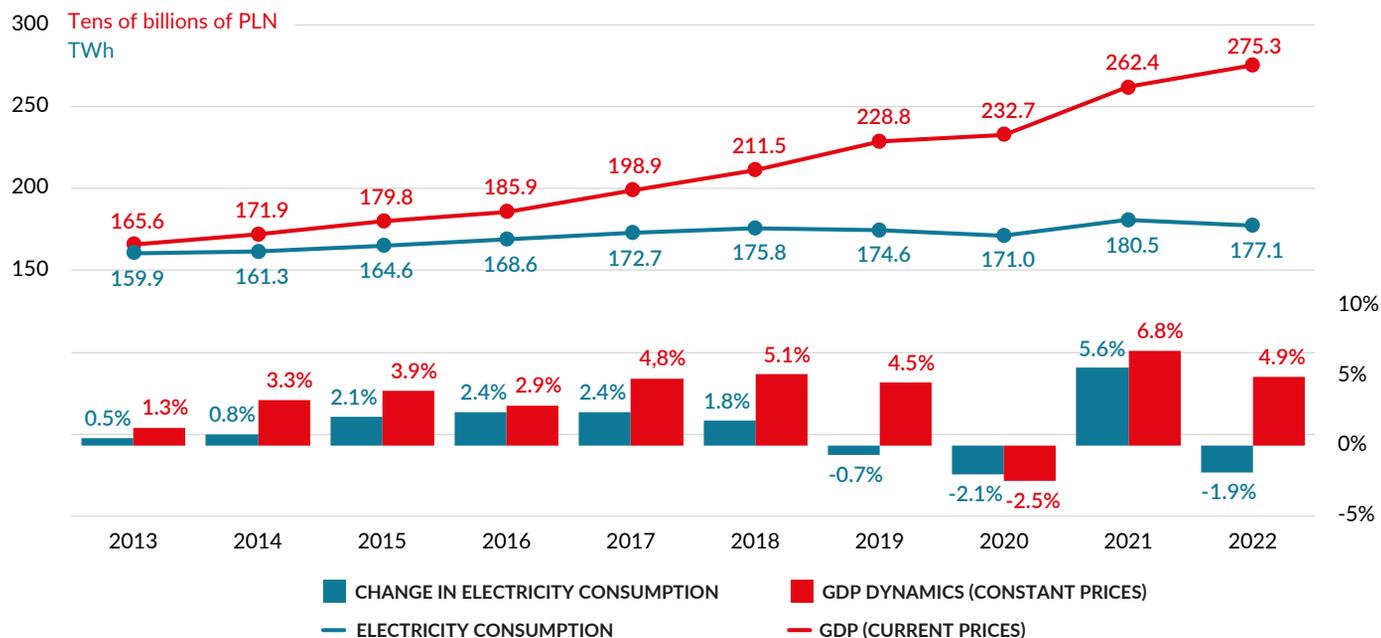
Energy transition indicators in 2022 (since 2004, entrance to the EU)



Own elaboration based on ARE, GUS, EEA, ARP, ENTSOG and Eurostat data.

Change in electricity demand vs. GDP

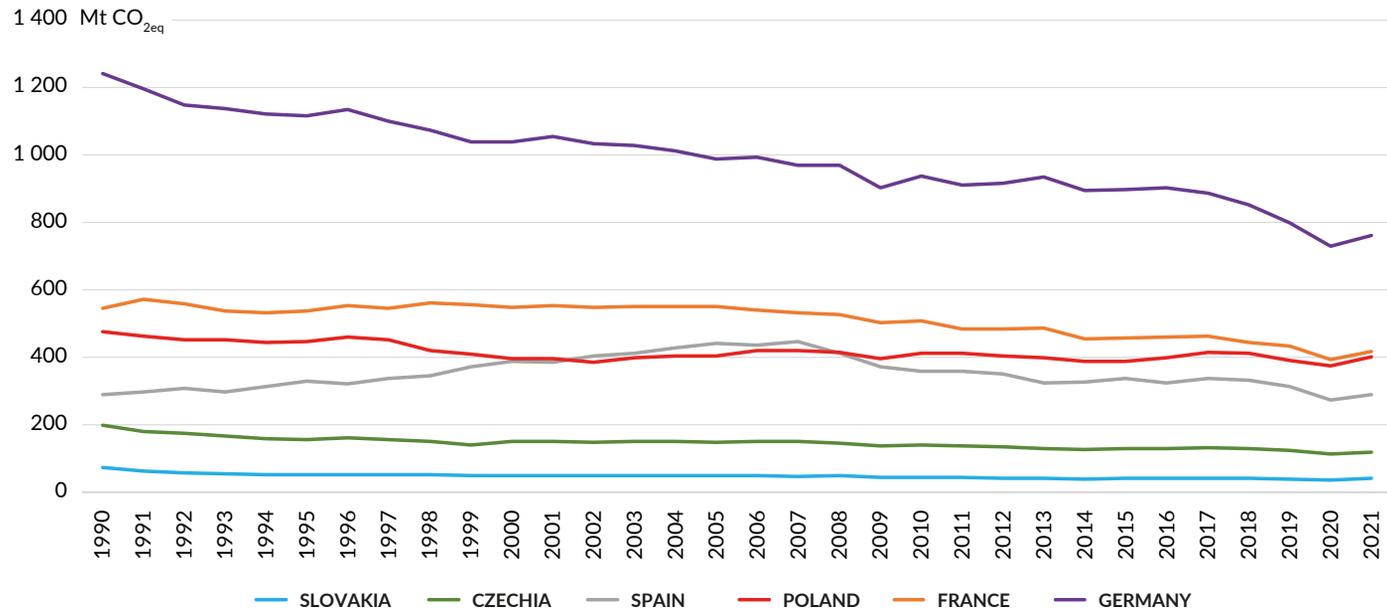
- In 2022 GDP grew by an estimated 4.9%, while electricity consumption fell by 1.9%.
- For years, there has been a so-called decoupling of economic growth from electricity demand in Poland – in 10 years, GDP (at constant prices) grew by 28%, with electricity consumption increasing by 10.7%.



Own elaboration based on ARE and GUS data.

Change in greenhouse gas emissions compared to other EU countries (2021)

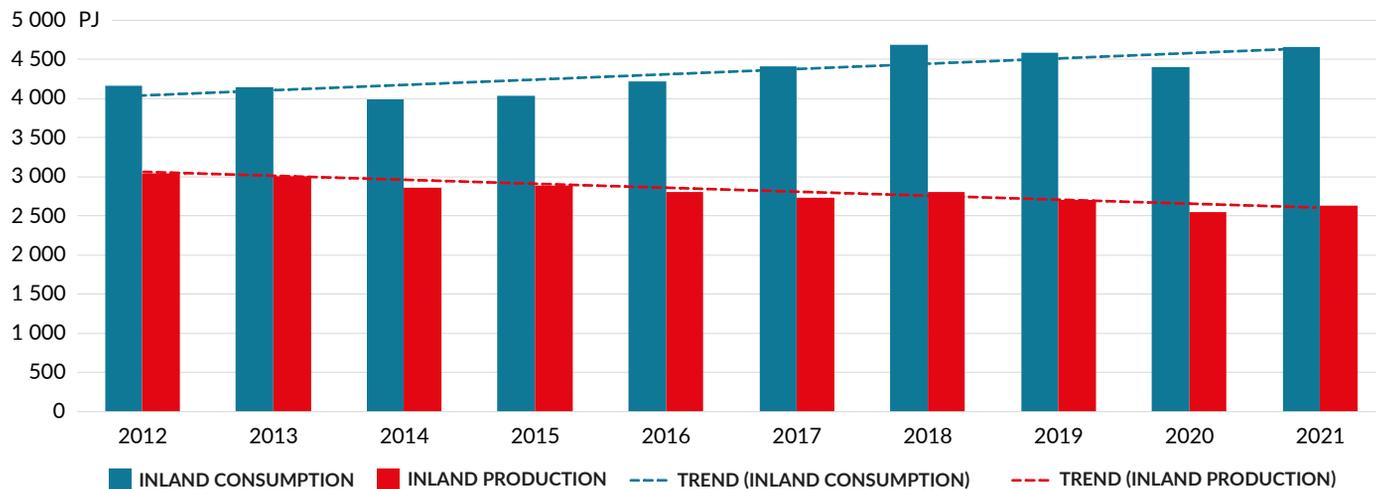
- Polish reductions in greenhouse gas emissions relative to 1990 are 15.7%. However, since 2005 (the year the emissions trading scheme began), it is only 1%.
- The EU average reduction from 1990 to 2021 is 29%. Relative to 2005, the decrease was 23.8%.
- Over the previous three decades, Germany has reduced GHGs by 38.7%. Even better (relative) results are observed in Czechia (-39.8%) and Slovakia (-44.4%).



Own elaboration based on EEA data.

Import wedge – demand and supply of total energy (2021)

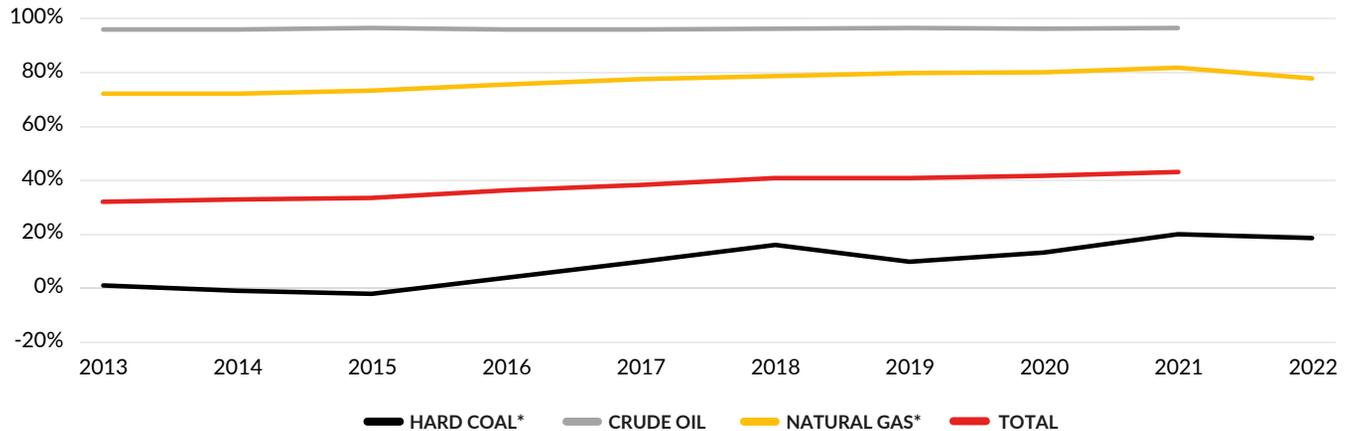
- An increase in total energy consumption in the Polish economy has been observed for years. Over 10 years, domestic consumption has increased by 12% (495 PJ).
- At the same time, a reduction in the domestic supply of primary energy has been observed, mainly through a decline in the extraction of energy resources and slow RES development. In the previous 10 years, the supply dropped by 14% (-410 PJ).
- This means increasing dependence of the economy on energy imports from abroad.



Own elaboration based on ARE data.

Poland's import dependence

- Import dependency is defined as the ratio of imported energy to final energy consumption.
- For years, the greatest import dependence has been observed in the case of crude oil: 96-97% of the crude oil consumed in Poland has been imported.
- In 2022, the estimated import dependency for natural gas was 78%, 4 p.p. lower than in 2021. Nevertheless, it increased by 8% (6 p.p.) over 10 years.
- 19% was the import dependence for hard coal in 2022 (Forum Energii estimate). This represents a decrease of 1-2 p.p. relative to 2021. However, it has increased by 18 p.p. over 10 years.
- The total dependence of the Polish economy on energy imports was 43% in 2021. In 2013, it was 32%.

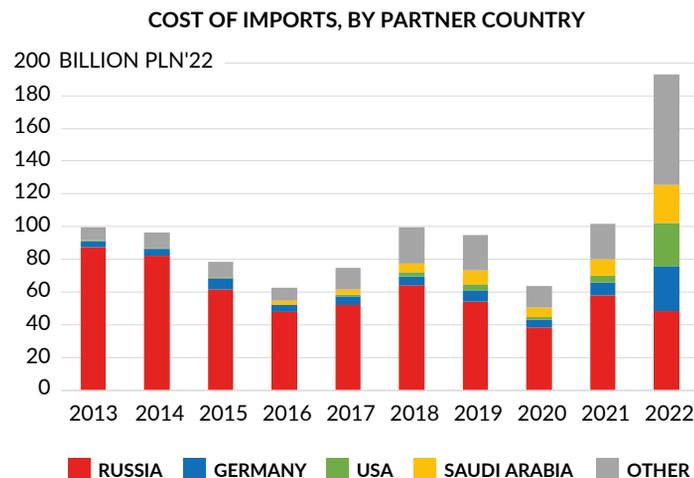
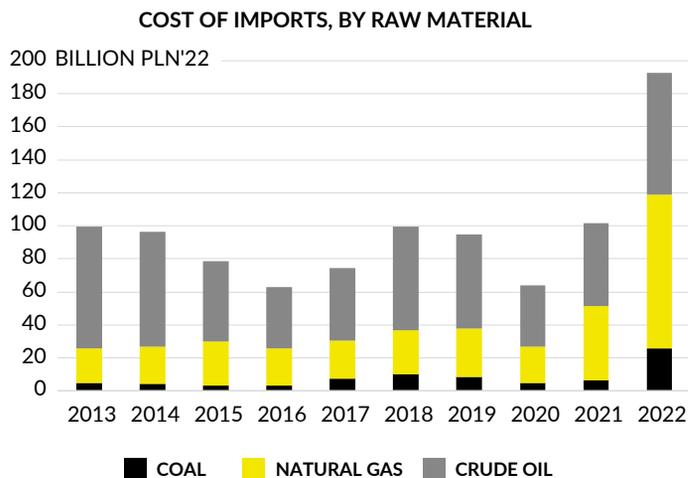


Own elaboration based on ARE, GUS, ARP, ENTSOG and Eurostat data.

* Estimated values for 2022. For the purposes of the estimates for hard coal, unchanged calorific values from 2021 were assumed.

The cost of importing raw energy materials

- In 2022 Polish imports of energy raw materials amounted to PLN 193 billion. Relative to the previous year, this represents an increase of 117% (PLN 104 billion).
- Nearly half (48%) was the cost of importing natural gas (PLN 93 billion), 38% was crude oil (PLN 74 billion). The cost of coal imports amounted to PLN 26 billion, accounting for 13% of raw material import expenditures.
- In 2022, the value of raw material imports from Russia decreased by PLN 9.2 billion relative to 2021, and the country's share of total import expenditures also decreased, from 57% to 25%. Despite this, Russia remained the biggest beneficiary of Poland's dependence on imports, receiving revenue of PLN 48.6 billion in 2022.
- 14% of the revenues from imports flowed to Germany (PLN 27.1 billion), 14% to the US (PLN 26.4 billion), 12% was taken by Saudi Arabia (PLN 23.6 billion), and 35% was transferred to other countries, mainly Qatar, Norway, Kazakhstan, the UK and Australia combined.



Own elaboration based on GUS, NBP and Eurostat data.

Chapter 2.

National Grid System



20.6%

was in 2022 the share of RES in the electricity production. The share of coal is at 70.7%.



1.68 TWh

of electricity was exported by Poland. It became a net exporter for the first time in seven years. Production amounted to 178.8 TWh, and consumption to 177.1 TWh.



1.4 GW

minimum reserve capacity in the NPS – the least in 7 years. The reason: the lowest power of centrally dispatched units since 10 years and their increasing unavailability.



-8.7%

decrease of electricity production from coal and gas. The reason: high fuel prices and record high production from RES.



4.1%

share of domestic electricity production for which prosumer installations (1.2 million installations) were responsible.



203 thous.

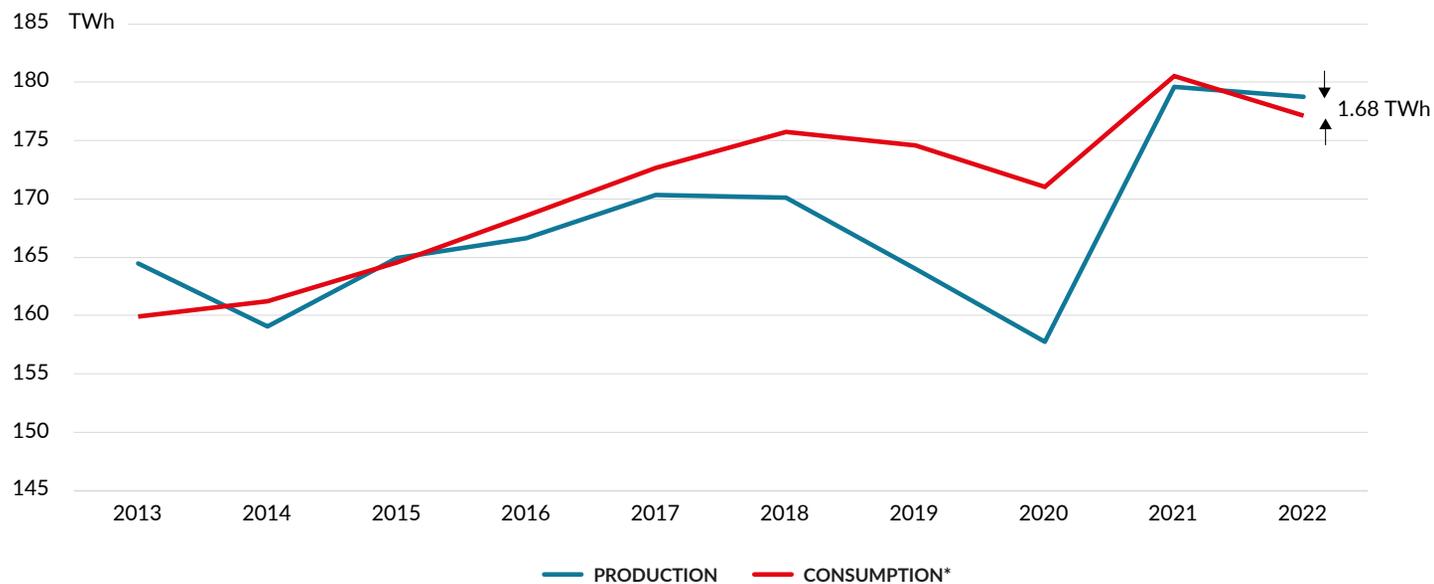
heat pumps were sold in Poland in 2022 alone.

