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Polish transformation climate and energy in numbers

Infographics

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a larger publication entitled:
Climate for Poland – Poland for Climate
1988 – 2018 – 2050

Key words: GHG, transformation, emissions, greenhouse gases, carbon dioxide, climate protection, power industry, mining, carbon leakage, electromobility, EU ETS, non-ETS, agriculture, transport, construction, industry.

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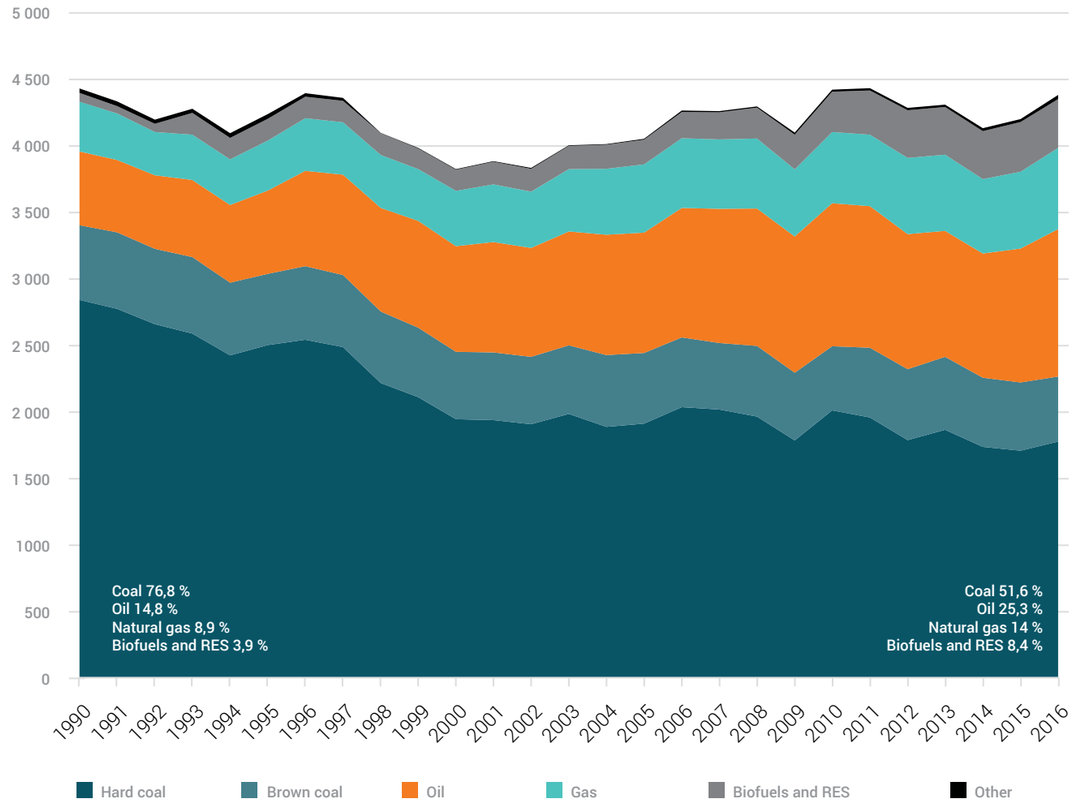
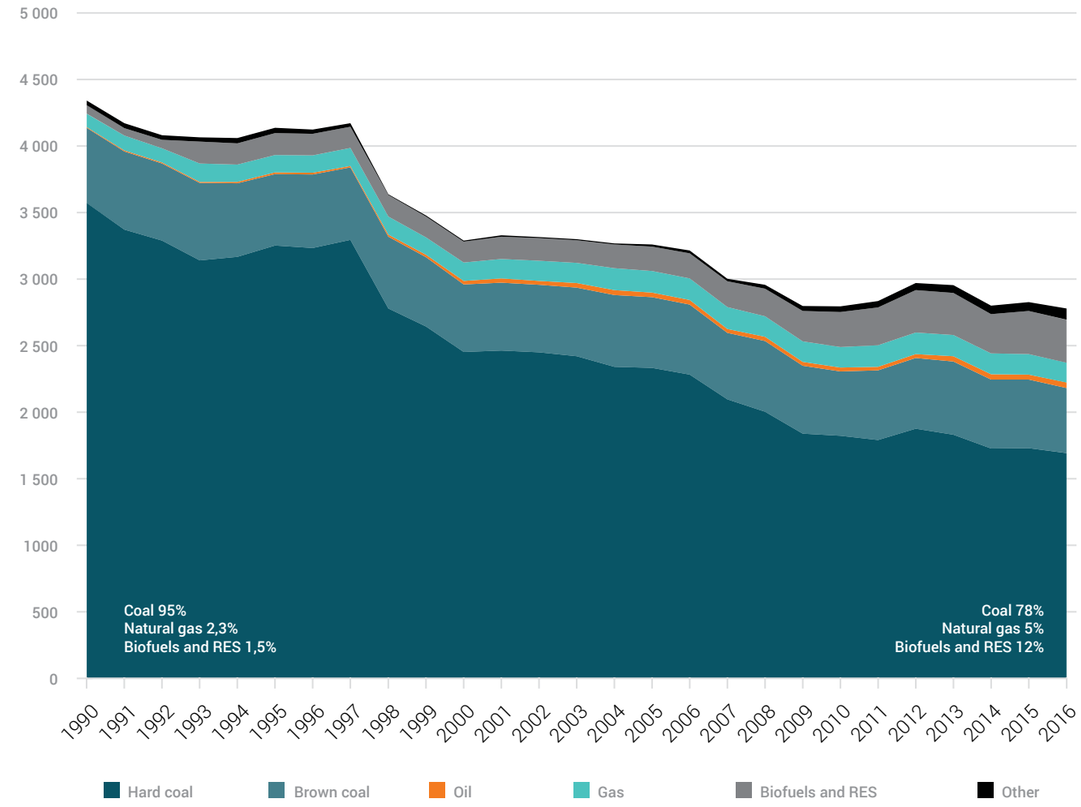
Fig. 1. Structure of primary energy consumption in Poland in the years 1990-2016 [PJ]



Source: Own study by KOBiZE

In the last thirty years the structure of primary energy consumption in Poland has changed. Demand ranges from 3 800 PJ to 4 500 PJ. The share of coal use decreased significantly from 76.8% in 1990 to 51.6% in 2016 with relatively stable use of lignite. In the same time period the use of crude oil has increased from 14.8% to 25.3%, natural gas from 8.9% to 14% and biofuels and renewable energy sources from 3.9% to 8.4%.