Despite the increase in achievable capacity, controllable dispatchable capacity is decreasing, which increases the risk of system imbalance. The share of RES in electricity generation is growing, and the importance of new demand sources is also increasing. Through record high commodity prices, electricity consumption has fallen, and Poland has become a net exporter of electricity.

National balance

Balance of domestic electricity production and consumption

- Gross electricity production was 178.8 TWh in 2022 – 0.5% less than a year earlier and 8.7% more than 10 years ago.
- Gross electricity demand was 177.1 TWh – 1.9% less than in 2021 and 10.7% more than in 2013.
- For the first time in 7 years, Poland was a net exporter of electricity, with exports amounting to 1.68 TWh.

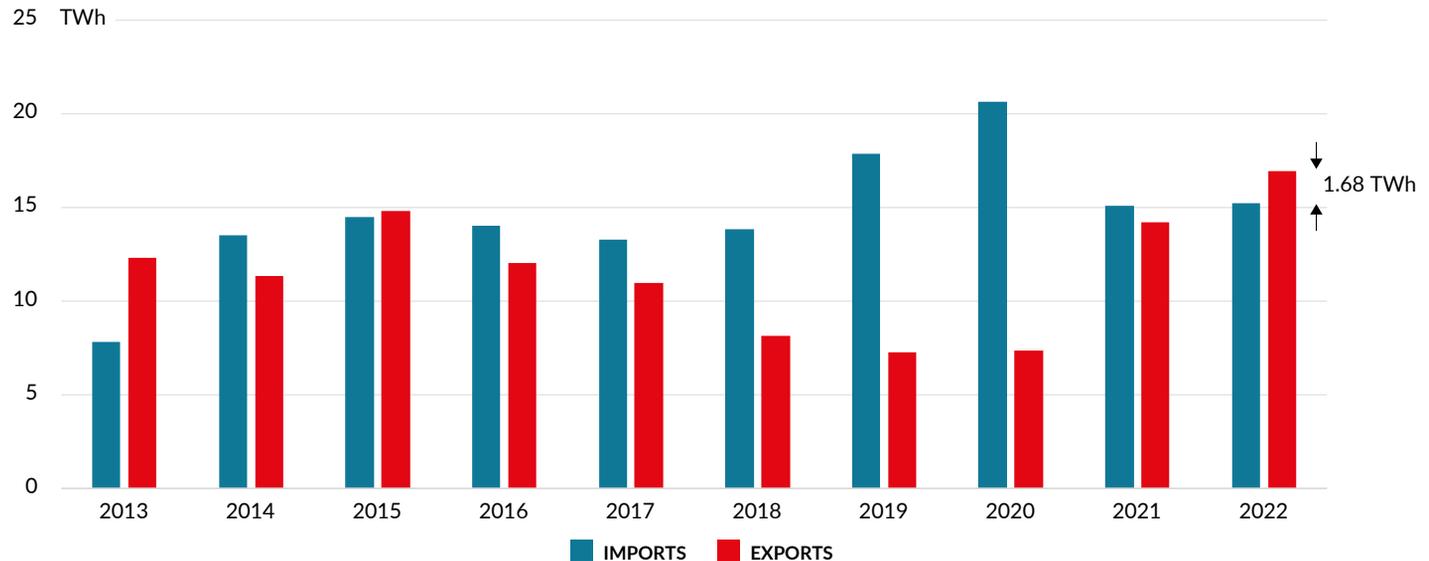


Own elaboration based on ARE data.

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

Cross-border exchange of electricity

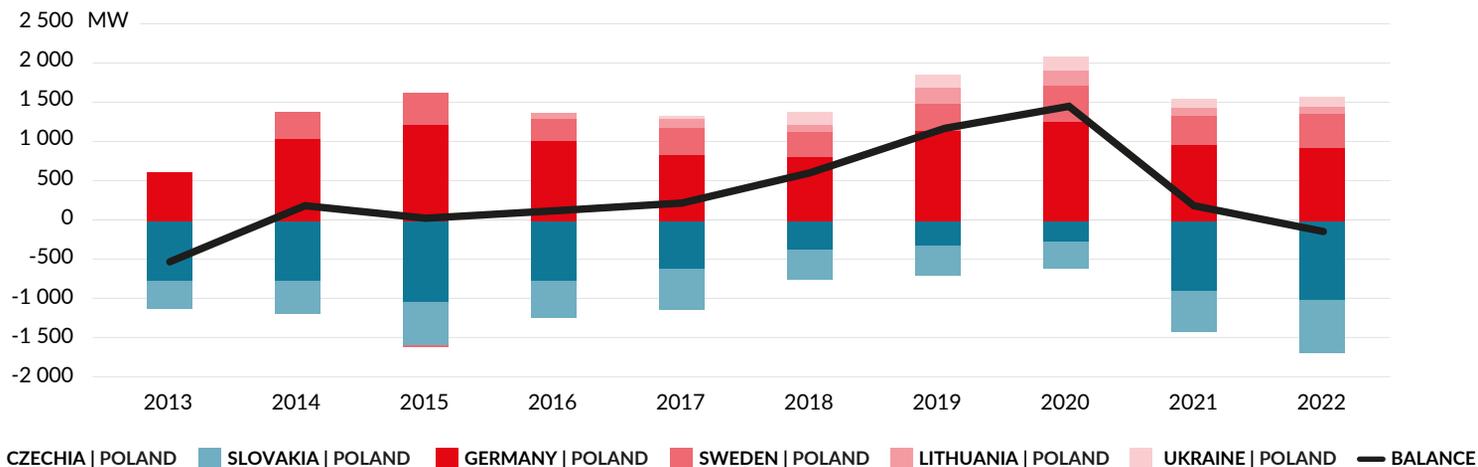
- In 2022, electricity imports amounted to 15.24 TWh, while exports amounted to 16.92 TWh. The balance of exchange with foreign countries amounted to -1.68 TWh.
- Electricity exports were the highest since 2013, mainly due to lower prices on the wholesale market in Poland. This was due to the lower cost of producing electricity from RES and coal in Poland than from natural gas in neighboring countries (even after taking into account the high price of CO₂).



Own elaboration based on ARE data.

Cross-border electricity exchange capacity

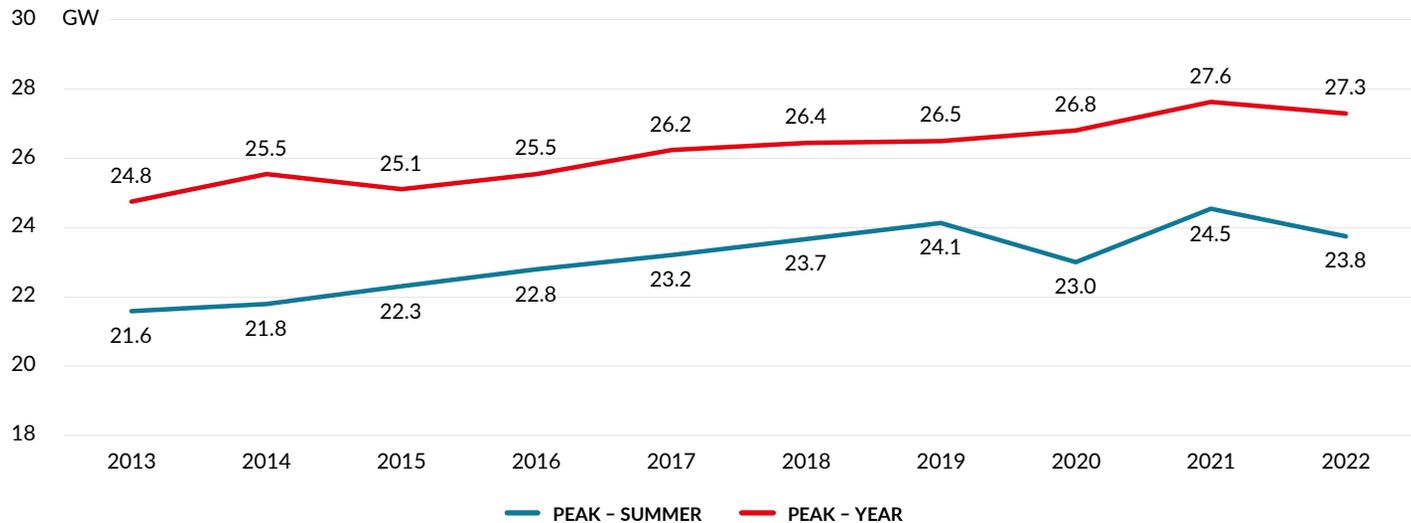
- For years, Poland has been importing electricity from Germany, the north (Sweden, Lithuania) and Ukraine, while exporting south, to Czechia and Slovakia.
- The highest average annual cross-border exchange capacity was observed from Germany (923 MW) to Czechia (995 MW).
- Through DC links (with Sweden and Lithuania), an average of 400–600 MW has been imported over the years.
- Average annual exports amounted to 105 MW in 2022.
- The highest average import capacity in recent years was observed in 2020 and amounted to 1,466 MW. This value is equivalent of the capacity of about one and a half of the output of the newest unit at the Koźienice power plant.



Own elaboration based on ARE data.

Change in peak power demand

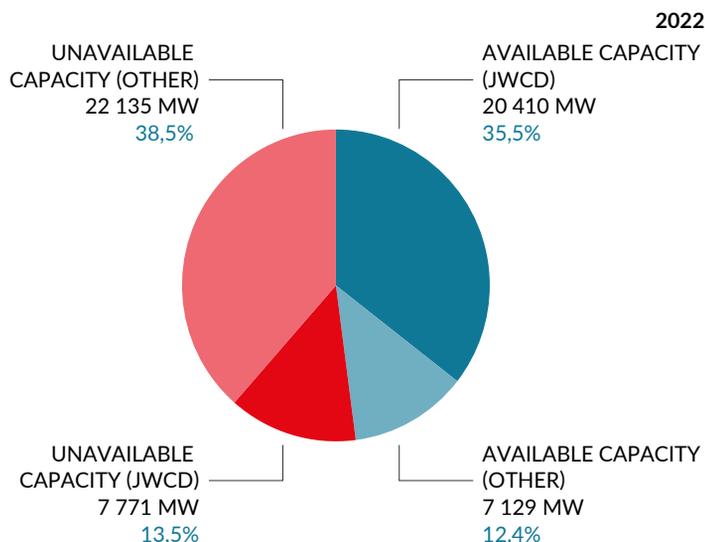
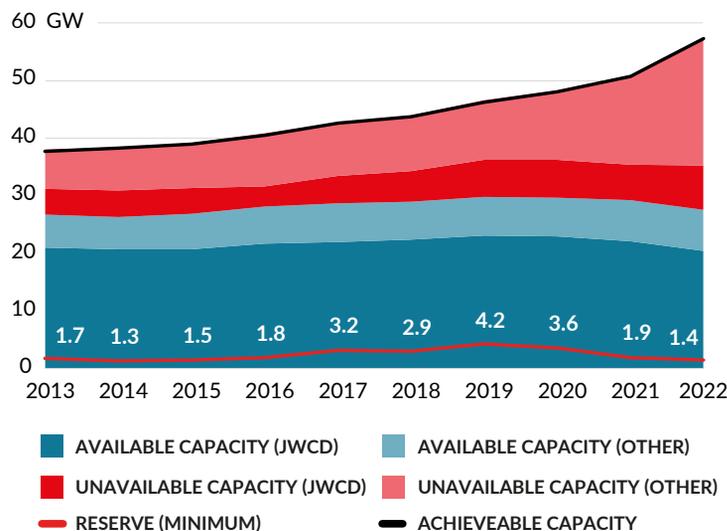
- Winter peak power demand in 2022 was 27.3 GW, around 0.3 GW less than the previous year. Summer power demand also declined, dropping to 23.8 GW, down more than 0.7 GW from 2021.
- The decline in peak demand, despite the increase in number of heat pumps, air conditioners and electric cars, can be partly explained by electricity savings due to its high price, especially for industry.
- Increasing prosumer self-consumption (summer peak) and the shift of some households to non-electric heating (winter peak) are also reasons for the declines.



Own elaboration based on PSE data.

Reserve and unavailable capacity

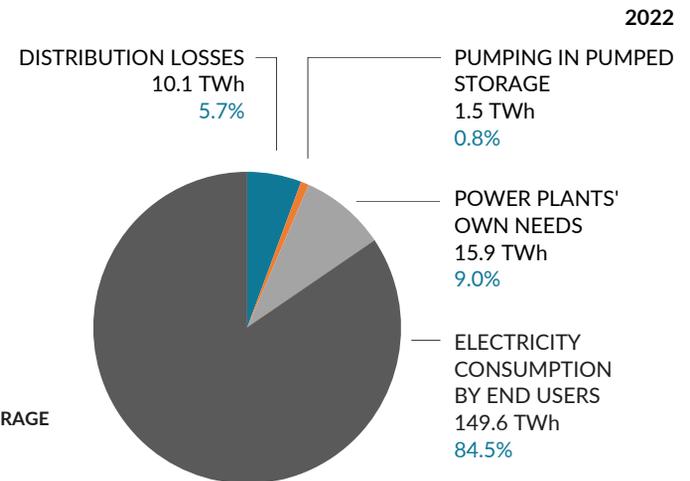
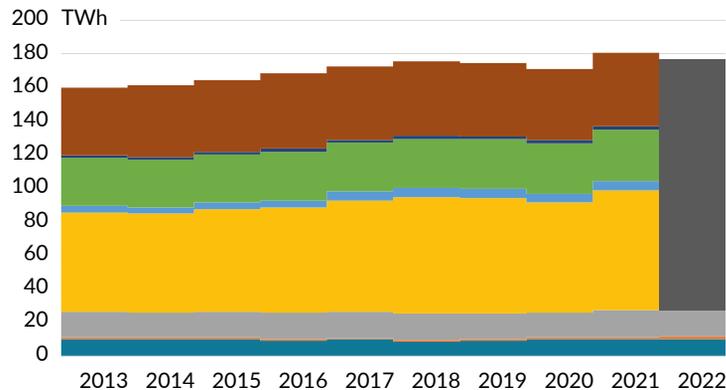
- 2022 marks the fifth-lowest level of power reserve in the electricity system, at 1.4 GW. It is also the lowest in 7 years.
- The system's achievable capacity rose to as much as 60 GW in December, averaging over year 57.4 GW.
- On average, unavailable capacity accounted for 52% of the achievable capacity – 13.5% was unavailable from centrally dispatched generation units (JWCDs), while the remaining 38.5% was unavailable from non-JWCDs and non-working RES.
- The available capacity of JWCDs fell to its lowest level in at least 10 years, to 20.4 GW. This means that the share of JWCD capacity in the system's available capacity has fallen from 56% in 2013 to less than 36% in 2022.



Own elaboration based on PSE data.

Structure of electricity consumption

- Gross electricity consumption amounted to 177.1 TWh in 2022; consumption by end users was 15.5% lower, at 149.6 TWh.
- The remaining 27.5 TWh includes consumption for power plants' own needs (15.9 TWh, 9% of gross consumption) and losses in transmission and the distribution grid (10.1 TWh, 5.7%).
- Pumped storage units required 1.5 TWh of electricity in 2022 (0.8% of gross domestic consumption). These units produced 1.1 TWh, so the efficiency of these energy storage units was 70%.

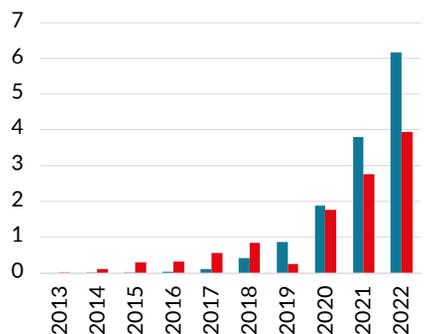


Own elaboration based on ARE data.

Electricity consumption – demand increasing factors

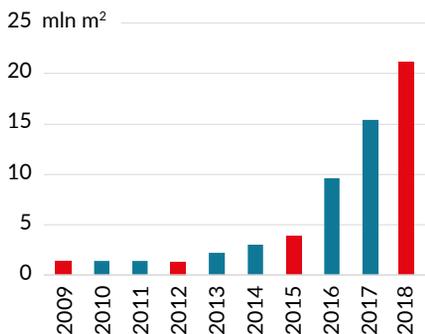
- Through the electrification of heating, transportation, and the rising number of air conditioners, the power system will be subjected to increasing stress.
- In 2022, a record number of heat pumps were sold (more than 200,000) and the most electric cars (BEVs and PHEVs) on Polish roads was recorded at more than 60,000.
- Also, air-conditioned space in households is growing rapidly. According to Forum Energii estimates, in 2018 it exceeded 20 millions m².
- The increase in the percentages of EVs, heat pumps, and air-conditioned space was 62%, 119%, and 37% y/y, respectively.