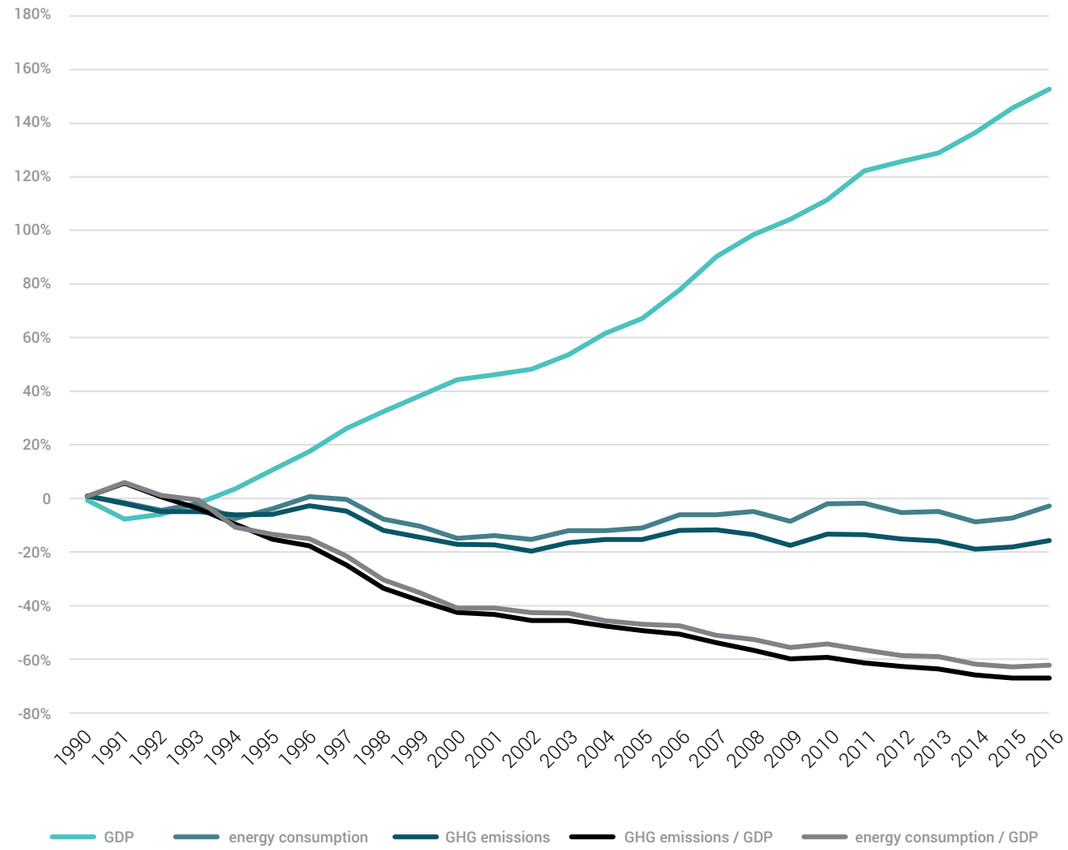
Fig. 2. Structure of primary energy production in Poland in the years 1990-2016 [PJ]



Source: Own study by KOBiZE

In Poland, the structure of primary energy production has changed over the last thirty years. The level of primary energy production decreased from 4 344 PJ in 1990 to 2 781 PJ in 2016. The share of coal in the structure of primary energy production fell from over 95% in 1990 to 78% in 2016, while lignite extraction remains at an unchanged level. At the same time, the importance of biofuels and renewable energy sources has increased from about 1.5% in 1990 to 12% in 2016.

Fig. 3. Changes in GDP, greenhouse gas emissions and energy consumption in Poland in reference to 1990.

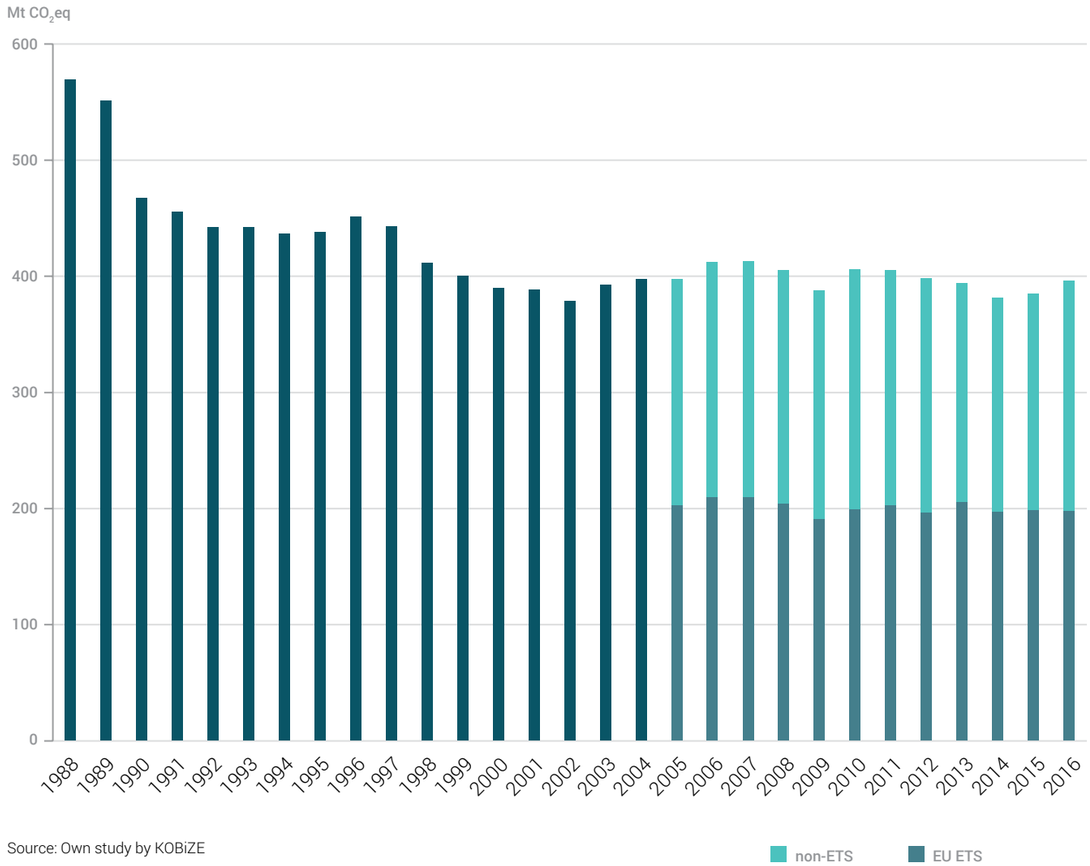


Source: International Monetary Fund, Eurostat, KOBiZE

A broad package of structural, legislative and economic changes ultimately results in simultaneous economic growth and emission reductions. Between 1988 and 2016, GDP grew more than twice and GHG emissions fell by about 30%. The phenomenon of the separation of two processes that from the historical point of view could have a similar course, is called decoupling.

Since the early 1990s, the Polish economy has been characterized by decoupling economic growth from greenhouse gases emissions resulting from economic and social activities (the so-called decoupling phenomenon). This is particularly evident in comparing greenhouse gas emissions and energy consumption to GDP, where changes have already exceeded -60%.

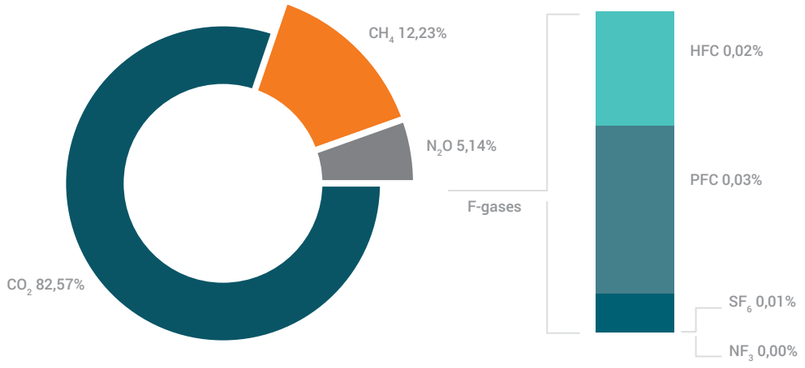
Fig. 4. Domestic greenhouse gas emissions in Poland (without LULUCF) in the period of 1988-2016.



Source: Own study by KOBiZE

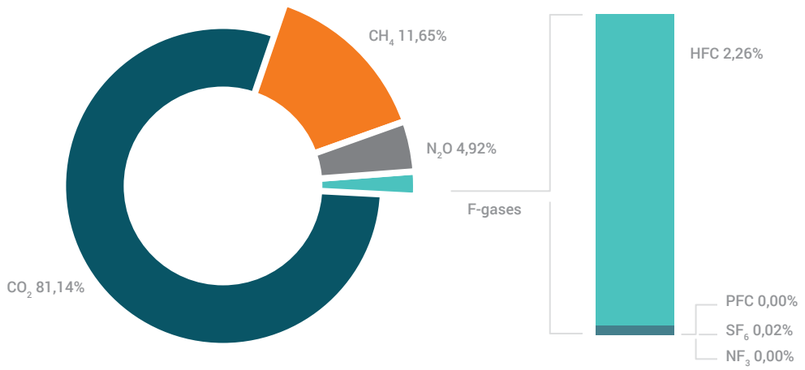
Since 2005, Poland has participated in the EU Emissions Trading System, built, inter alia, on the basis of the Kyoto Protocol's flexibility mechanisms supporting measures to reduce emissions. The share of emissions from installations participating in the EU ETS system in the total domestic emissions in Poland in the period 2005-2016 was approximately 51% on average, and attention should be paid to the fact that since 2013, the scope of the EU ETS has been extended to include new activities (e.g. nitric acid production) and greenhouse gases (nitrous oxide).

Fig. 5. Greenhouse gas emissions in Poland in 1988.



Source: Own study by KOBiZE

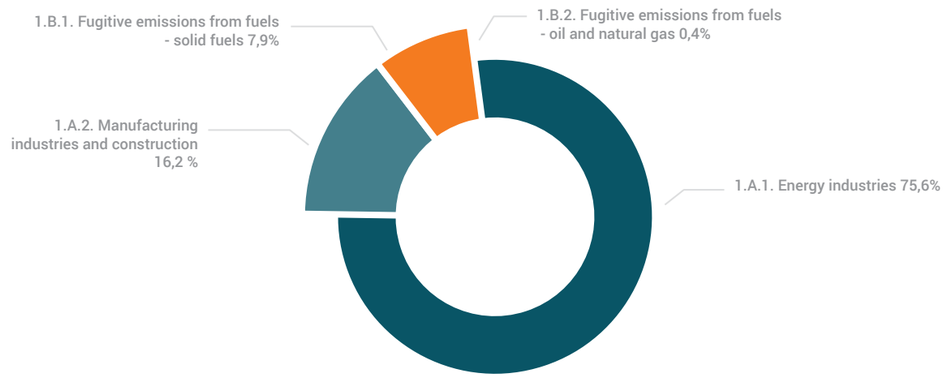
Fig. 6. Greenhouse gas emissions in Poland in 2016.



Source: Own study by KOBiZE

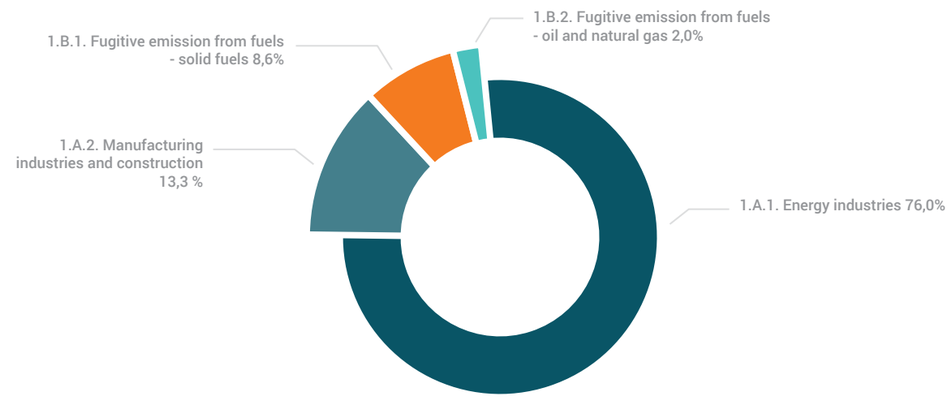
Carbon dioxide plays a dominant role in domestic emissions, with its share decreasing from 82.57% in 1988 to 81.14% in 2016, methane and nitrous oxide's share is also decreasing from 12.23% to 11.6% and from 5.14% to 4.91%, respectively. Fluorinated industrial gases (so-called F-gases) account for a small share of domestic GHG emissions (an increase from 0.06% to about 2.3%), with no NF_3 emissions reported in Poland. The shares of individual gases do not include emissions and GHG removals from category 4. Land use, land use change and forestry.

Fig. 7. Shares of sub-sectors in emissions from the sector IPCC 1. Energy in 1988. All greenhouse gases recalculated to CO_2 equivalent were taken into account, without emissions from transport (1.A.3) and buildings (1.A.4).



Source: Own study by KOBiZE

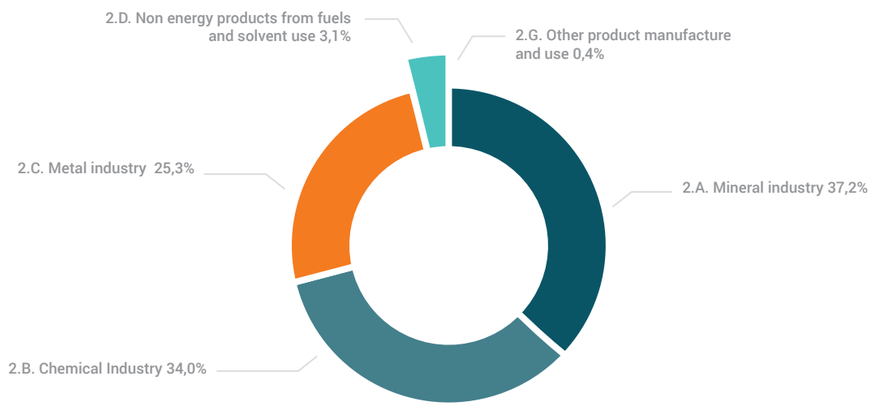
Fig. 8. Shares of sub-sectors in emissions from the sector IPCC 1. Energy in 2016. All greenhouse gases recalculated to CO_2 equivalent were taken into account, without emissions from transport (1.A.3) and buildings (1.A.4).



Source: Own study by KOBiZE

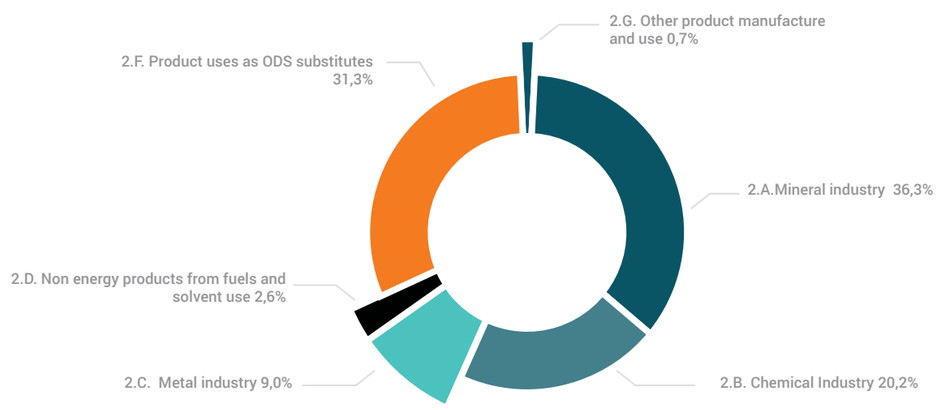
The dominant share in emissions related to the energy sector, both in 1988 and 2016, is held by the energy industries, including the subcategory 1.A.1.a Production of electricity and heat (47-60%). Changes in this subcategory had the greatest impact on the emission trend in the category 1. Energy. The decrease in emissions results mainly from reduction in fuel consumption in this sector and reduction in the share of coal and lignite in the fuel structure (in subcategories 1.A.1 and 1.A.2 the total decrease in fuel consumption between the base year and 2016 amounted to almost 32%, and the share of coal consumption decreased from about 90% to about 70%).