NUMBER OF EVS AND CHARGING POINTS

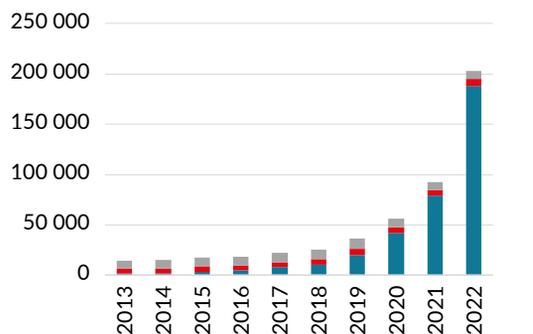


■ ELECTRIC VEHICLES (TENS OF THOUSANDS)
 ■ CHARGING POINTS (THOUSANDS)

AIR-CONDITIONED HOUSEHOLD SPACE*



NUMBER OF SOLD HEAT PUMPS IN EACH YEAR



■ AIR | WATER (HOT WATER)
 ■ BRINE | WATER (CENTRAL HEATING AND HOT WATER)
 ■ AIR | WATER (CENTRAL HEATING AND HOT WATER)

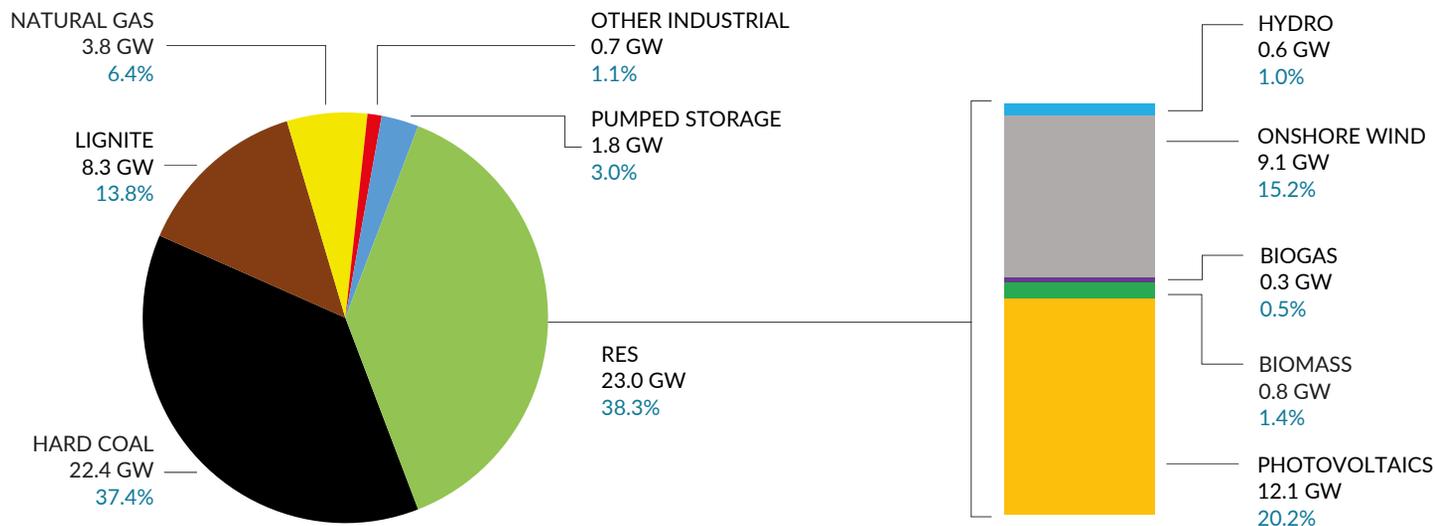
Own elaboration based on PSPA, EFAO, GUS and PORT PC data.

* Red bars are values estimated based on GUS reports, blue bars are values interpolated between these estimates.

Generation capacity

Achievable capacity in 2022

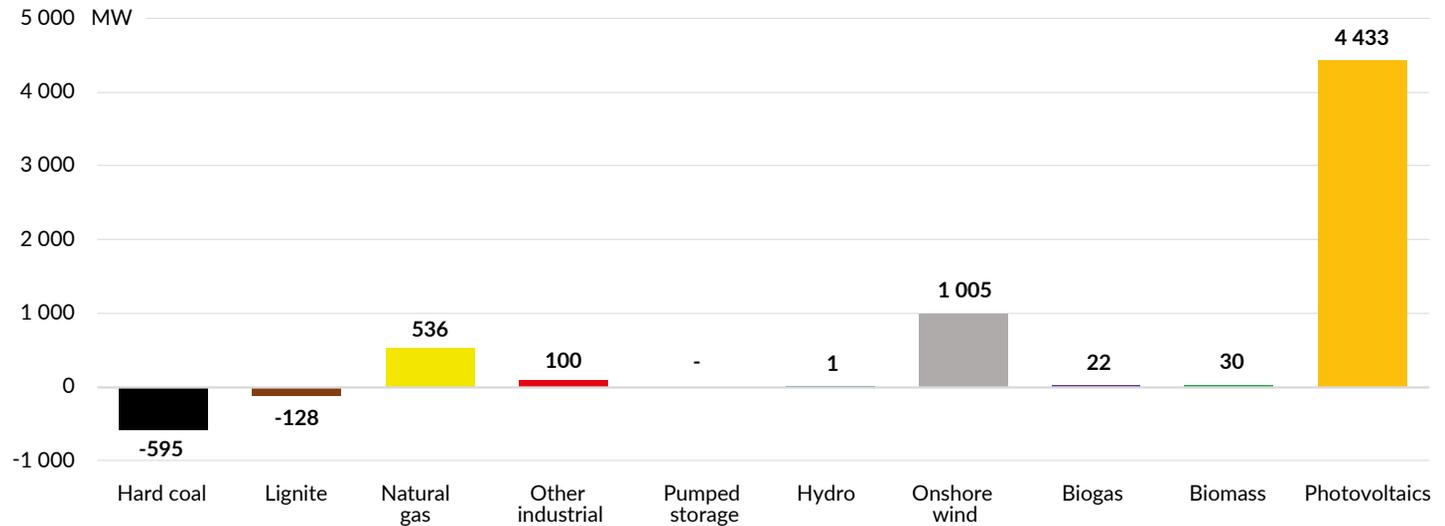
- 60.0 GW was the achievable capacity at the end of 2022. This is 5.4 GW more than a year earlier.
- The share of RES capacity increased to 38.3% (from 32%).
- At the end of 2022, the capacity of RES exceeded that of coal-fired power plants. The significance of this fact is symbolic, due to the different operating characteristics and functions provided in the system of these sources.
- Photovoltaics (53%) is responsible for more than half of RES capacity. 40% is wind power.



Own elaboration based on ARE data.

Changes in achievable capacity in 2022 as compared to 2021

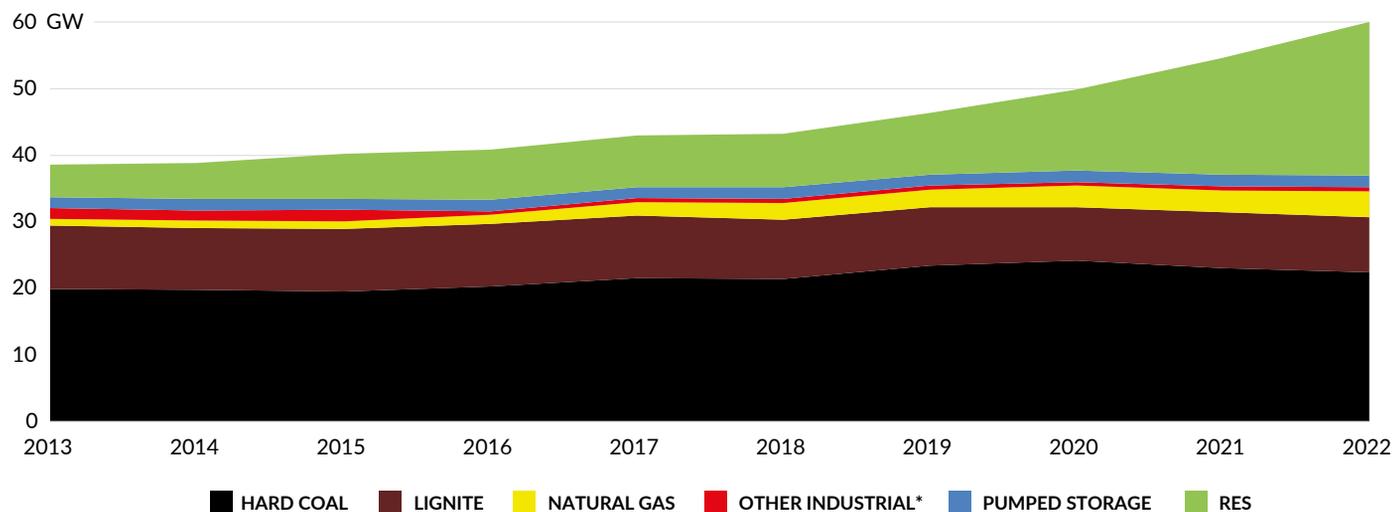
- No JWCD (centrally dispatched unit) was terminated in 2022, despite the notification of two units in Rybnik for closure.
- The decline in the capacity of coal and lignite power plants is due to a reduction in the achievable capacity of existing units.
- Achievable capacity in natural gas plants increased in 2022 by 0.5 GW, mainly due to commercial CHP.
- The largest increase in capacity, by 5.5 GW, was in RES, particularly in solar power (4.4 GW). The increase in wind power capacity is mostly due to the realization of investments concluded in RES auctions in earlier years.



Own elaboration based on ARE data.

Changes in achievable capacity over the last decade

- The achievable capacity of conventional sources has fluctuated in the 32–35 GW range for years, with a decrease in the last year of 0.1 GW to 35.2 GW.
- Over the 10-year period, the total achievable capacity increased to 60 GW – an increase of 21.4 GW, or 55%.
- The capacity of conventional units increased by 4.1 GW (+13%), most of it from gas sources (by 2.8 GW, +254%). Lignite-powered capacity decreased by 1.2 GW (-13%).
- RES capacity increased by 18.1 GW over the decade, from 4.9 GW to 23 GW (+372%).

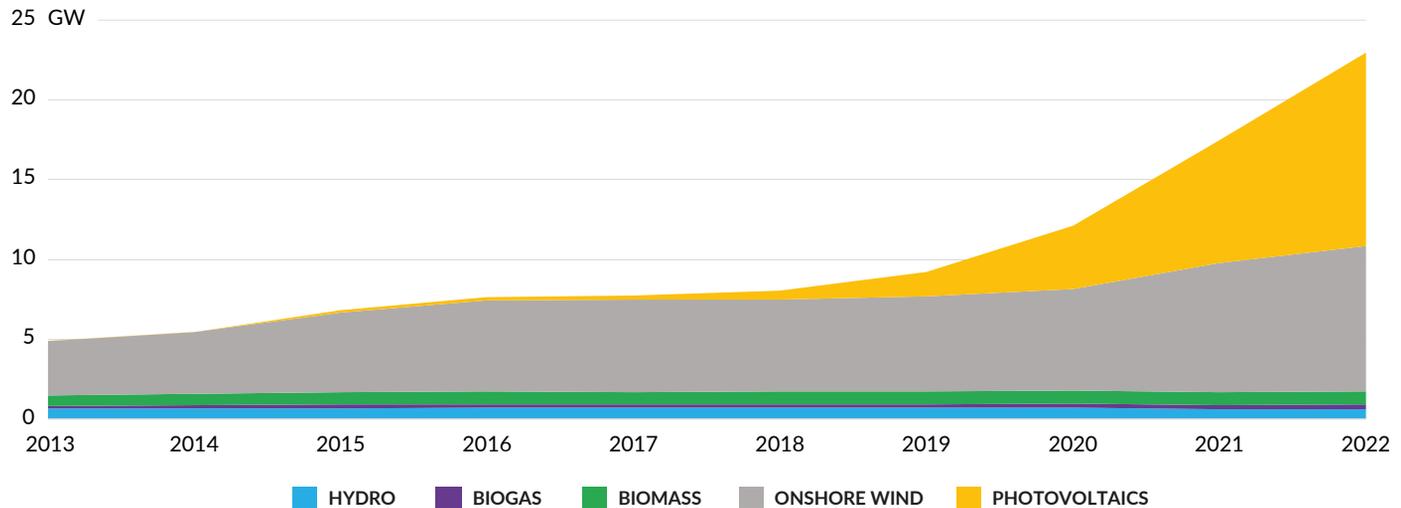


Own elaboration based on ARE data.

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

Changes in achievable renewable capacity over the last decade

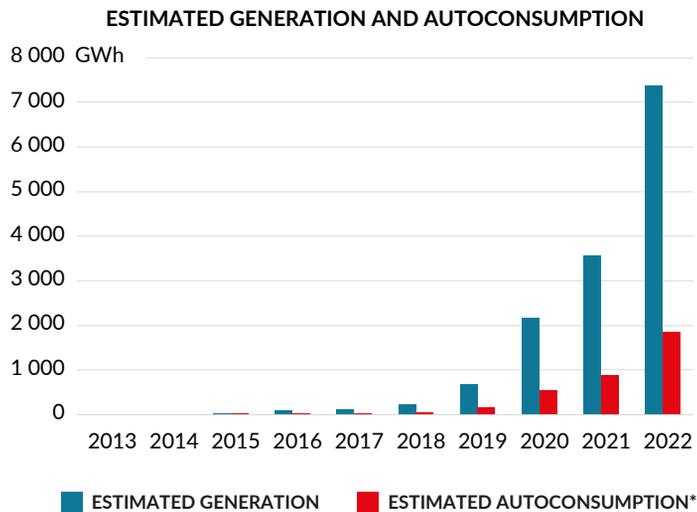
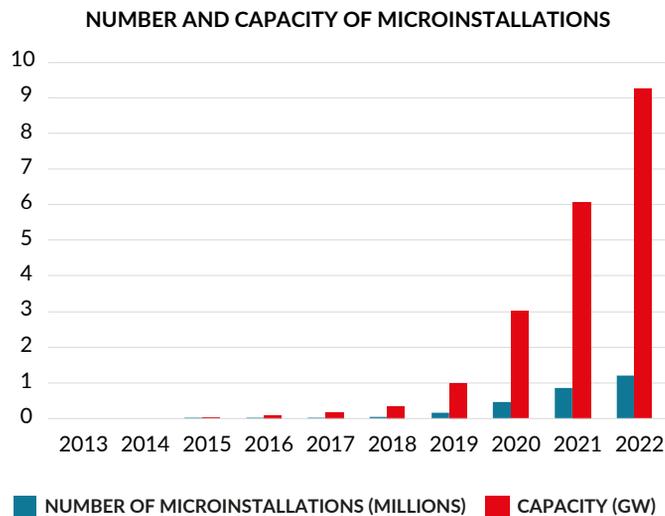
- At the end of 2022, 23 GW of RES was installed, an increase of 5.5 GW (+31% y/y).
- Photovoltaic capacity increased by 4.4 GW (+58% y/y), reaching 12.1 GW. Ten years ago, there was no capacity from this technology in Poland.
- Wind power increased by 1 GW during the year (+12% y/y). Over 10 years, these sources recorded an increase of 5.7 GW (+168%).
- RES development is almost entirely driven by wind and photovoltaic investments. Hydropower, biogas, and biomass added just 0.3 GW combined over the decade.



Own elaboration based on ARE data.

Electricity prosumers

- At the end of 2022, the capacity of microinstallations exceeded 9.2 GW. This represents an increase of more than 52% y/y.
- This capacity consists of more than 1.2 million prosumer installations (+41.7% y/y) – 99.98% are photovoltaic installations.
- Estimated total electricity production from microinstallations is about 7.4 TWh.
- Thanks to the development of community energy, about 1.8 TWh of electricity (about 1% of national production) did not have to be sent through the grid.
- 5.5 TWh of electricity was fed into the grid by prosumers. This corresponds to 3.1% of national generation.



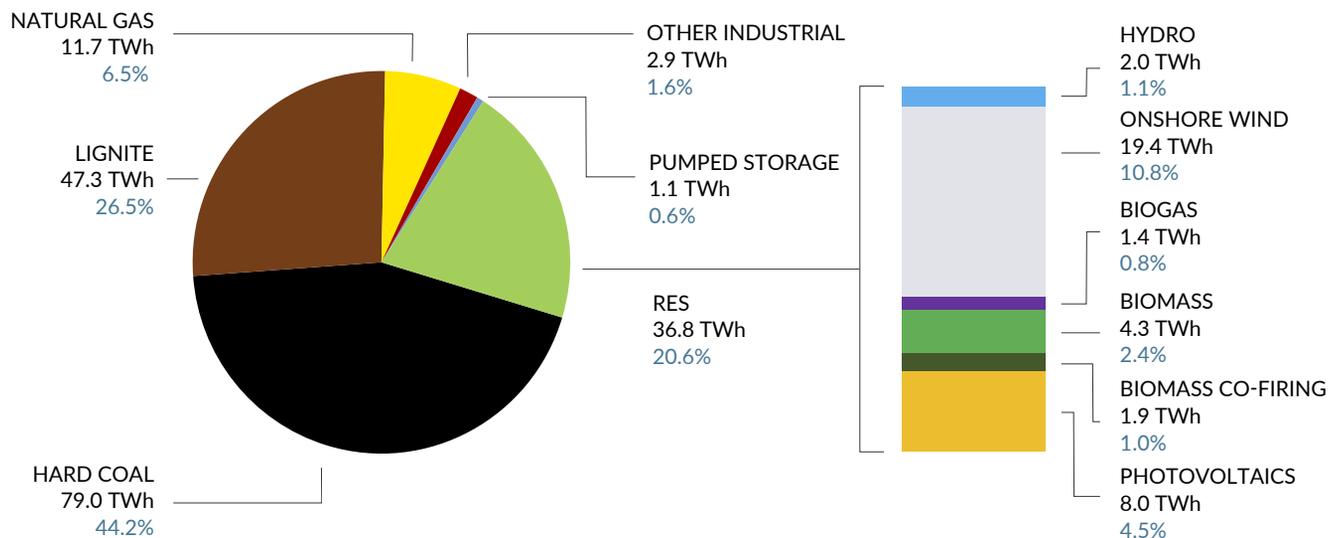
Own elaboration based on PTPIREE and ARE data.