Fig. 9. Shares of the sub-sectors in emissions from the sector IPCC 2. Industrial processes and product use in 1988. All greenhouse gases recalculated to CO_2 equivalent have been taken into account.



Source: Own study by KOBiZE

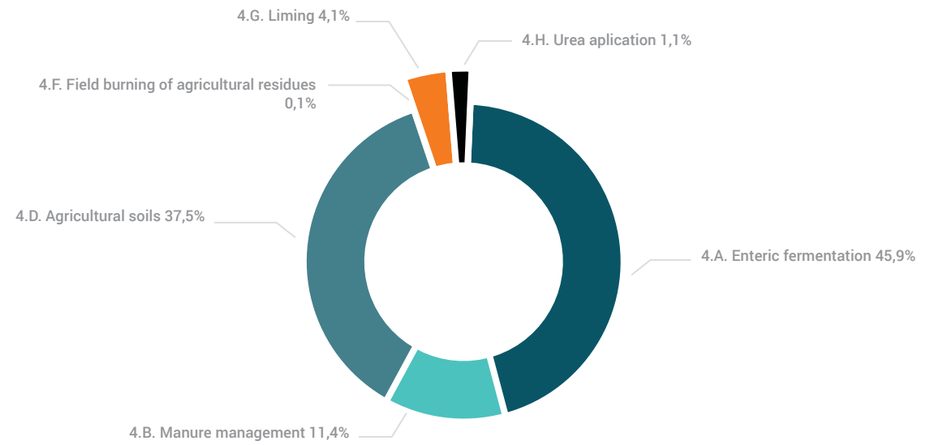
Fig. 10. Shares of the sub-sectors in emissions from the sector IPCC 2. Industrial processes and product use in 2016. All greenhouse gases recalculated to CO_2 equivalent have been taken into account.



Source: Own study by KOBiZE

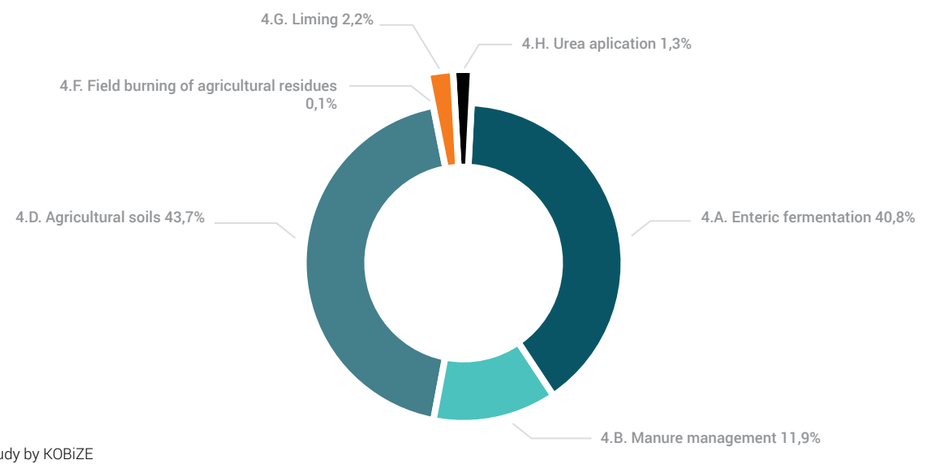
The industrial sector was the main beneficiary of economic changes. Access to modern technologies made plants more competitive compared to enterprises from outside Poland. Thanks to new opportunities, savings were introduced in the raw material economy, processes of production and processing of products were improved. Enterprises started to move towards gas technologies. In general, the reduction of emissions in industry consisted of many different factors. The final effect was very positive from the point of view of emission reduction - the relative reduction of carbon dioxide emissions in the industrial sector amounted to over 40% of the 1988 value. Significant improvements were made in the area of fuel combustion in industry, where emissions dropped by 48%. Due to the limitations of emission reduction possibilities within the process transformations, the progress was not equally intense and in the period 1988-2016 the emission drop amounted to 8%. Shares of emissions from metallurgical and chemical industries decreased in favour of fluorinated gases used mainly in refrigeration.

Fig. 11. Share of sub-sectors in emissions from the sector IPCC 3. Agriculture in 1988. All greenhouse gases recalculated to CO_2 equivalent have been taken into account.



Source: Own study by KOBiZE

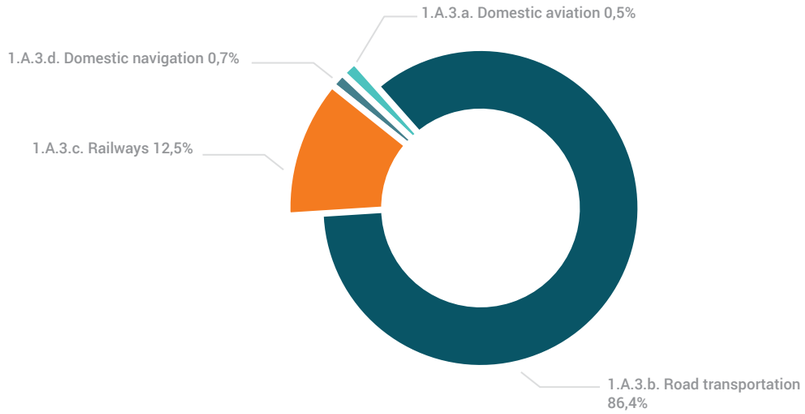
Fig. 12. Share of sub-sectors in emissions from the sector IPCC 3. Agriculture in 2016. All greenhouse gases recalculated to CO_2 equivalent have been taken into account.



Source: Own study by KOBiZE

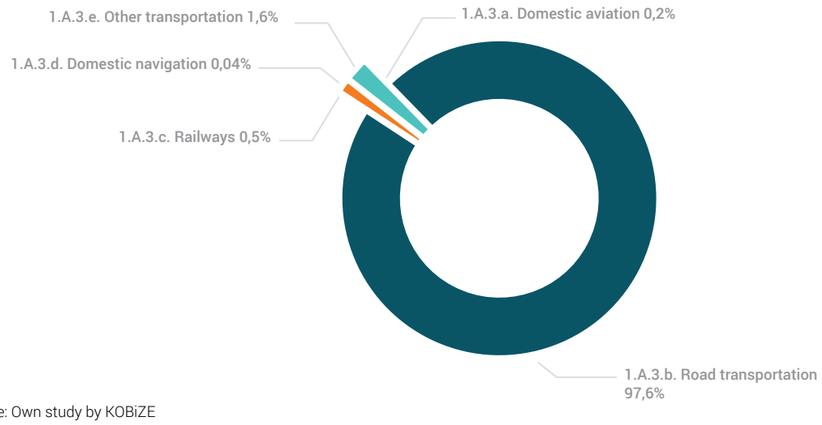
The two main sources of greenhouse gas emissions from agriculture include livestock intestinal fermentation (CH_4) and agricultural soils (N_2O), which together account for more than 80% of greenhouse gas emissions, and the share of these sources has changed between 1988 and 2016: the share of emissions from intestinal fermentation is decreasing and the share of soil emissions is increasing. Natural fertilizers (CH_4 and N_2O), liming and application of urea (CO_2) and combustion of agriculture residues (CH_4 and N_2O) are responsible for the remaining several percent of emissions. Total greenhouse gas emissions from agriculture amounted to 30.1 Mt of CO_2 eq. in 2016 and were lower by 37% compared to 1988. The largest changes in emissions occurred after 1989 in the period of social and economic transformation taking place in Poland. At that time, the profitability of agricultural production changed significantly - after 1989, both prices of agricultural products and prices of production means (such as mineral fertilisers or tractors) were market-based, and state subsidies for agricultural production were discontinued. Since 2004, i.e. since Poland's accession to the European Union, the key role in the development of Polish agriculture and rural areas has been played by the Common Agricultural Policy of the EU aimed primarily at increasing agricultural productivity through the introduction of technical progress and stabilisation of the agricultural market.