*Autoconsumption of 25% was assumed for the calculations.

Electricity generation

Electricity generation in 2022

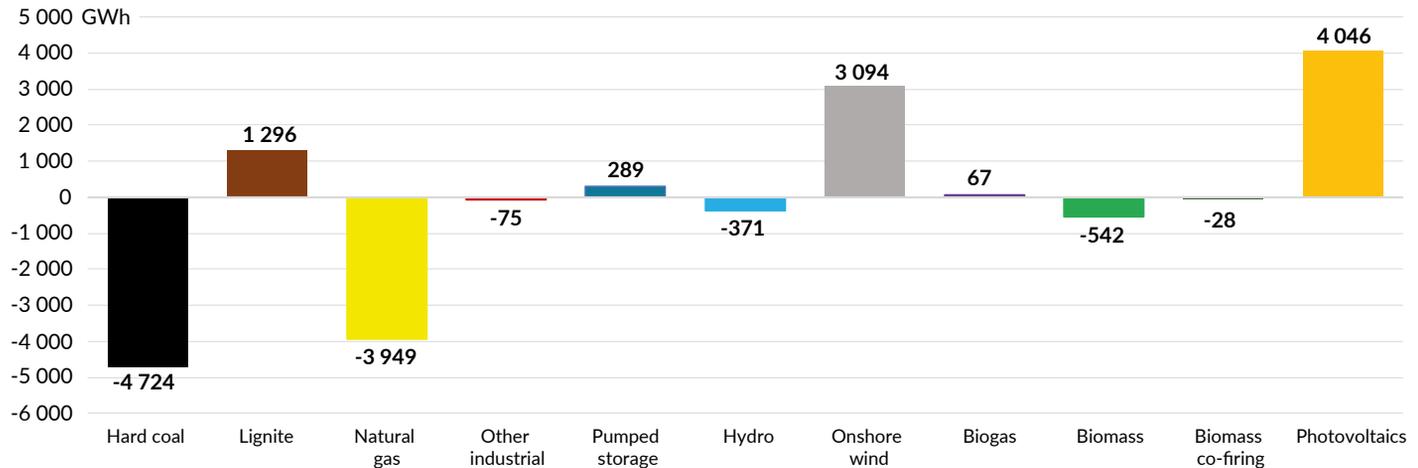
- 70.7% was the share of coal in gross electricity generation in 2022 (1.7 p.p. less than in 2021).
- For the first time, production from RES exceeded 20% of the mix and amounted to 20.6%, thanks to record production of 36.8 TWh and reduced (by 1.9%) demand for electricity.
- Production from natural gas reached its lowest level since 2017, due to record high gas prices on global exchanges.
- Production from photovoltaics doubled relative to 2021, to 8.0 TWh.
- Gas and coal-fired capacity recorded the lowest-ever capacity factors.



Own elaboration based on ARE data.

Changes in electricity generation in 2022 as compared to 2021

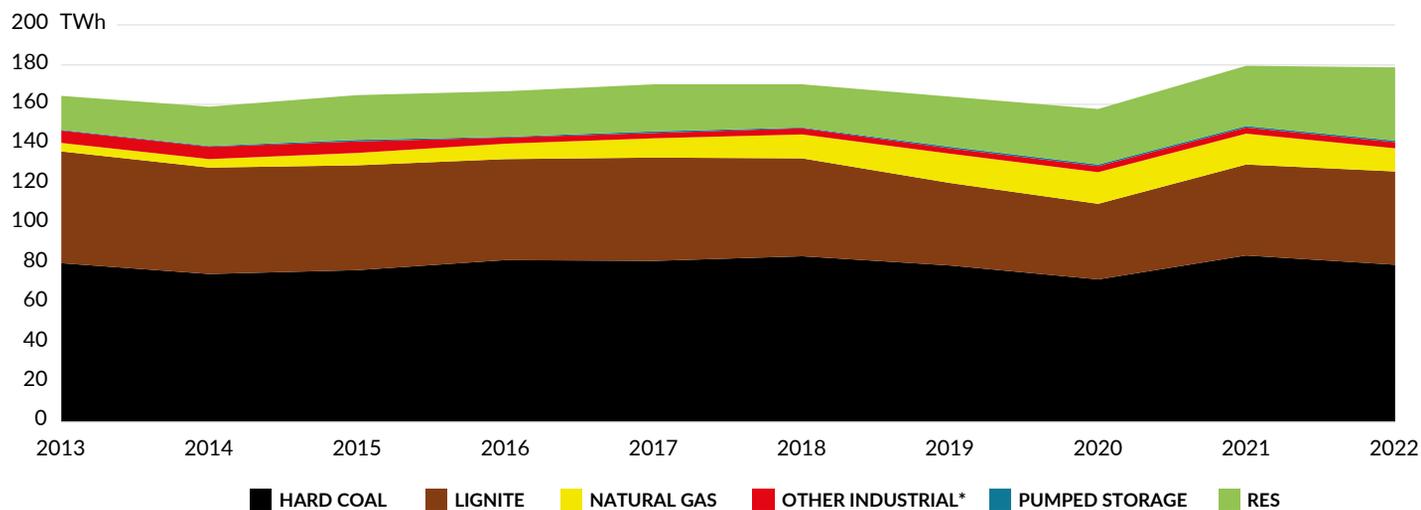
- Production from natural gas fell by 4 TWh (-25% y/y), and from hard coal by 4.7 TWh (-6% y/y). This is a result of high prices for these fuels and increased production from RES, with reduced electricity consumption.
- Production from lignite increased by 1.3 TWh (+3% y/y).
- Among renewable sources, photovoltaic power generation grew most rapidly (+102% y/y, +4 TWh), while biomass sources recorded the largest decline (-11% y/y, -0.5 TWh), due in part to the cutoff of fuel supplies from Belarus.
- Production from wind farms increased by 19% y/y (+3.1 TWh), or 7 p.p. more than the capacity increase alone, thanks to more favorable wind conditions in 2022.
- Pumped storage power plants were used at record levels, 38% more than in 2021.



Own elaboration based on ARE data.

Changes in electricity generation over the last decade

- Gross domestic electricity production amounted to 178.8 TWh, 0.5% less than a year ago.
- Over a 10-year period, electricity generation increased by 8.7%, from 164.4 TWh in 2013.
- Production from conventional sources fell by 4%, from 146.9 TWh in 2013 to 140.9 TWh. Production declines were recorded from hard coal (-0.9 TWh, or -1%) and lignite (-9 TWh, or -16%), while production from gas sources increased (by 7.3 TWh, or 169%).
- Generation from renewable energy sources increased by 117%, from 17 TWh in 2013 to 36.8 TWh.

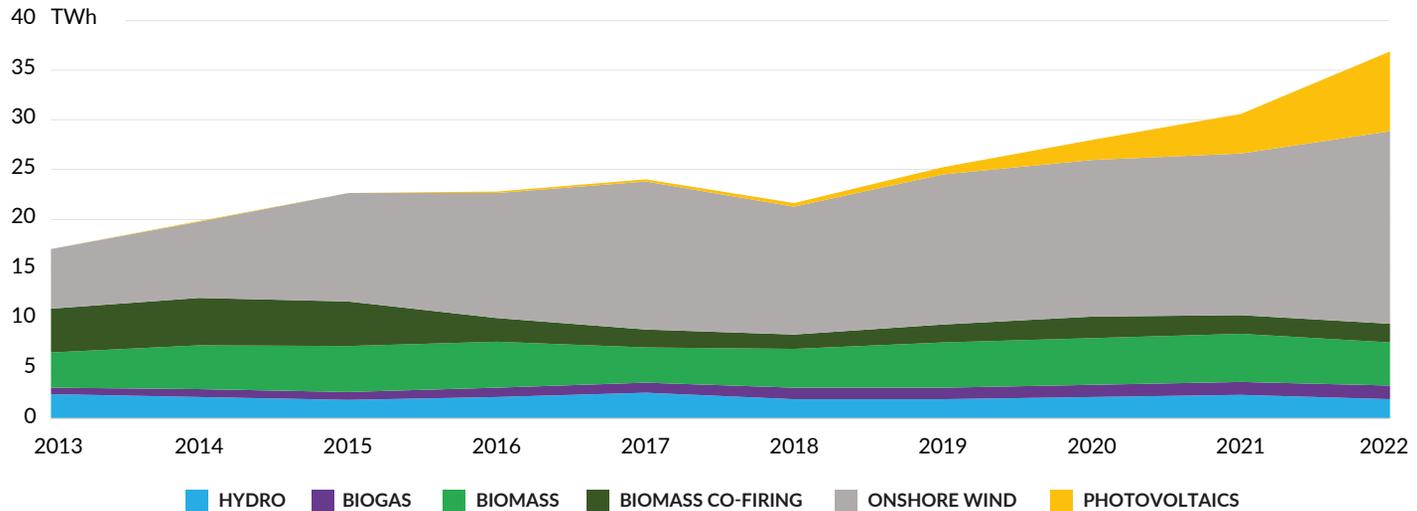


Own elaboration based on ARE data

*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 2022, 36.8 TWh of electricity was produced from RES – 20% more than in 2021.
- Wind power was responsible for more than half of the production from RES (53%) in 2022, solar PV accounted for 22%, and biomass for 12%.
- The largest increase, aside from solar PV, was in wind generation – up 222%, from 6 TWh in 2013 to 19.4 TWh in 2022. Declines were recorded in biomass co-firing, down 57%, and hydro generation, down 19%.

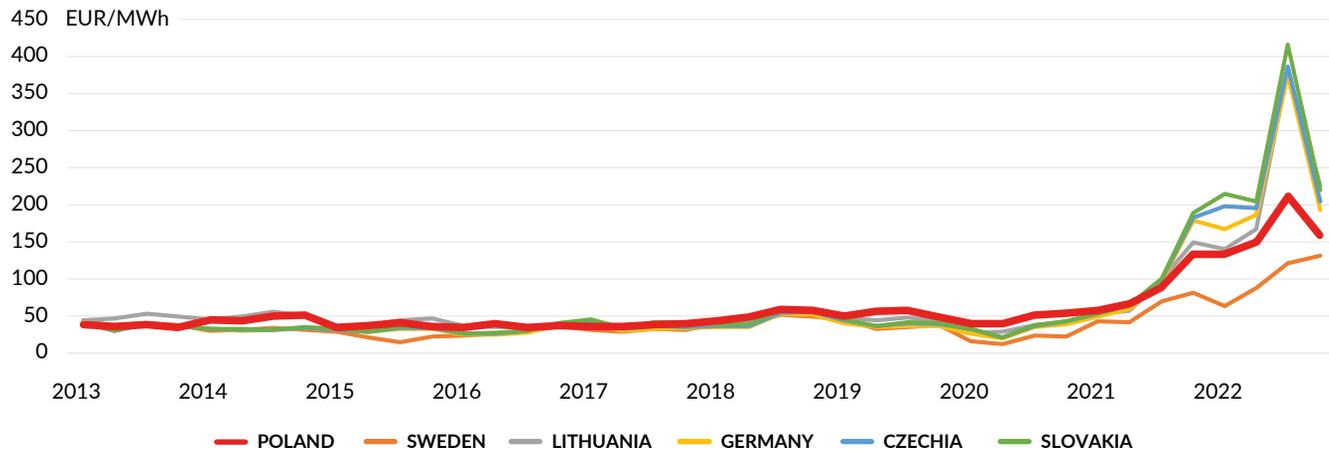


Own elaboration based on ARE data.

Electricity prices

Comparison of SPOT electricity prices in neighboring markets

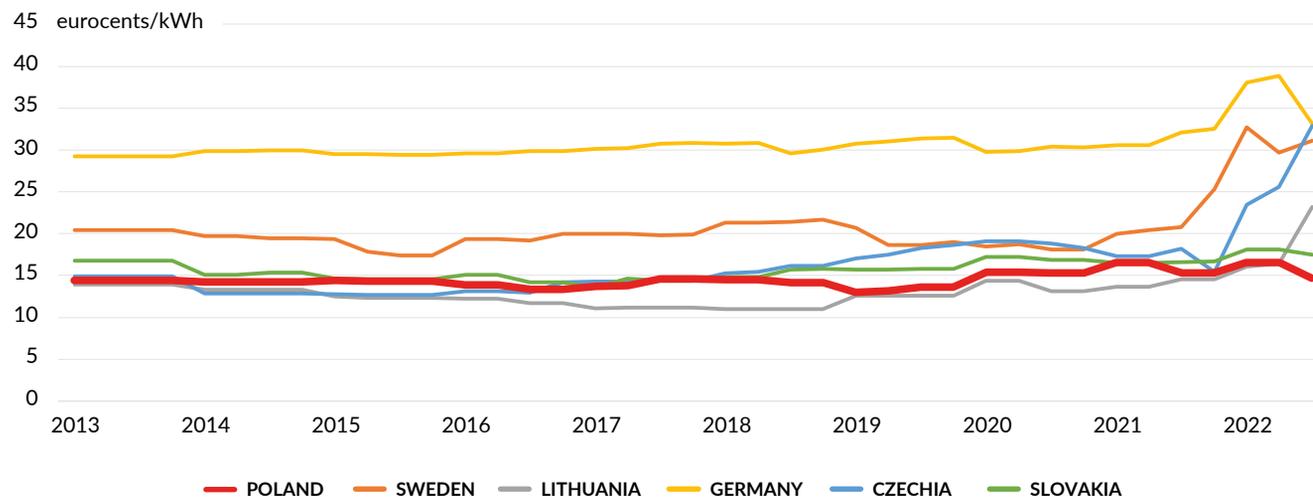
- The year 2022 was the most expensive ever on European electricity exchanges.
- In the third quarter, prices were boosted to record levels by panic caused by the tense situation in European power systems. The drought in France further reduced the already low generation from nuclear reactors due to repairs, an embargo on Russian coal was imposed, 3 of the 4 lines of Nord Stream were destroyed, which, combined with the earlier shutdown of the Yamal gas transmission line, pushed gas prices on the TTF to more than 340 EUR/MWh.
- The decline in exchange prices at the end of 2022 is mainly due to the drop in European exchanges for natural gas, which sets electricity prices in most EU countries. The decline was made possible by a record high filling of gas storage facilities before the winter season.
- Poland, with a smaller share of gas-fired power generation in its mix, despite the high price of CO₂, proved to be a cheaper market than most of its neighbors, apart from Sweden, which has an electricity mix based on nuclear and hydro sources.



Own elaboration based on European Commission - Quarterly Report on Energy Markets and ENTSO-E data.

Comparison of electricity prices in neighboring markets – prices for households

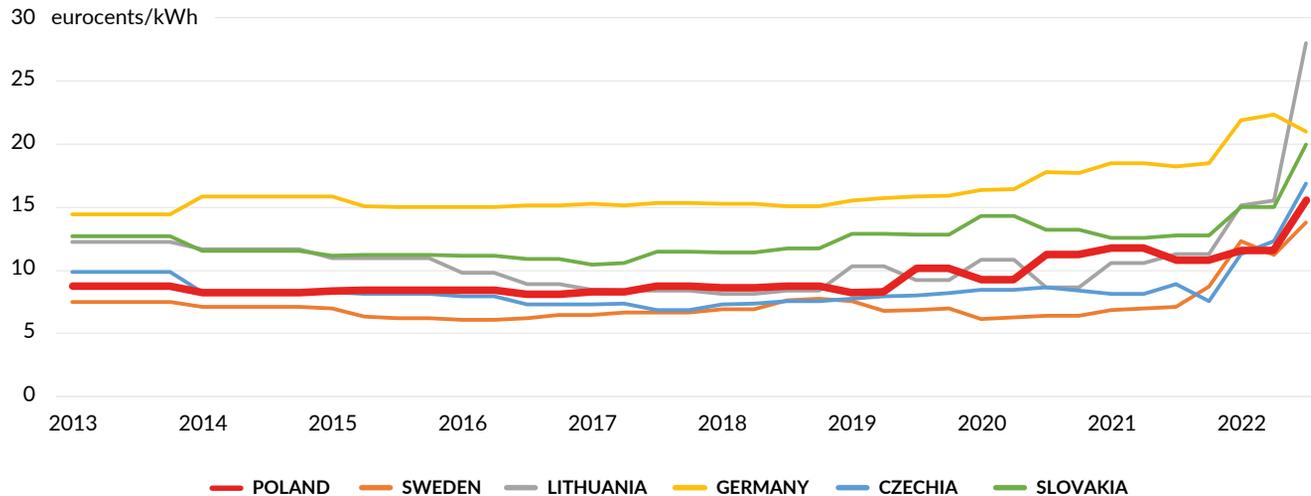
- For years, electricity prices for households in Poland have been among the lowest (nominally) among neighboring countries.
- Factoring in all taxes and tributes, the price of electricity in Poland in the third quarter of 2022 was 14.7 cents/kWh, which was 55.8% less than in Germany and 16.2% less than in Slovakia.
- The price of electricity for households is shaped largely by state tax and regulatory policies. It is not a simple reflection of wholesale energy prices on the exchange.



Own elaboration based on European Commission – Quarterly Report on Energy Markets.

Comparison of electricity prices in neighboring markets – prices for industry

- After deducting VAT and all recoverable taxes and tributes, the price of electricity for industry in Poland was 15.57 cents/kWh.
- In 2022, for the first time, the price for industrial customers was higher than that for households.
- Price growth for industry (quarter-on-quarter) was 44.3% in Poland, more than in traditionally expensive Germany (+15.2%), but significantly less than in Czechia (+89.2%) or Lithuania (+148%).
- Energy prices for industry are more closely correlated with the stock market than prices for households. Their level is reflected in the competitiveness of the economy internationally and in the prices of locally consumed products.



Own elaboration based on European Commission – Quarterly Report on Energy Markets.

Chapter 3.

Energy raw materials



87%

by that much during the year increased imports of steam coal due to declining domestic mining.