Fig. 13. Shares of the sub-sectors in emissions from the sector IPCC 1.A.3. Transport in 1988. All greenhouse gases recalculated to CO_2 equivalent have been taken into account.



Source: Own study by KOBiZE

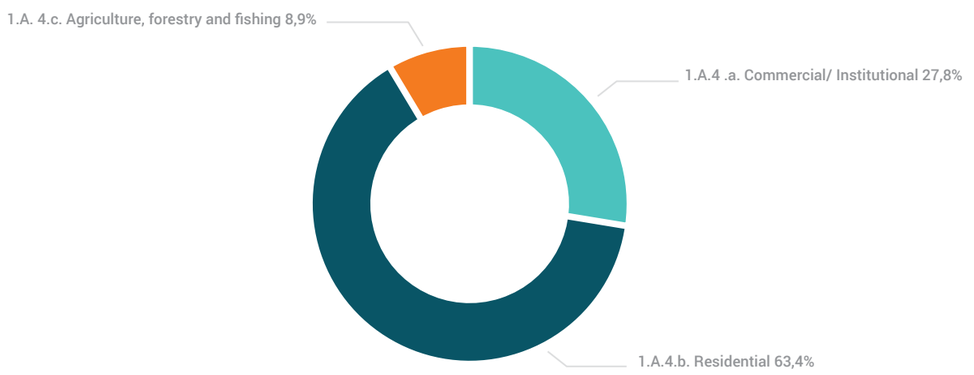
Fig. 14. Shares of the sub-sectors in emissions from the sector IPCC 1.A.3. Transport in 2016. All greenhouse gases recalculated to CO_2 equivalent have been taken into account.



Source: Own study by KOBiZE

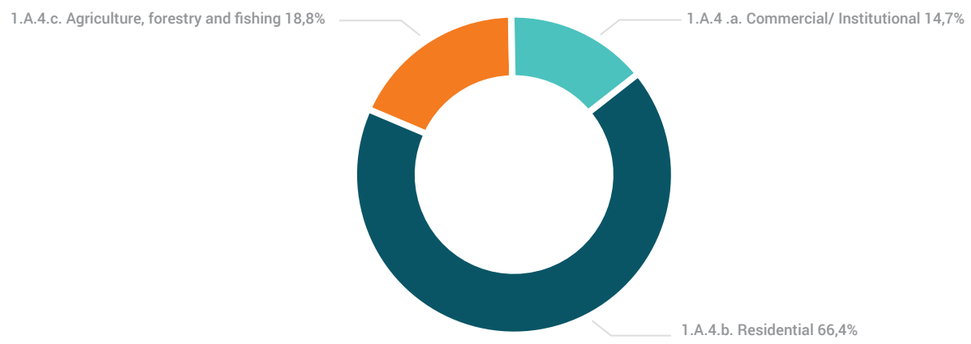
Between 1988 and 2016, greenhouse gas emission from the Polish transport increased by 120% along with dynamically increasing number of vehicles and fuel consumption. At the same time, the share of this sector emissions in total greenhouse gas emissions increased from 4% in 1988 to more than 13% in 2016. Road transport is by far the dominant mode of transport means, its emissions share rose from 86% in 1988 to over 98% in 2016.

Fig. 15. Share of sub-sectors in the emissions from the sector IPCC 1.A.4. Other (including commercial and public buildings, residential buildings, and buildings used in agriculture, fisheries and hunting) in 1988. All greenhouse gases recalculated to their CO_2 equivalents are included.



Source: Own study by KOBiZE

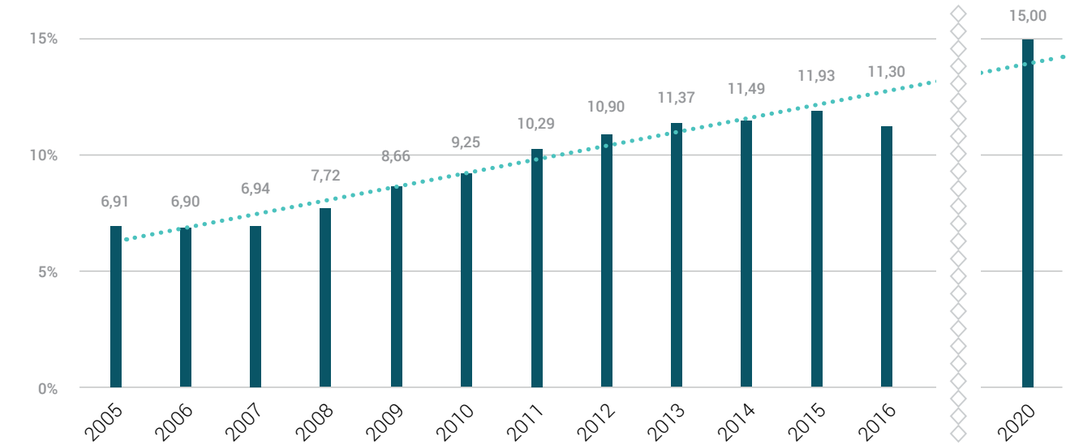
Fig. 16. Share of sub-sectors in the emissions from the sector IPCC 1.A.4. Other (including commercial and public buildings, residential buildings, and buildings used in agriculture, fisheries and hunting) in 2016. All greenhouse gases recalculated to their CO_2 equivalents are included.



Source: Own study by KOBiZE

Residential (subcategory 1.A.4.b) account for a predominant share, ranging from 60 to 68% depending on the year, of GHG emissions in the category of commercial and public buildings, residential buildings and buildings used in agriculture, fisheries and hunting. There is a visible decline in the share of commercial and public buildings in favour of an increase in the share of emissions from fuel combustion for agriculture between 1988 and 2016. Total GHG emissions in these sub-sectors decreased by more than 46% between 1988 and 2016. The main reason for this decline is the total reduction in fuel consumption compared to 1988 (by approx. 29%) and change in the fuel structure - reduction in coal consumption from 67% in 1988 to 40% in 2016 and increase in the use of natural gas from 10% in 1988 to 27% in 2016.