47%

of crude oil imports in 2022 came from Russia (natural gas: 19%, steam coal: 13%).



-13 million tons

this is how much domestic consumption of coal decreased in 10 years.



-17%

by that much decreased, over the year, natural gas consumption, primarily due to its high prices.



40%

of imported natural gas came from the record used (6.2 bcm) LNG terminal in Świnoujście.



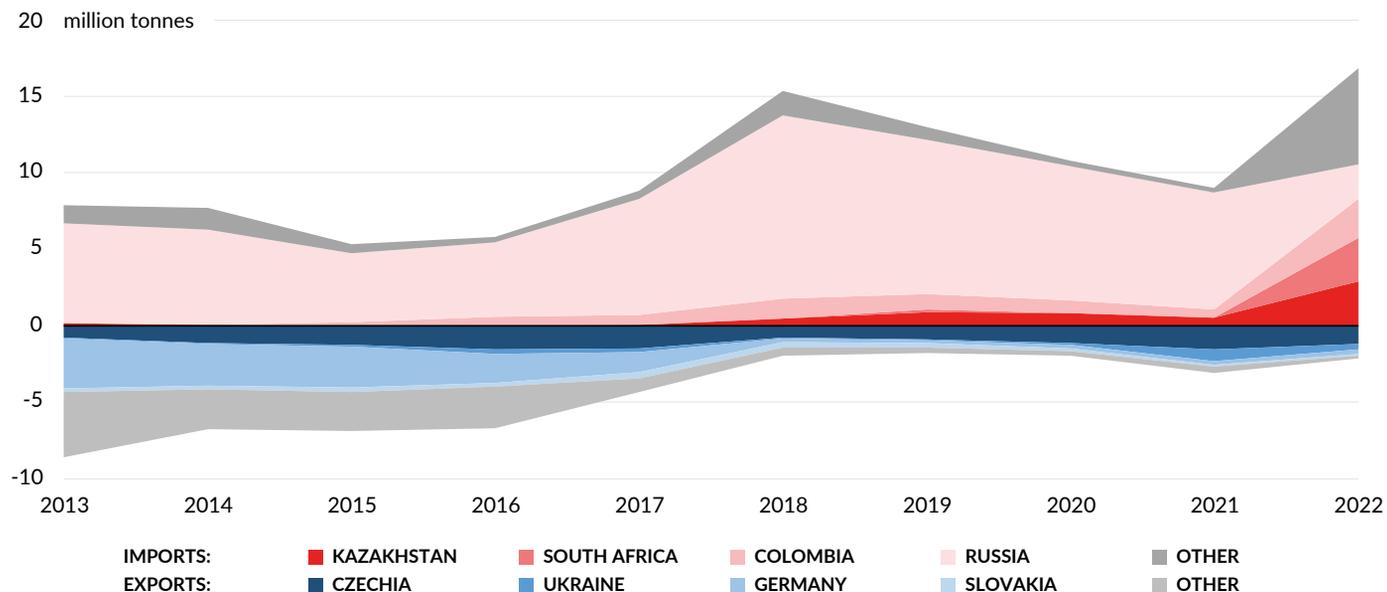
25%

of domestic natural gas consumption is in households. Over the 10 years gas consumption in this category has increased by more than a third.

Russia remained the largest supplier of energy commodities, but its market share fell sharply – by the end of the year to zero for coal and natural gas. This decline was made possible by a reduction in consumption, diversification of imports and, in the case of gas, the expansion of infrastructure. Coal consumption, both overall and in the power industry itself, fell. The coal renaissance has not happened.

Trade balance of steam coal

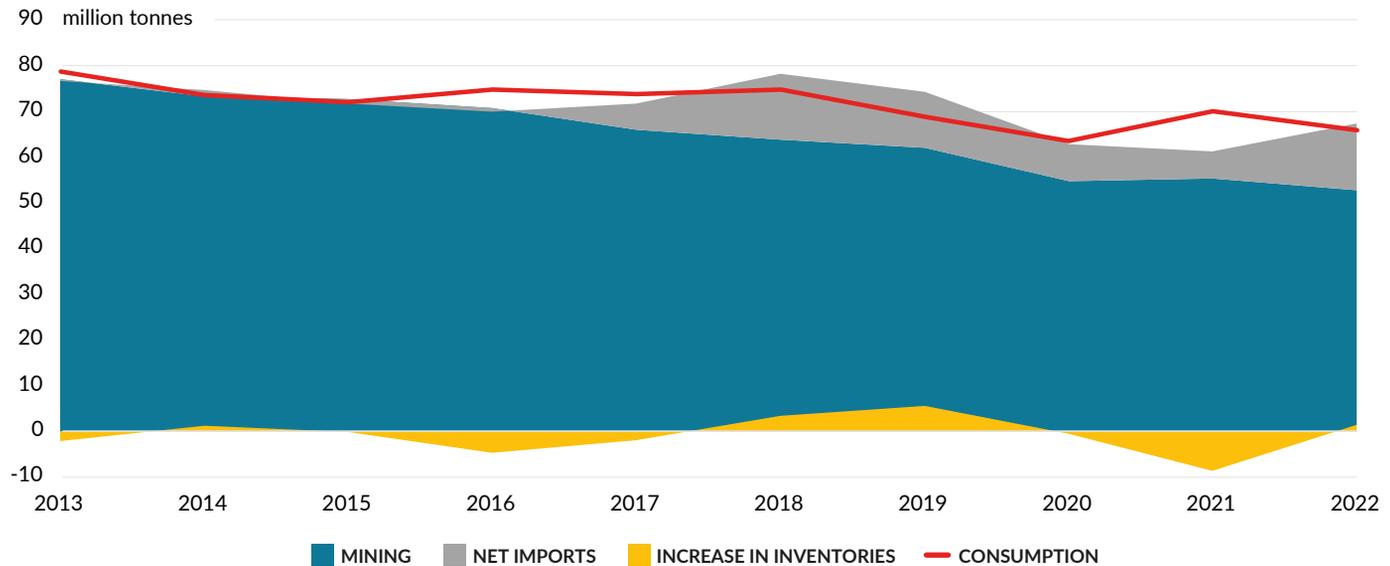
- In 2022, steam coal imports totaled 16.9 million tonnes – 7.9 million tonnes more than in 2021.
- 34% (17% each) of the imported coal came from Kazakhstan and South Africa; 15% came from Colombia, with only 13% coming from Russia. As much as 37% came from other countries, mainly Australia and Indonesia.
- In 2022, 2.1 million tonnes of steam coal were exported. The main customers were Czechia (55%), Ukraine (18%), Germany (12%), and Slovakia (8%).



Own elaboration based on GUS and Eurostat data.

Hard coal balance in Poland

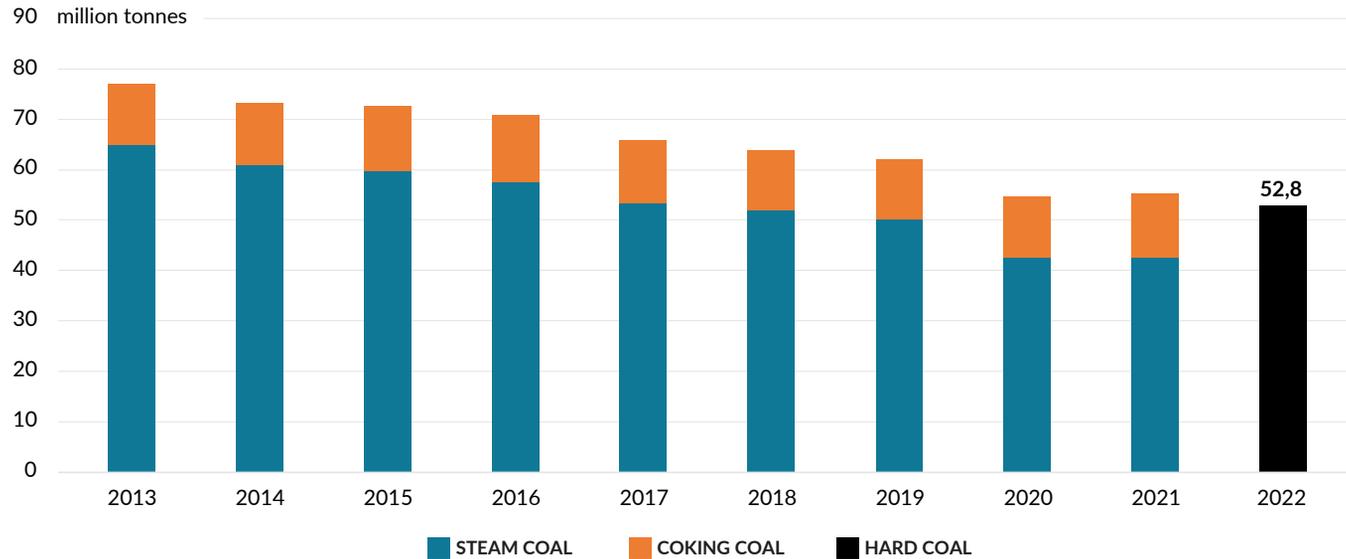
- According to Forum Energii estimates, hard coal consumption in 2022 amounted to about 66 million tonnes, down about 4 million tonnes (-5.9% y/y) from the previous year.
- Net imports increased by 8.5 million tonnes (up 143.2%; to 14.5 million tonnes), mining fell by 2.5 million tonnes (down 4.4%; to 52.8 million tonnes), so according to estimates, about 1 million tonnes were put on the heap (increased stocks).
- Over the 10-year period, hard coal consumption fell by 13 million tonnes (-16.4%), mining fell by 24.2 million tonnes (-31.4%), and net imports increased by 14.8 million tonnes.



Own elaboration based on GUS, ARE and Eurostat data.

Domestic hard coal production

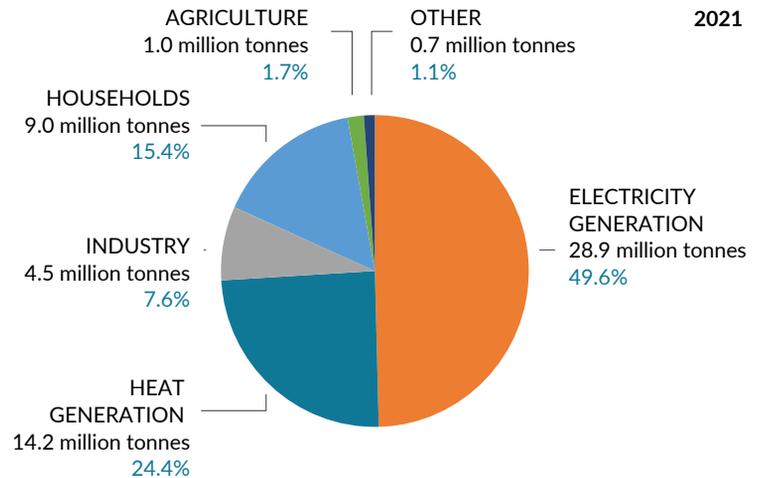
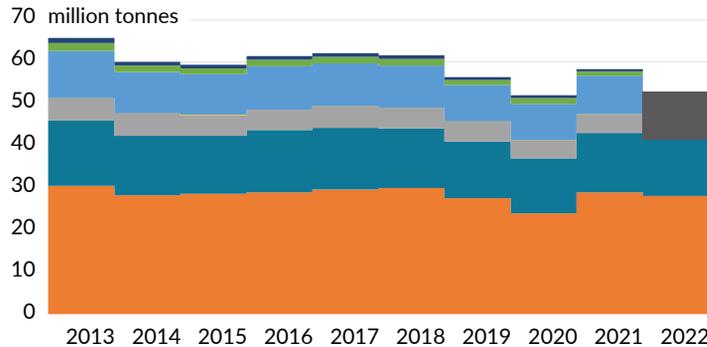
- 52.8 million tonnes of hard coal were mined in the domestic mines in 2022.
- Compared to last year, domestic production fell by 2.5 million tonnes.



Own elaboration based on GUS and ARP data.

Structure of steam coal consumption

- Nearly half (49.6%; 28.9 million tonnes) of steam coal was used in 2021 for electricity generation. A quarter (24.4%; 14.2 million tonnes) was used to produce heat.
- Households consumed in 2021 9 million tonnes (15.4%).
- Estimated consumption of steam coal fell by about 9% y/y (about 5.5 million tonnes) to about 53 million tonnes in 2022.
- In 2021, relative to 2020, the consumption of steam coal increased by 12.1% (6.3 million tonnes), but the share of each category followed a similar pattern. Only the share of electricity production increased, by 3 p.p.
- Compared to 2013, hard coal consumption fell by about 13 million tonnes (-19%) in 2022.

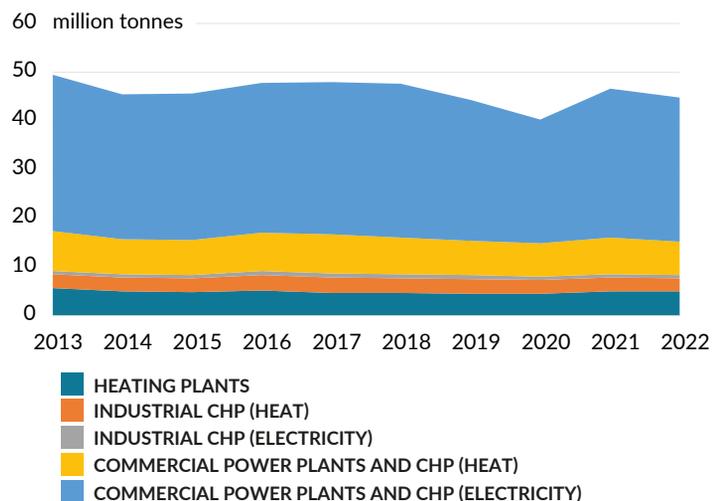
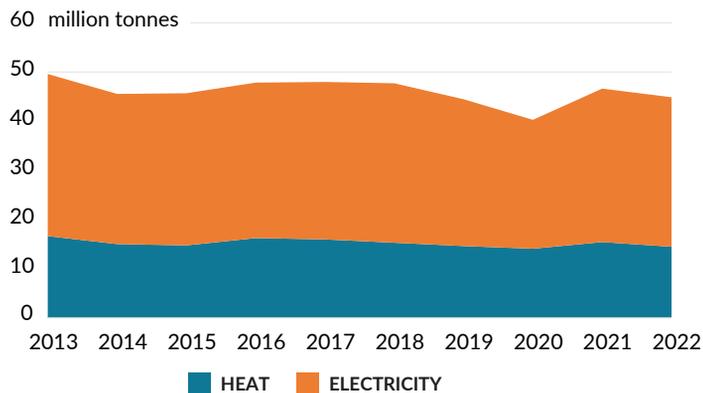


Own elaboration based on ARE, GUS, ARP and Eurostat data.

* In estimating consumption, consumption of coking coal was assumed unchanged from 2021.

Structure of steam coal consumption – power and heat industry

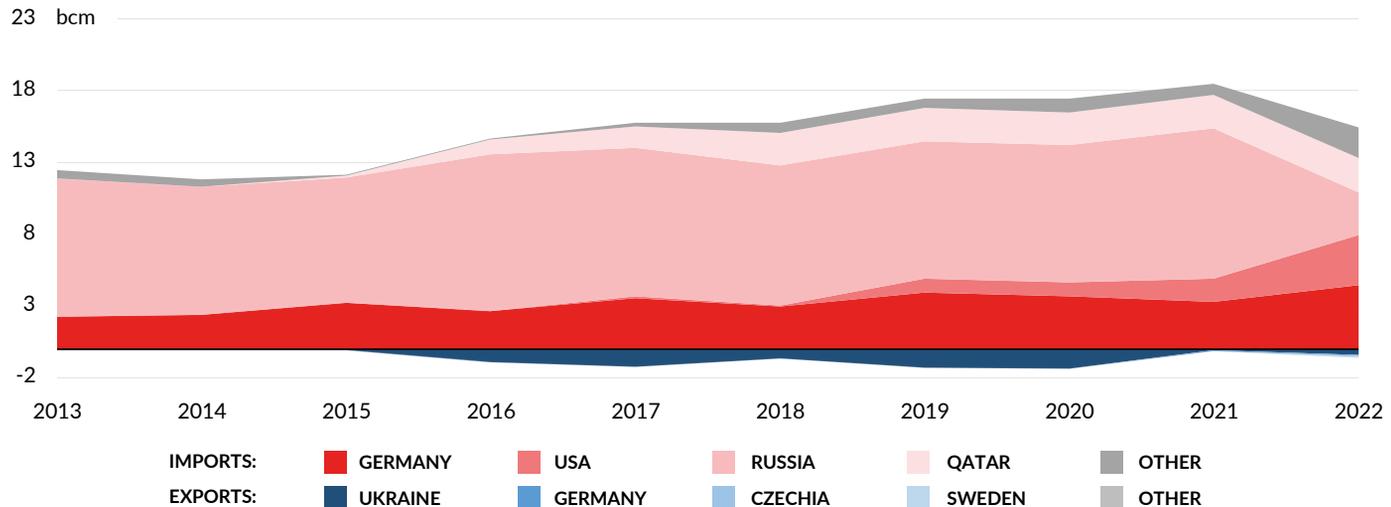
- 44.8 million tonnes of hard coal were consumed by power plants, CHP, and heating plants in 2022. This is a decrease of 1.8 million tonnes against 2021, or -3.7%.
- In 2022, the commercial power industry consumed 36.5 million tonnes of coal, of which 29.7 million tonnes were used for electricity generation. Industrial power generation consumed 3.4 million tonnes (mostly for heat – 2.8 million tonnes), and heating plants consumed 4.9 million tonnes.
- Coal consumption fell in every category of consumption, but the most for heat production in commercial units (-9.1%; -0.7 million tonnes).
- About a third of the hard coal (32.4%, or 14.5 million tonnes) was used for heat production. The remaining 67.6% (30.3 million tonnes) was used to produce electricity.



Own elaboration based on ARE and GUS data.

Trade balance of natural gas

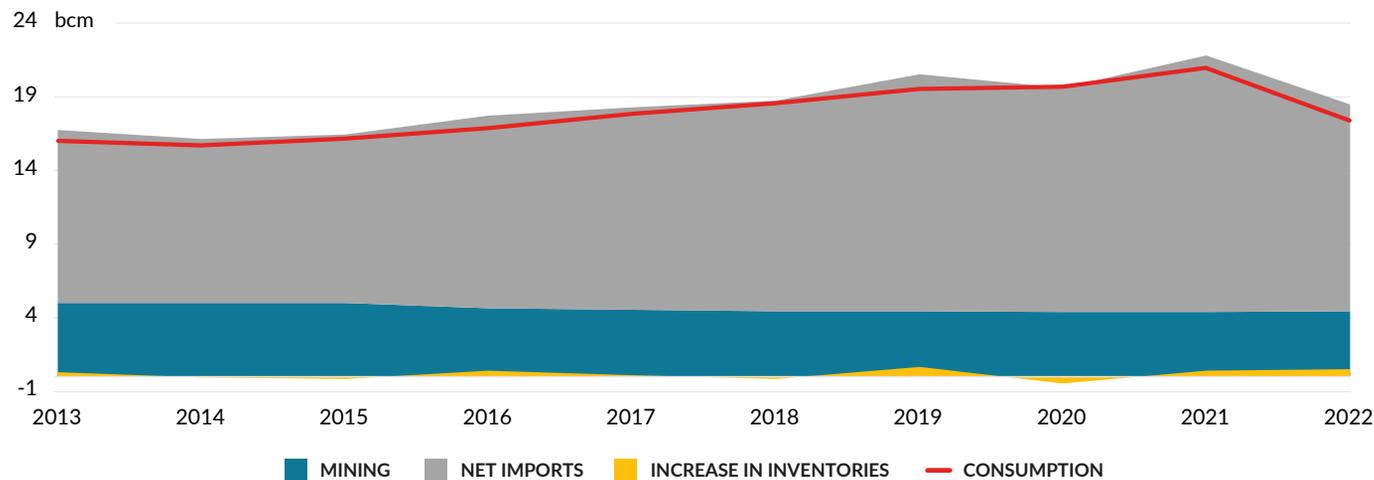
- In 2022, natural gas imports (both via pipelines and LNG) amounted to 15.4 bcm, 3.1 bcm (-17% y/y) less than in 2021.
- 29% of imported natural gas came from Germany. Other significant import destinations were the US (23%), Russia (19%), and Qatar (15%).
- Imports from the US rose by 118% from the previous year, while those from Russia fell by 72%.
- In 2022, 0.6 bcm of natural gas was exported. More than two-thirds (67%) flowed to Ukraine. The remaining 23% flowed mainly to Germany (15%) and Czechia (12%).
- LNG imports accounted for a record 40% (6.2 bcm after regasification) of gas fuel imports. The main suppliers were the US (55%) and Qatar (37%).



Own elaboration based on GUS and Eurostat data.

Natural gas balance in Poland

- According to Forum Energii estimates, in 2022 natural gas consumption fell by 3.6 bcm from the previous year (-17% y/y), to 17.4 bcm of high-methane gas equivalent.
- Net imports fell by 3.4 bcm (down 19.4%; to 14 bcm), extraction is estimated to have remained unchanged (4.4 bcm), so inventories increased by 0.5 bcm. By the end of 2022, the storage level reached a record 96.55%.
- Over the 10-year period, natural gas consumption increased by 1.4 bcm (+8.6%), production decreased by 0.6 bcm (-11.2%), and net imports increased by 2.3 bcm (+19.6%).

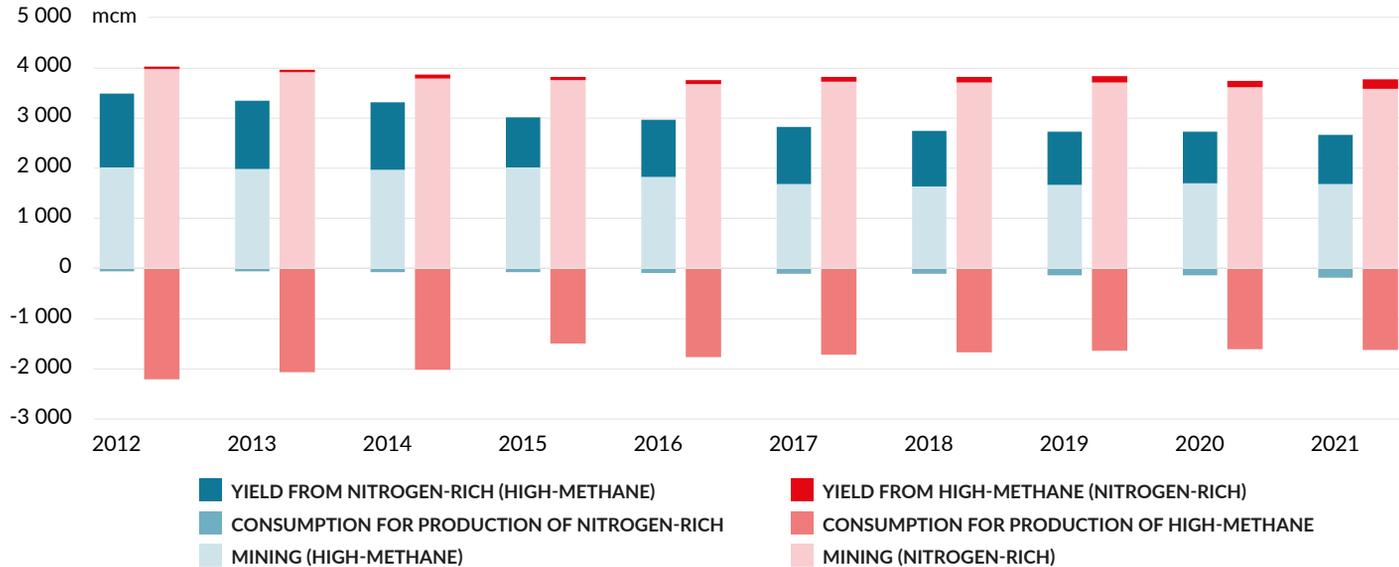


Own elaboration based on GUS, ENTSOG and Eurostat data.

Production and consumption of nitrogen-rich natural gas converted to the equivalent of high-methane gas.

Domestic natural gas production (2021)

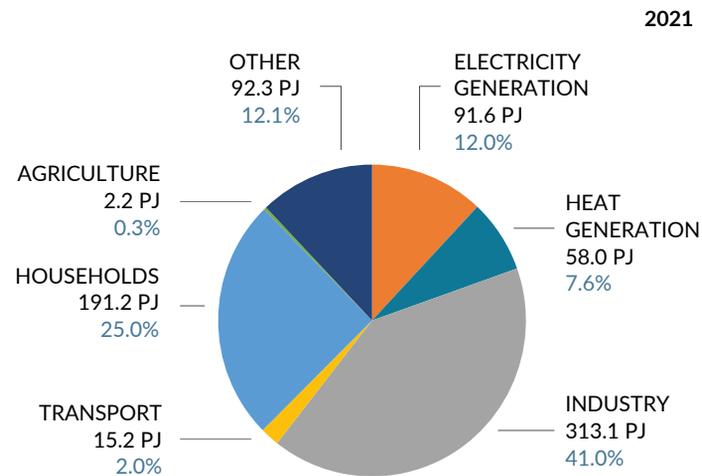
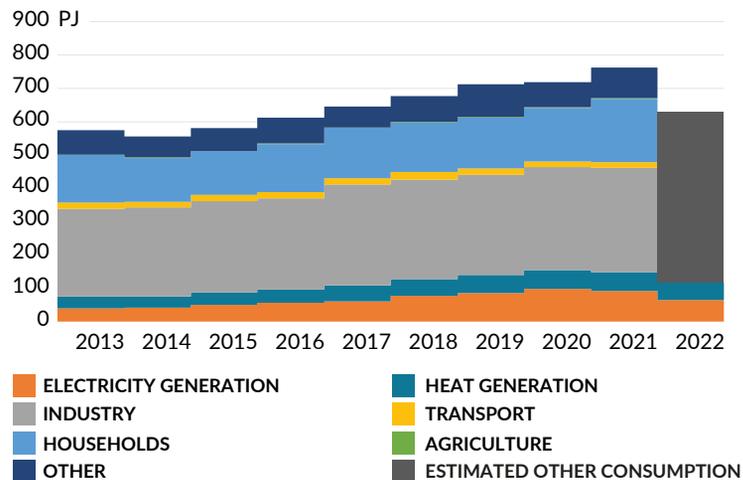
- Domestic production of high-methane gas is declining slightly. In 2021, 2.7 bcm were obtained, with 63% coming from production and the remaining 37% from denitrification of nitrogen-rich natural gas.
- Domestic production of nitrogen-rich natural gas also did not deviate from the multi-year trend. In 2021, 3.8 bcm were obtained, with 95% coming from production and 5% from gas blending plants (from conversion of high-methane gas).



Own elaboration based on ARE data.

Structure of natural gas consumption

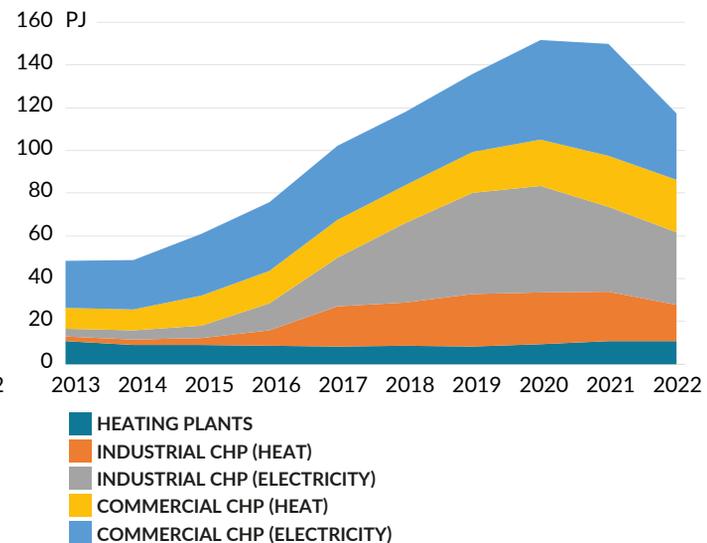
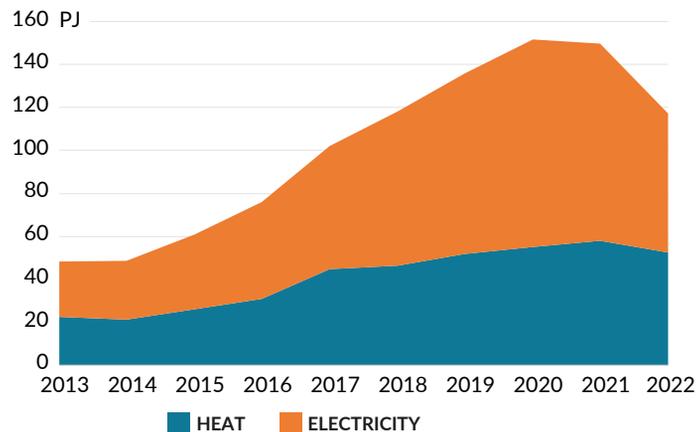
- The largest consumer of gas in Poland is industry, which in 2021 was responsible for 41% of domestic consumption
For years, the sector has been responsible for 41-48% of demand.
- Households were responsible for a quarter of Poland's natural gas consumption in 2021, at 191.2 PJ.
- The largest increase in gas consumption in 2021 relative to 2020 was in households (by 30.3 PJ, +19% y/y) and in other customers (by 17.7 PJ, +24% y/y).
- Estimated consumption of natural gas fell by about 12% (about 88 PJ) to about 630 PJ in 2022.
- Compared to 2013, natural gas consumption increased by about 55 PJ (10%).



Own elaboration based on ARE, GUS and ENTSOG data.

Structure of natural gas consumption – power and heat industry

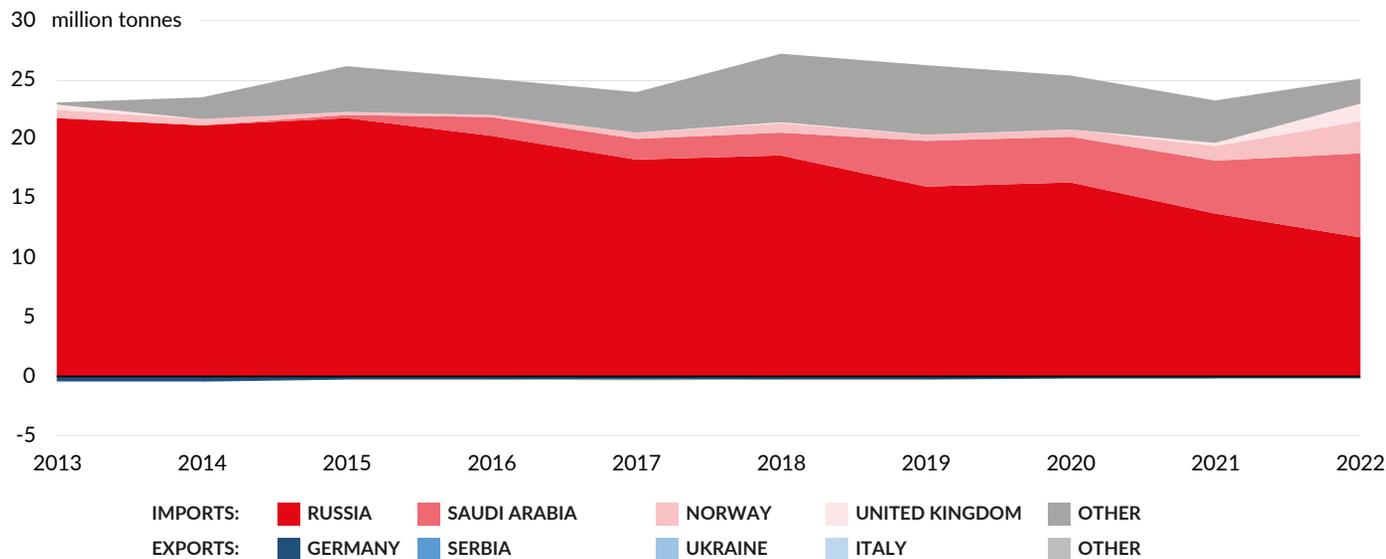
- 117.3 PJ of natural gas was consumed by CHP and heating plants in 2022. This is a decrease of 32.4 PJ from 2021, or 21.7%.
- 55.3% (64.9 PJ) was used for heat production. The remaining 44.7% (52.5 PJ) was used to produce electricity.
- Relative to 2021, when the share of electricity to heat was close to a 2:1 ratio, this means a decline in electricity production, a byproduct of CHP, while covering thermal needs.
- Most of the reduction in gas consumption in the electric power and district heating industry took place in electricity generation in commercial CHPs (-40% y/y) and industrial CHPs (-19% y/y), mainly for heat (-27% y/y).



Own elaboration based on ARE and GUS data.

Trade balance of crude oil

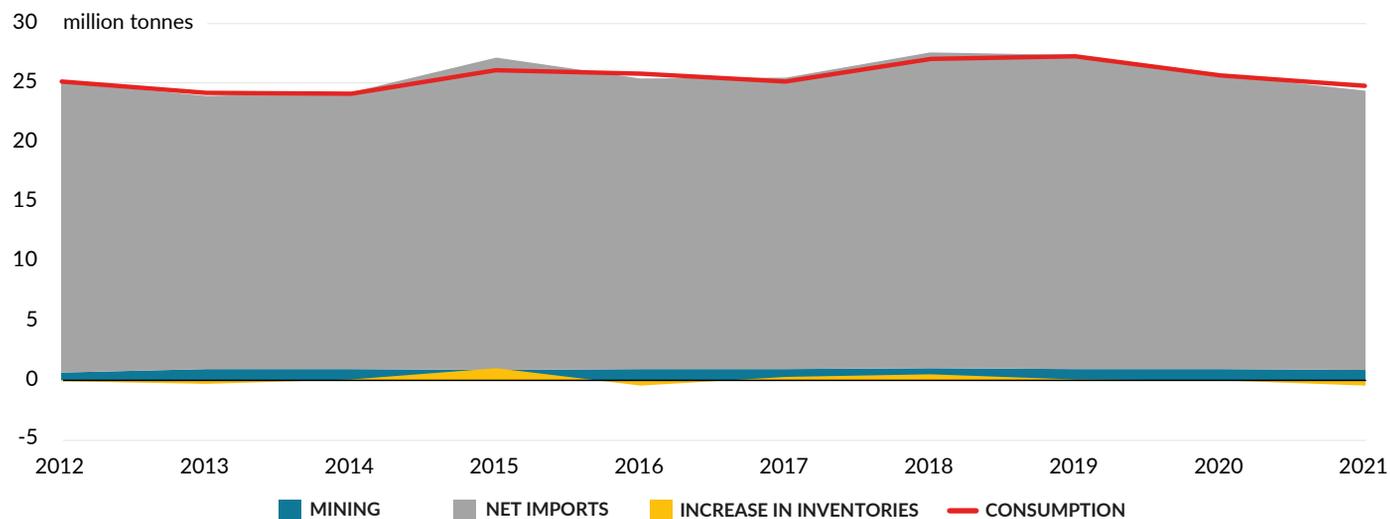
- In 2022, Poland's crude oil imports amounted to 25.1 million tonnes, 1.8 million tonnes (+8% y/y) more than in 2021.
- Despite a 15% y/y decrease in imports from Russia, it remained the dominant import destination at 47% (11.7 million tonnes) of imported raw material. The rest came from Saudi Arabia (28%; 7.1 million tonnes), Norway (11%; 2.8 million tonnes) and the UK (6%; 1.5 million tonnes).
- Poland exports almost no crude oil. The only flow in 2022, an insignificant stream (0.2 million tonnes), was to Germany.