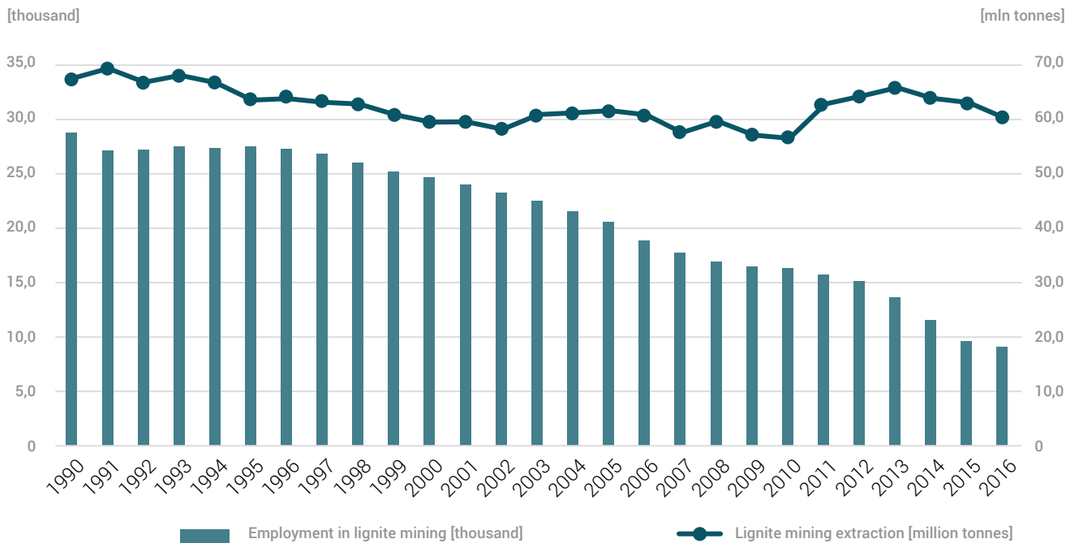
Fig. 17. Share of energy from renewable sources in the final gross consumption of energy in Poland in 2005 – 2016 [%]



Source: Energy from renewable sources in 2016, Polish Central Statistical Office (GUS), Warsaw, 2017

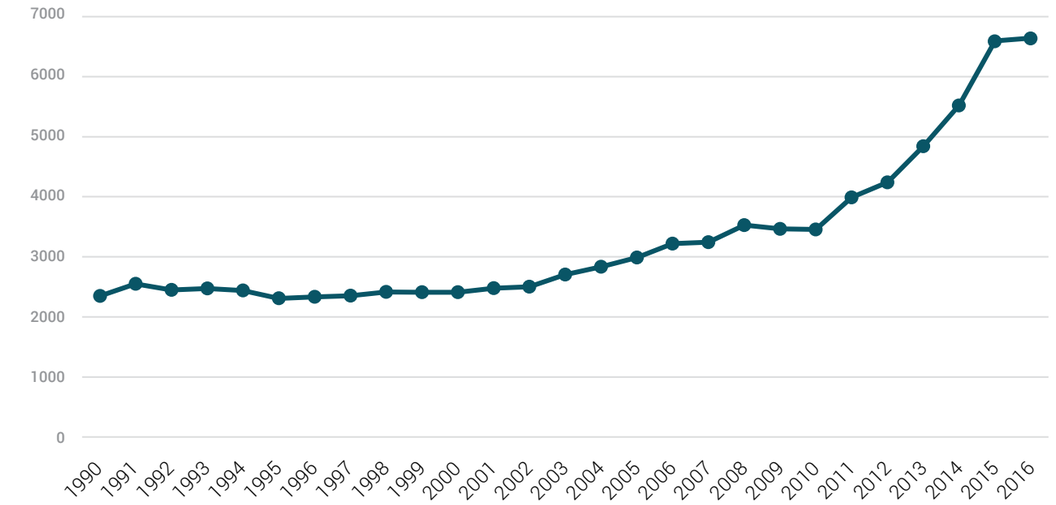
In 2016, the value of the indicator of renewable energy sources share in gross final consumption of energy amounted to 11.30% and it increased by 4.39 percentage points compared to 2005. The average annual growth rate of the share of energy from renewable sources in gross final consumption of energy in the years 2005 - 2016 amounted to 4.6%

Fig. 18. Employment and lignite mining in Poland in the years 1990-2016



Source: Eurostat database; Kasztelewicz Z., 2018: A report on the state of the lignite industry in Poland and Germany, together with a diagnosis of activities for the development of this industry in the first half of the 21st century. Krakow 2018.

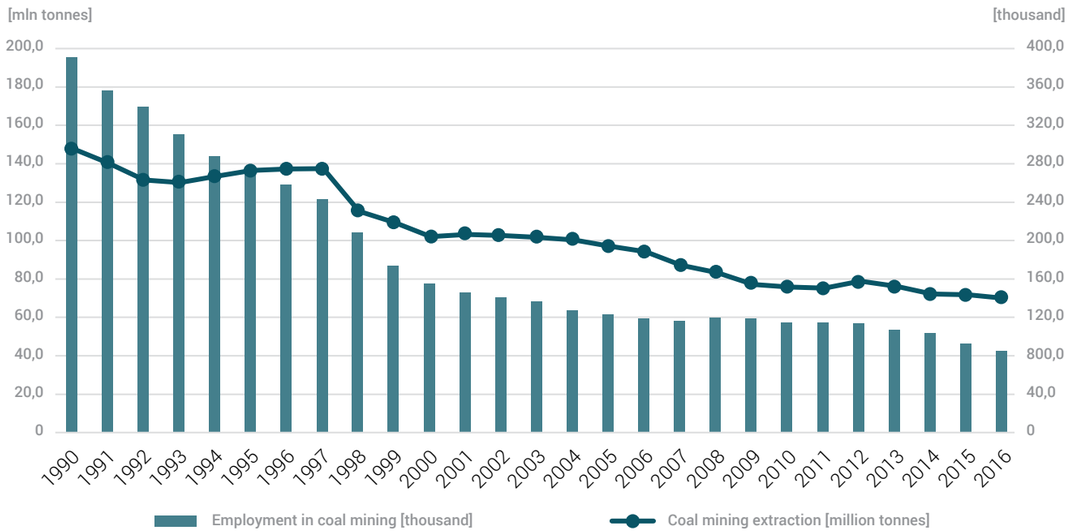
Fig. 19. Volume of lignite mining extraction per person employed in the lignite mining industry in Poland between 1990-2016 [tonnes/person]



Source: Eurostat database; Kasztelewicz Z., 2018: A report on the state of the lignite industry in Poland and Germany, together with a diagnosis of activities for the development of this industry in the first half of the 21st century. Krakow 2018.

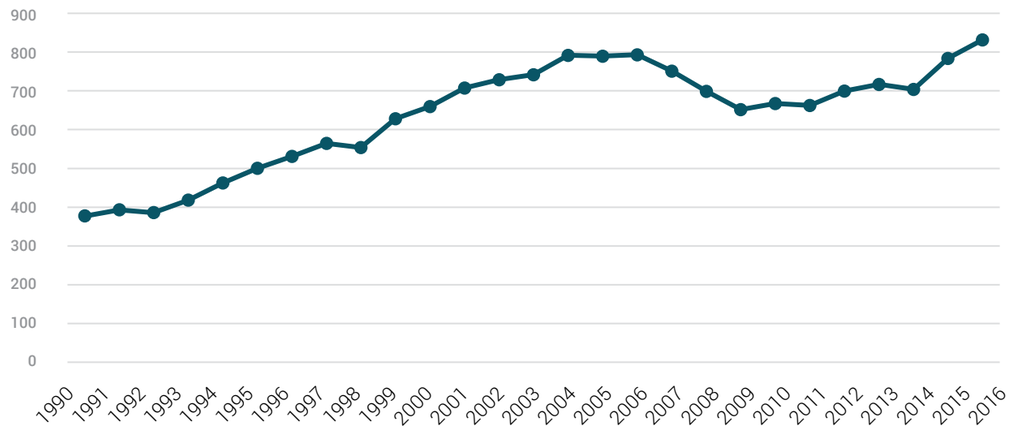
Lignite mining in Poland in the period 1990-2016 is characterised by a stable level of mining close to 60 million tonnes. In this period of time employment decreased from 28.8 thousand to 9.1 thousand. Continuous rationalization of employment increased the volume of extraction per employee from 2 351 tonnes in 1990 to 6 639 tonnes in 2016.

Fig. 20. Employment and coal mining extraction in Poland in the years 1990-2016



Source: Eurostat database; Bednorz J., 2015: Socio-economic policy of the state towards the Polish coal mining sector after 1989, Doctoral thesis, University of Silesia, 2015.; Olszowski J. 2017: The importance of coal mining for the economy and regions and the barriers to its functioning, Conference "Raw materials for the economy of Poland" Krakow 2017.

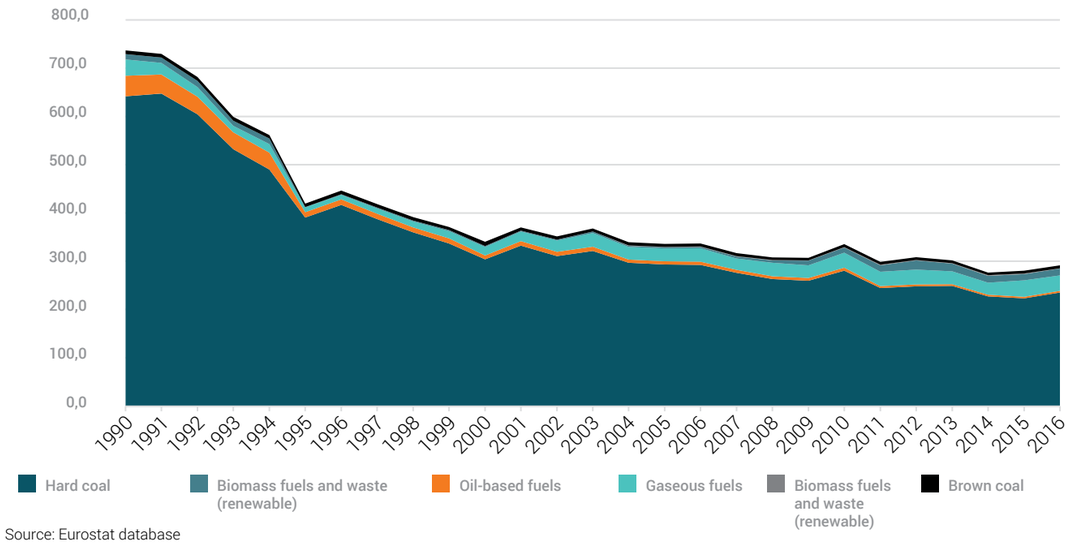
Fig. 21. Volume of coal mining per person employed in the coal mining industry in Poland between 1990-2016 [tonnes/person]



Source: Own study based on: Eurostat database; Bednorz J., 2015: Socio-economic policy of the state and the Polish coal mining sector after 1989, Doctoral thesis, University of Silesia, 2015.; Olszowski J. 2017: The importance of coal mining for the economy and regions and the barriers to its functioning, Conference "Raw materials for the economy of Poland" Krakow 2017.

The coal mining sector underwent very dynamic changes, especially during the transformation of the economy towards a free market economy after the fall of communism. Extraction in the period from 1990 to 2016 fell by more than half from 147.5 million tonnes to 70.4 million tonnes. Employment in the sector decreased from 391 thousand to 84.6 thousand. It was followed by a significant improvement in extraction efficiency from as little as 377 tonnes per employee in 1990 to 832 tonnes per employee in 2016.

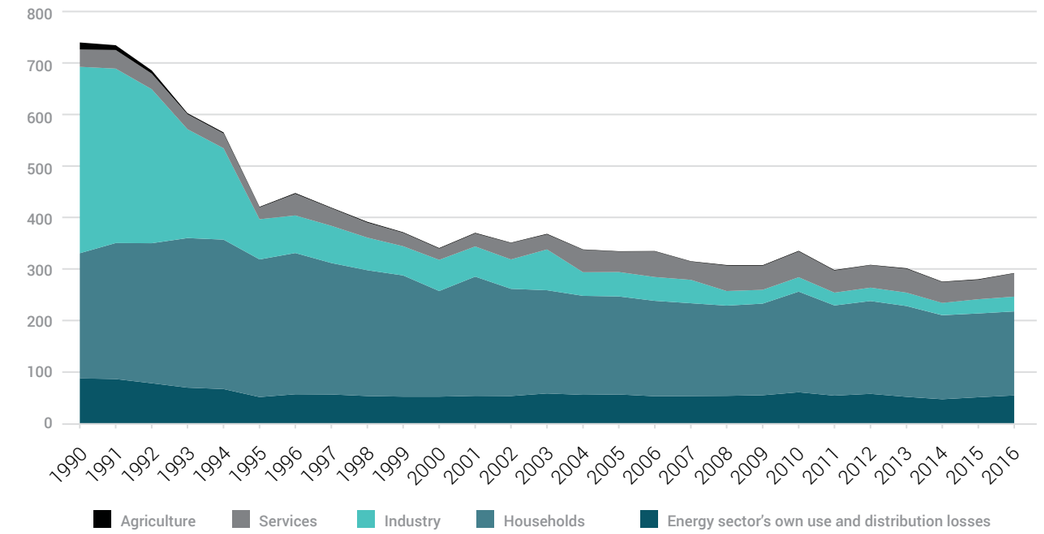
Fig. 22. Production of derived heat by fuels in Poland in years 1990-2016 [PJ]



Source: Eurostat database

Most of the derived heating in Poland is produced from coal and in the period under analysis its share dropped slightly from 87.8% to 82.4%. The share of RES tripled from 1.5% to 4.5%. The share of gas increased from 4.6% to 10.9%.

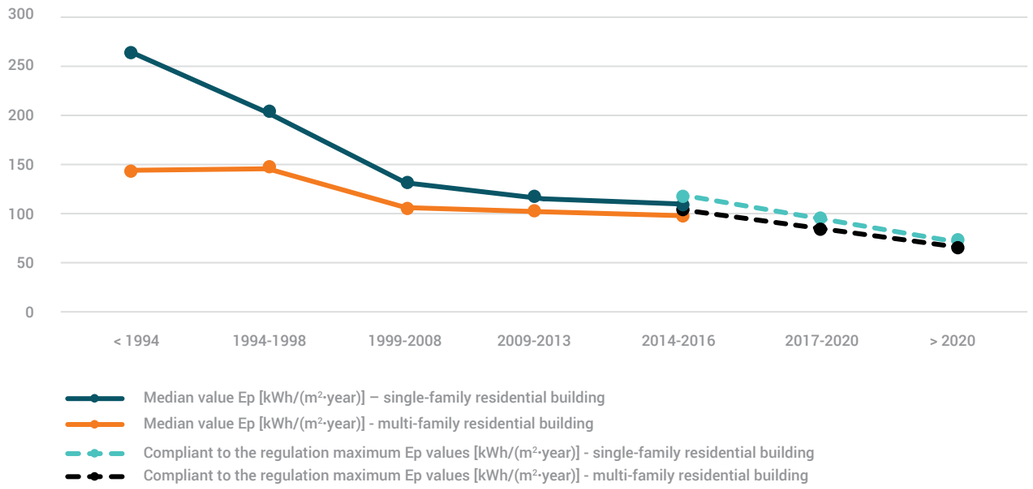
Fig. 23. Derived heat consumption by economy sectors in Poland in years 1990-2016 [PJ]



Source: Eurostat database

As a result of ownership transformations, a significant amount of derived heat used by the industry has ceased to be recorded as derived heat. Consumption fell in this sector from 361.7 PJ in 1990 to 77.8 PJ in 1995 and to 28.7 PJ in 2016. In other sectors, changes were less dynamic. In households, consumption fell from 242.7 PJ to 163 PJ. Energy sector's own consumption and distribution losses fell from 87.9 PJ to 54.9 PJ. Only in the services sector can we notice an increase in consumption from the initial 33.1 PJ to 44.8 PJ.