Own elaboration based on GUS and Eurostat data.

Crude oil balance in Poland (2021)

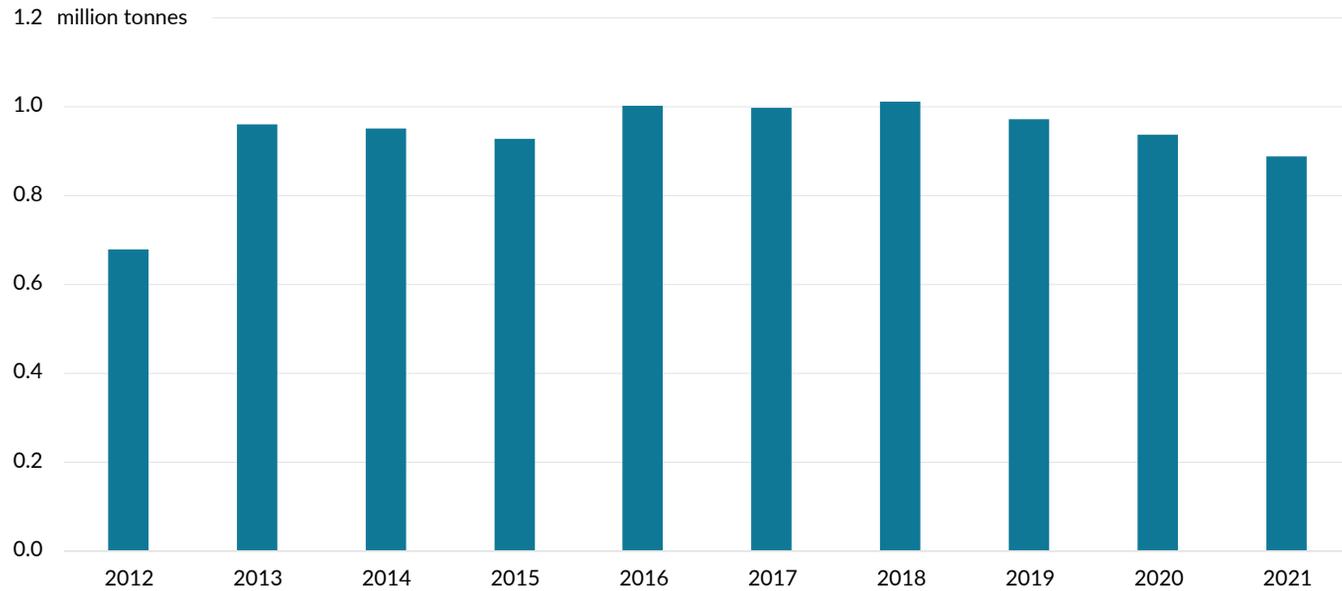
- The trend of a slow decline in crude oil consumption has continued for the past three years, dropping to 24.8 million tonnes in 2021 (0.8 million tonnes less than in 2020).
- Net imports fell by 1.3 million tonnes (to 23.4 million tonnes), domestic extraction remained unchanged (0.9 million tonnes), so 0.4 million tonnes were taken from stocks.
- Over the decade from 2012 to 2021, crude oil consumption fell by 0.4 million tonnes (-2%), production increased by 0.2 million tonnes (+31%), and net imports fell by 1 million tonnes (-4%).



Own elaboration based on GUS data.

Domestic crude oil production (2021)

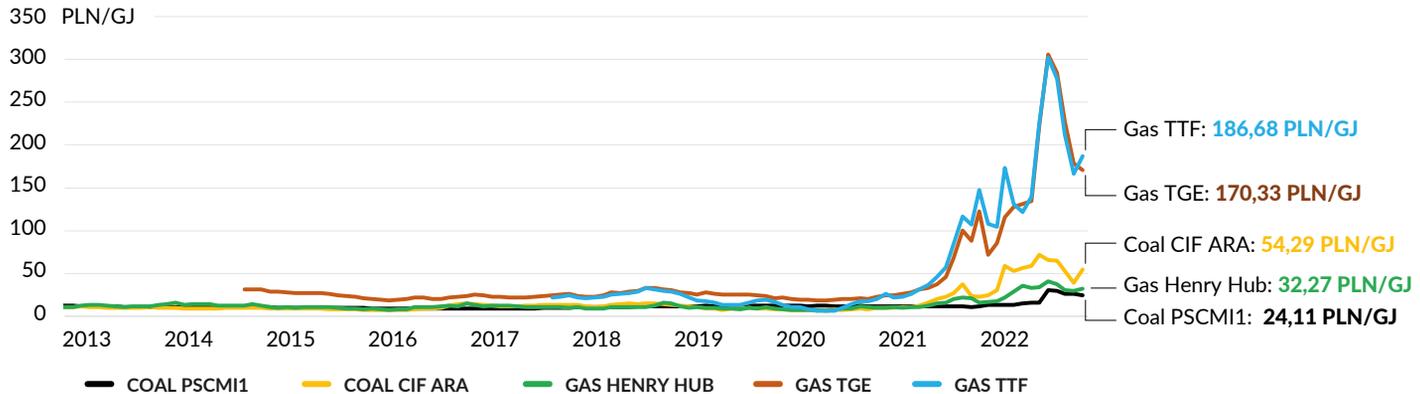
- Domestic production has remained at 0.7 to 1 million tonnes for years.
- In 2021, it amounted to 0.9 million tonnes.



Own elaboration based on ARE data.

Coal and natural gas prices

- In 2022, every energy commodity, on every exchange, scored multiple corrected records.
- Natural gas on Europe's TTF exchange (and therefore on Poland's correlated TGE) was most affected. Smaller increases (but still record high) were recorded on the US Henry Hub.
- The European market has been hit hardest, due to the highest import dependence on raw materials from Russia, dynamically reduced by the change in attitude towards this partner and the sanctions imposed on Russian crude oil, gas, and coal.
- Unpredictable factors, such as the breaching of 3 of the 4 Nord Stream pipelines, also had a major impact on market sentiment.
- Relative to the end of 2021, in December 2022, Polish coal (PSCMI1) was 106% more expensive, while European coal (ARA) was 143% more expensive.
- Relative to the (already very expensive) price in December 2021, at the end of 2022 natural gas on the Polish exchange (TGE) had become 39% more expensive, the European exchange (TTF) was 27% more expensive, and the US exchange (Henry Hub) was 106% more expensive.



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

Chapter 4.

Impact on climate. Emissions



26th

place in the EU (penultimate), which Poland occupies in terms of specific CO₂ emissions of electricity generation.



7th

rank in the world (from the bottom) occupies Poland in terms of specific greenhouse gas emissions associated with primary energy consumption.



PLN 23 billion

gained Polish budget in 2022 from the sale of CO₂ emission allowances. Since 2013, the value has been PLN'22 95.6 billion.



38%

of Poland's greenhouse gas emissions come from electricity and heat production (more than 150 million tons of CO_{2eq}).



48%

of Polish emissions in 2021 were covered by the ETS (93% in power generation, 79% in industry).



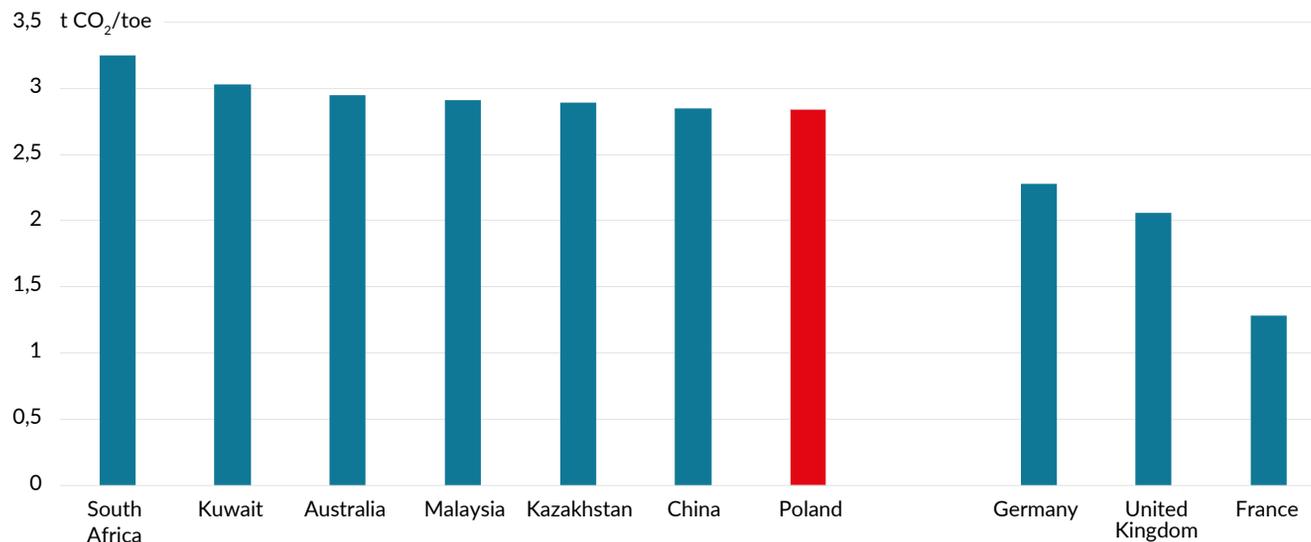
-11.5%

that's the amount of reduction in greenhouse gas emissions from the power industry relative to 2005.

The rate of reduction in CO₂ emissions is much lower in Poland than in other countries in the region and the EU as a whole. It is insufficient to achieve climate neutrality by 2050. Emissions in the electricity and heating sectors are falling faster than total emissions in the country as a whole, but they remain very high, which will translate into high electricity and heat prices.

Specific emissions of primary energy consumption (2021)

- In 2021, Poland was ranked 7th (-1 y/y) in the world in terms of specific carbon intensity of primary energy consumption.
- South Africa had the most carbon-intensive economy (3.25 tonnes CO₂/toe). Poland, with 2.84 tonnes CO₂/toe (-0.01 y/y) ranked just ahead of China (2.85 tonnes CO₂/toe). For comparison, the British economy emitted 27% less than Poland (2.06 tonnes CO₂/toe), and the French economy emitted 55% less (1.28 tonnes CO₂/toe).

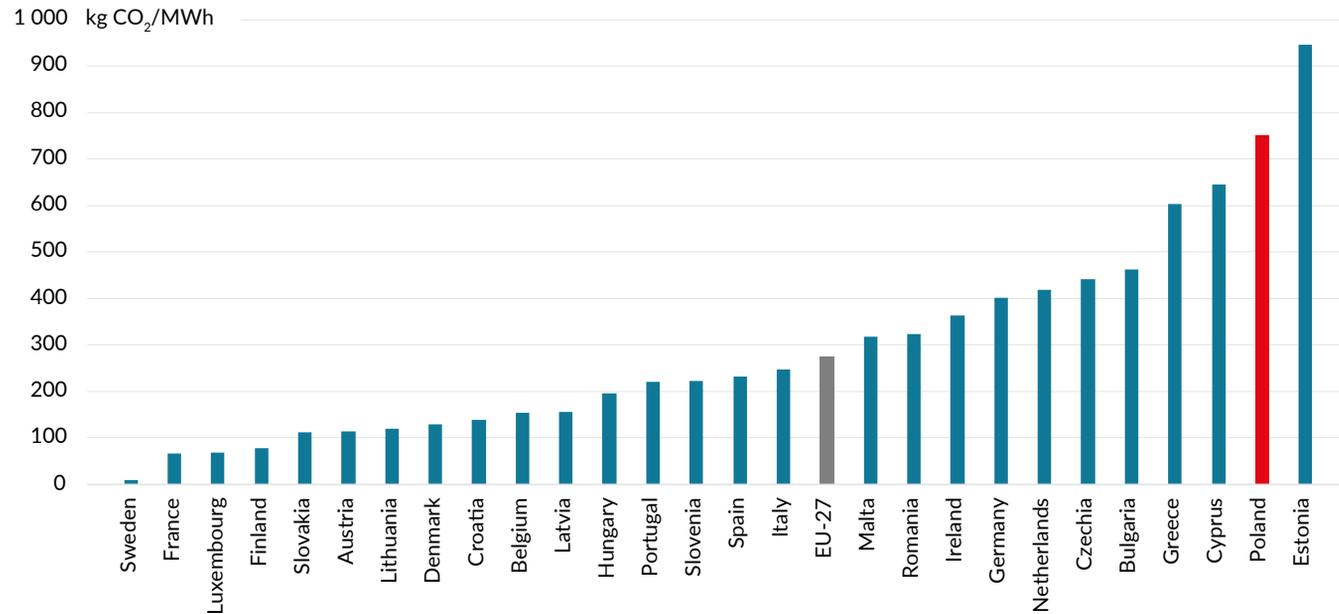


Own elaboration based on Enerdata data.

The specific emissions of primary energy consumption shows how many tonnes of CO₂ were emitted on average when 1 unit of primary energy was consumed (toe – tonnes of oil equivalent, 1 toe ≈ 41.9 GJ). In other words, it is the emissivity of energy consumption, regardless of its form (heating, fuels, electricity, etc.).

Specific emissions of electricity generation (2021)

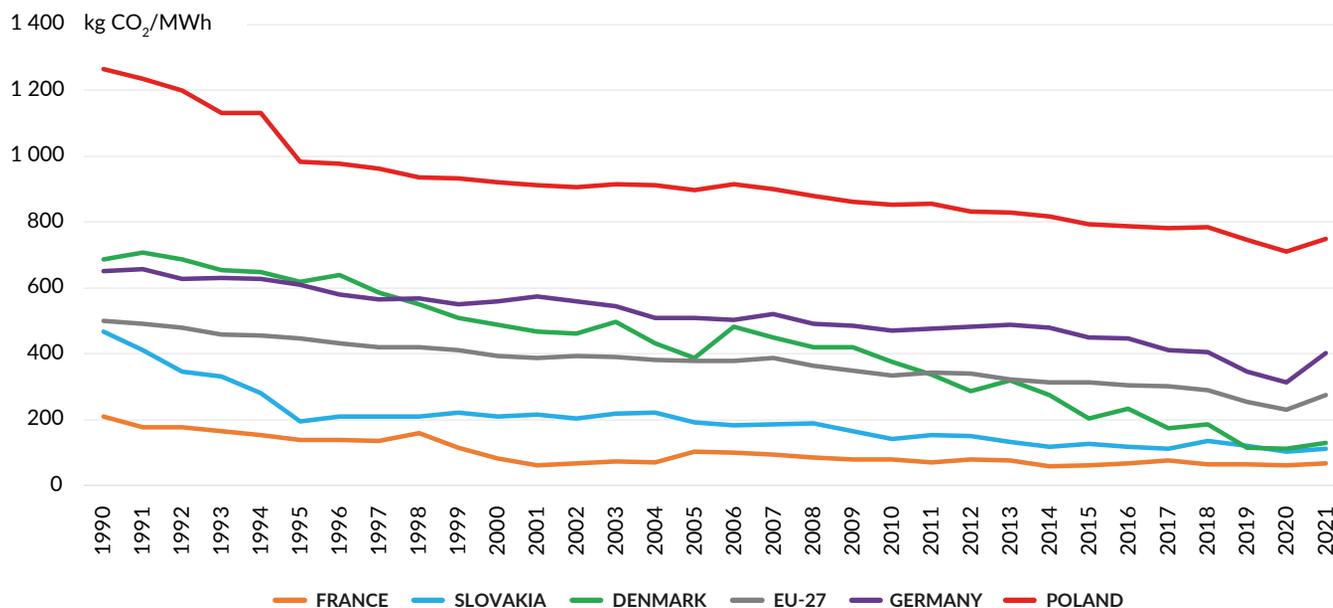
- In 2021, specific emissions of electricity generation Poland were 750 kg CO₂/MWh, one of the highest in the European Union.
- Such a high carbon footprint has and will continue to have an impact on the industry due to the increasing importance of monitoring the carbon footprint in production, which must be reported. High CO₂ prices also significantly increase the cost of electricity generation, which may translate into high electricity prices on the wholesale market.



Own elaboration based on EEA data.

Change in specific emissions of electricity generation over time (2021)

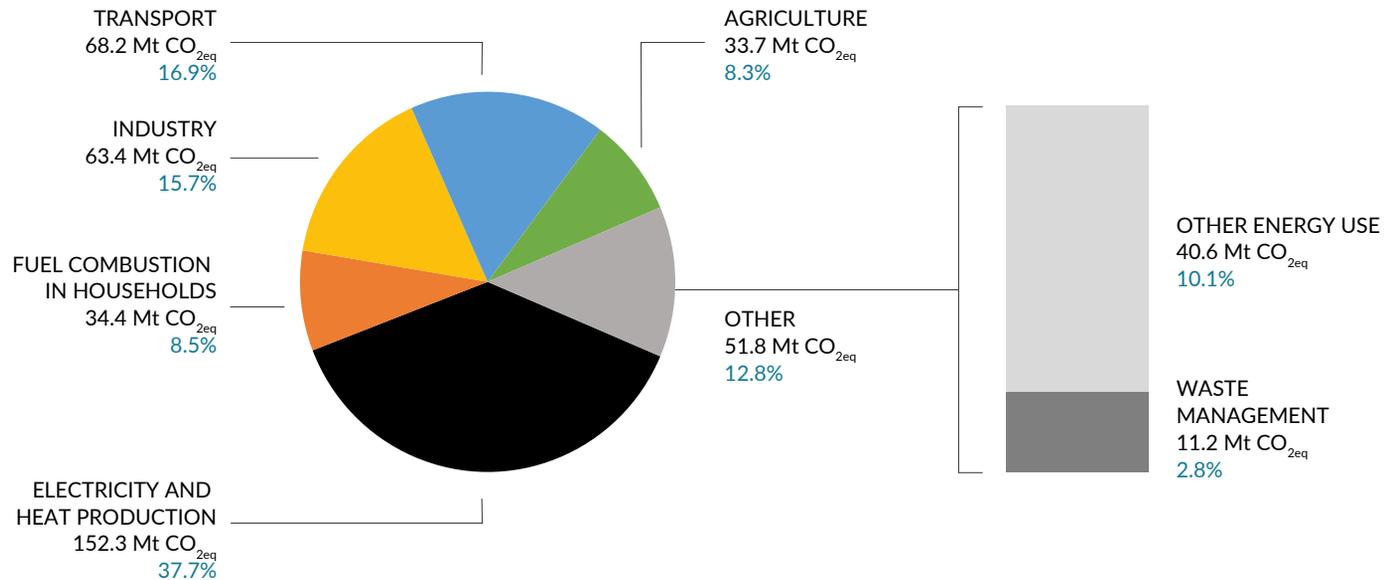
- Despite a 40.6% reduction in GHG emissions (relative to 1990), Poland's energy sector is and always has been one of the most carbon-intensive in the European Union.
- The EU average reduction from 1990 to 2021 is 45%. Denmark boasts the greatest success, with reductions in GHG emissions from the power industry reaching 81%. However, it should be noted that due to Denmark's size, location, and connection to its neighbors, it is not a reference country for Poland.



Own elaboration based on EEA data.

Structure of greenhouse gas emissions in Poland (2021)

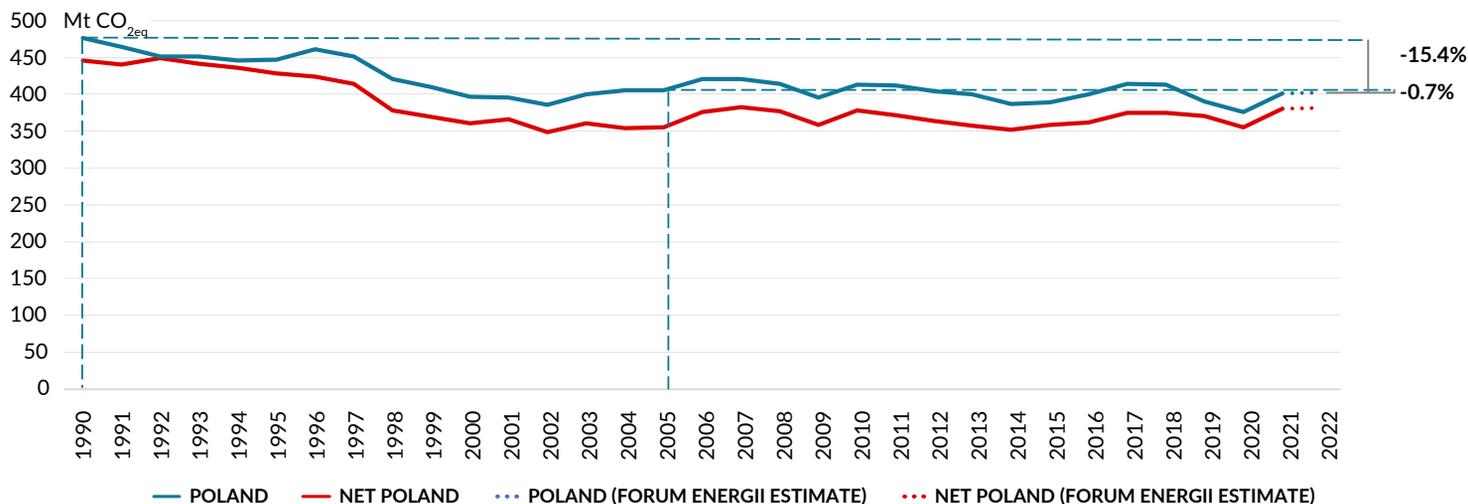
- In 2021, most GHG emissions came from electricity and heat production: 152.3 million tonnes of CO_{2eq}, or 37.7% (+2.6 p.p. y/y) of total gross emissions.
- Transportation and industry were responsible for 68.2 (16.9%; n.s.) and 63.4 Mt CO_{2eq} (15.7%; -0.8 p.p. y/y), respectively.
- Households emitted 34.4 million tonnes of greenhouse gases (8.5%; -0.5 p.p.).
- Emissions from agriculture amounted to 33.7 million tonnes of CO_{2eq} (8.3%; -0.8 p.p.).



Own elaboration based on EEA data.

Changes in greenhouse gas emissions in Poland

- According to Forum Energii estimates, gross emissions in 2022 increased by 0.3% relative to 2021 and remained above 400 million tonnes of CO_{2eq}. About 403 million tonnes of CO_{2eq} were emitted in 2022.
- Land use, land use change and forestry (LULUCF) was responsible for absorbing about 21 million tonnes of CO₂ equivalent, reducing net emissions to about 381 million tonnes of CO_{2eq}.
- Relative to 1990 (the reference year for the European Union), gross emissions fell by 15.4%.
- Relative to 2005 (the year the ETS began), gross emissions fell by 0.7%.

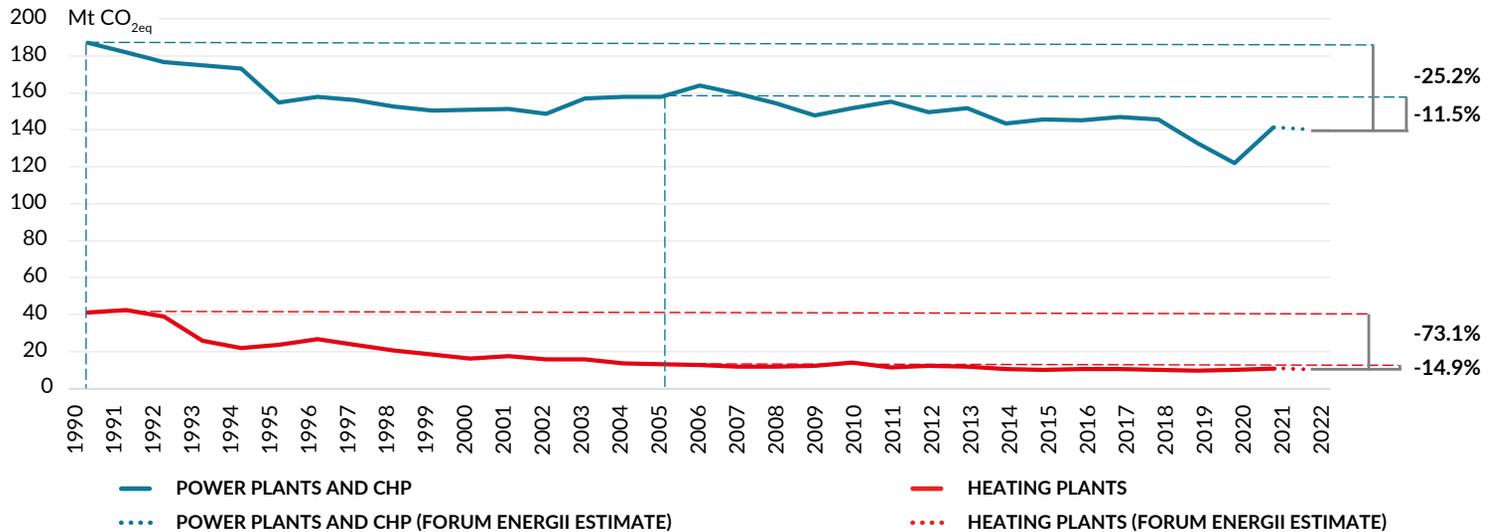


Own elaboration based on EEA, KOBiZE, ARE and GUS data. Greenhouse gases: CO₂, methane, nitrous oxide.

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).

Changes in greenhouse gas emissions from electricity and heat generation

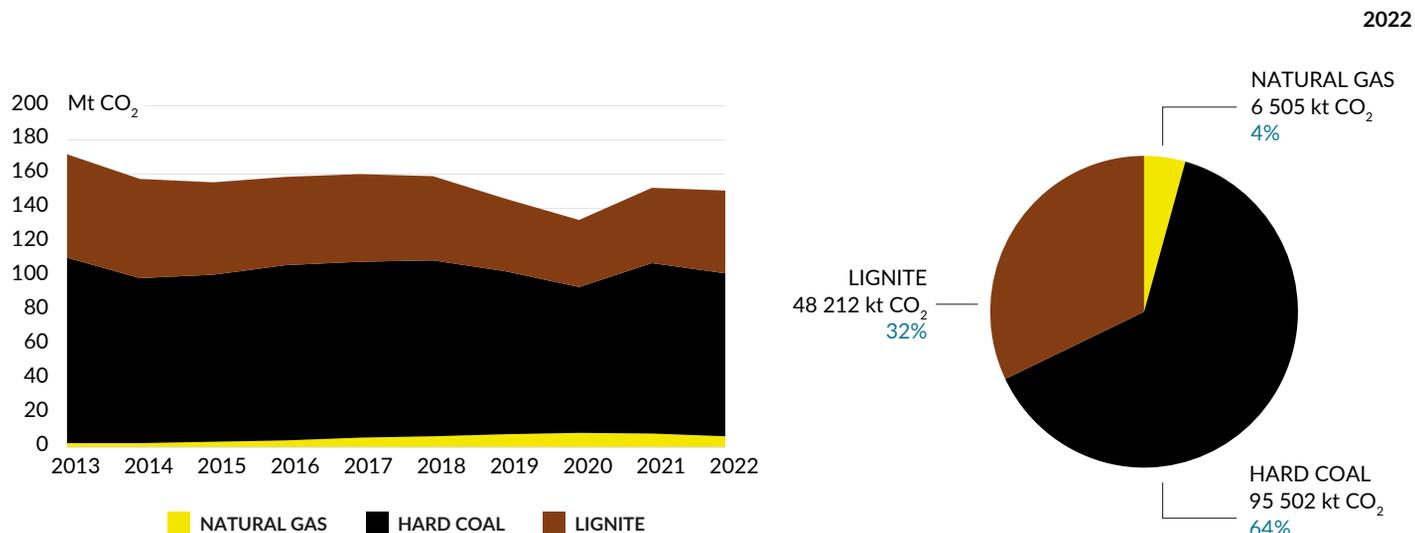
- According to estimates, in 2022, emissions from power plants and combined heat and power (CHP) plants fell 0.9% from the previous year to 151 million tonnes of CO_{2eq}.
- GHG emissions from heating plants increased by an estimated 0.1% to 11.1 million tonnes of CO_{2eq}.
- Relative to 1990, emissions from power plants and combined heat and power (CHP) plants fell by 25.2%, and from district heating plants by 73.1% (mainly due to a decline in industrial demand and modernised district heating systems).
- Relative to 2005 the emission reductions are, respectively, -11.5% and -14.9%.



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

Emissions from electricity and heating, by fuel

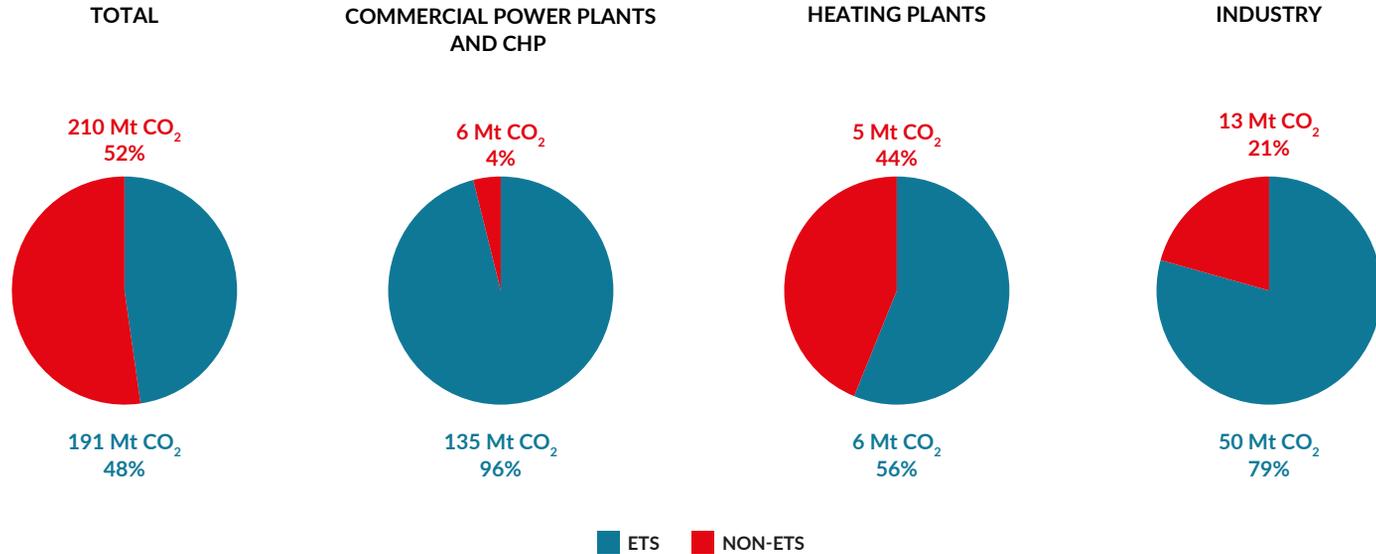
- Hard coal comprised 64% of CO₂ emissions from the power and heat industry in 2022 (95.5 million tonnes CO₂; -4% y/y).
- Lignite was responsible for 32% of emissions (48.2 million tonnes CO₂; +10% y/y).
- Production of electricity and heat from gaseous fuels was associated with emissions of 6.5 million tonnes of CO₂ (-22% y/y).
- In 10 years, emissions related to electricity and heat production fell by 12%.
- During the decade, emissions from lignite fell by 20% (-12.4 Mt CO₂) and from hard coal by 12% (-12.7 Mt CO₂). CO₂ emissions increased, however, from gas by 142% (+3.8 Mt CO₂).



Own elaboration based on EEA, KOBiZE, ARE and GUS data.

Carbon dioxide emissions covered by the Emissions Trading System (2021)

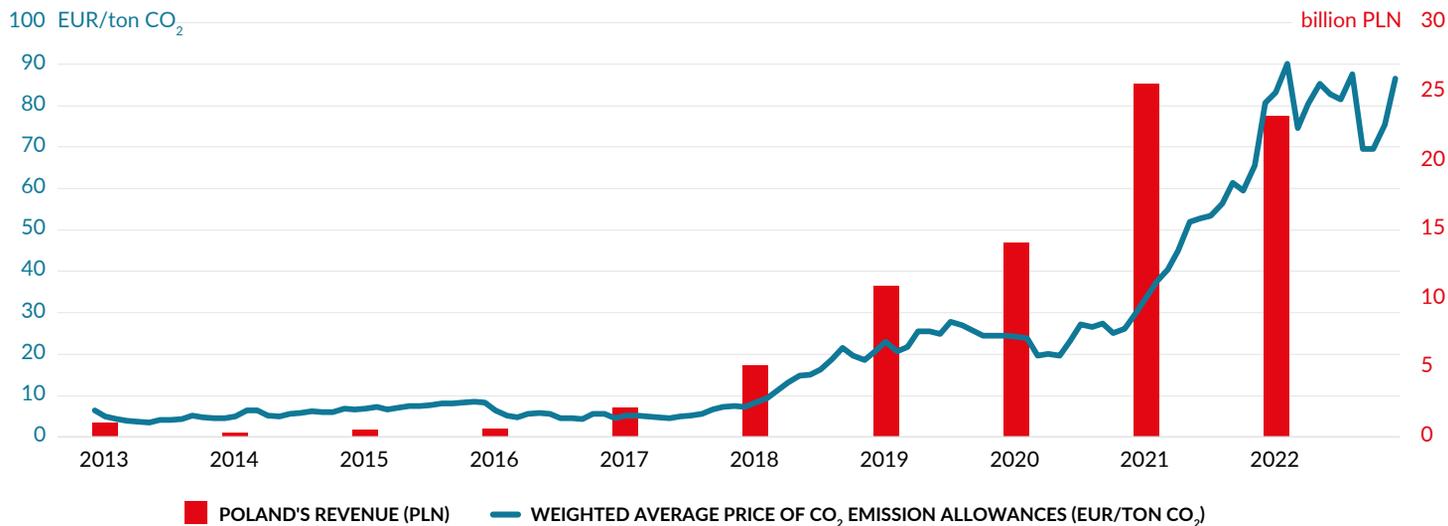
- Poland's total CO₂ emissions in 2021 were 401.27 million tonnes, with 48% covered by the European Union Emissions Trading System (EU ETS).
- In commercial power plants and CHP, 135 million tonnes of CO₂ (96% of all emissions from this sector) were subject to the ETS. For heating plants, it was 56% – 6 million tonnes of CO₂ were subject to the ETS in 2021.
- 79% of industrial emissions were covered by the ETS – 50 million tonnes of CO₂.



Own elaboration based on EEA and KOBiZE data.

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

- At the end of 2022, the weighted average price of CO₂ allowances on the primary market (EEX) was 86.54 euros/ton CO₂.
- In 2022, the price of EUAs was not observed to rise as dynamically as in 2021. The market tested the level of 100 euros/ton of CO₂ several times, but it was not permanently exceeded.
- The volume of allowances sold by Poland was in 2022 63.03 million tonnes, 42.3 million tonnes less than in 2021. Despite this, budget revenues remained at a comparable level due to the increase in the average price of allowances.
- The Polish budget gained PLN 23.29 billion from auctions of CO₂ emission allowances (EUA and EUAA). This was PLN 2.3 billion less than in 2021.
- PLN 83.66 billion are the total budget revenues over 10 years of CO₂ sales. Adjusted for inflation, this is PLN'22 95.65 billion.



Own elaboration based on EEX and NBP data.

Energy Transition
in Poland
2023 Edition



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