Fig. 24. Values of the indicator of residential buildings' annual primary energy demand depending on the purpose and year of commissioning Ep [kWh/(m²·year)]

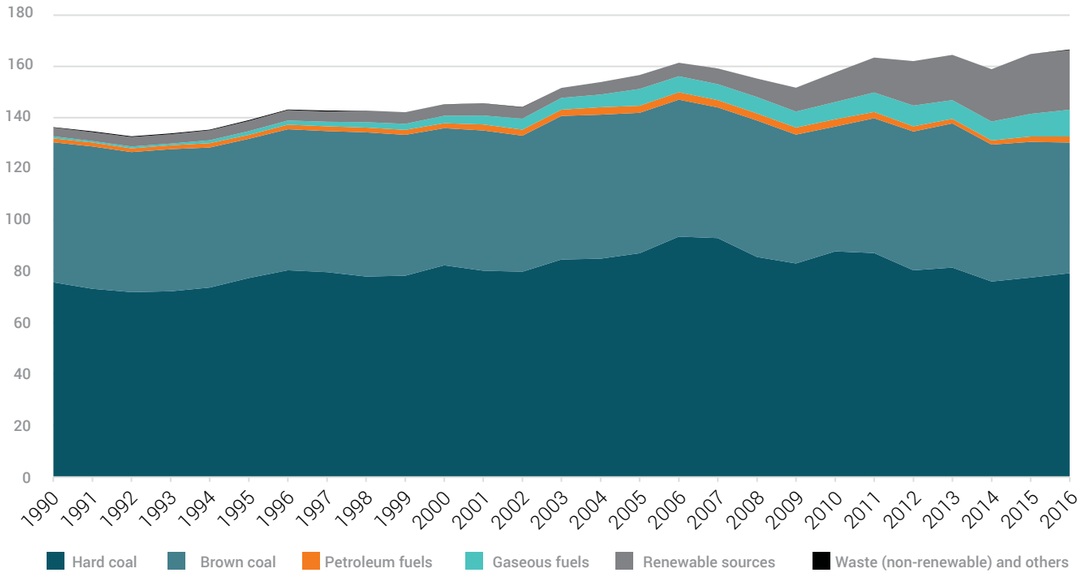


Source: Announcement of the Ministry of Infrastructure and Development of 17 July 2015 on the announcement of a consolidated text of the Regulation of the Minister of Infrastructure on technical conditions to be met by buildings and their location (Journal of Laws of 2015, item 1422). Ministry of Energy: National Energy Efficiency Action Plan for Poland 2017 (Fourth). Warsaw 2017.

Improvement of buildings' energy efficiency is the most promising direction of reducing energy consumption by households. According to the study by the Polish Central Statistical Office (GUS) titled: "Energy consumption in households in 2015", about 80% of energy consumption in this sector is dedicated to heating of buildings and water. In single-family buildings there is particularly much to be done, as the oldest of them are characterized by the median value of the Ep index above 265 [kWh/(m²·year)]. This value describes the annual calculated demand for non-renewable primary energy for heating, ventilation, cooling and hot utility water production. Currently, the maximum allowed value of this parameter for new buildings is 95 [kWh/(m²·year)], and from 1 January 2021 it is to fall to 70 [kWh/(m²·year)]. Multi-family buildings are relatively better insulated and the oldest of them are characterized by the median Ep index of 145 [kWh/(m²·year)], current requirements for new buildings are 85 [kWh/(m²·year)], and are expected to increase from 1 January 2021 to 65 [kWh/(m²·year)].

This high demand for heat by the existing residential buildings was the underlying reason for the Polish government's announcement of the "Clean Air" programme, with the planned budget of 103 PLN billion for the years 2018-2029.

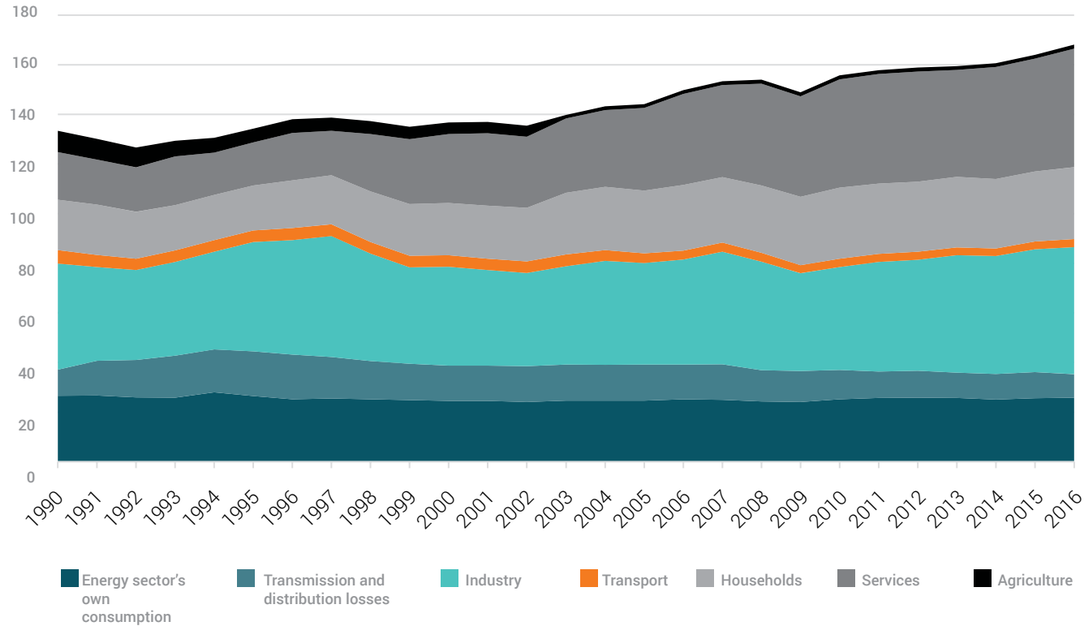
Fig. 25. Electricity production in Poland in years 1990-2016 [TWh]



Source: Eurostat database

Between 1990 and 2016, electricity production in Poland increased by 22% from 136 TWh to 166.6 TWh. Over this period, the share of coal fell from 55.6% to 47.7% and lignite from 40% to 30.6%. The share of electricity from RES increased dynamically in this period from 2.5% to 14%.

Fig. 26. Electricity consumption by sectors of economy in Poland in years 1990-2016 [TWh]



Source: Eurostat database

The highest increase in consumption took place in the household sector with the values from 19.3 TWh to 47.8 TWh. This is partly due to changes in statistics at the turn of 2002 and 2003, where the share of energy consumption previously included in the agricultural sector was shifted to households. The agricultural sector, due to an improvement in efficiency and the above mentioned shift witnessed a decrease in consumption from 8.5 TWh to 1.6 TWh.

The services sector witnessed an increase from 20.2 TWh to 28.9 TWh and industry from 42.7 TWh to 51.2 TWh. In the transport sector, consumption fell from 5.5 TWh to 3.3 TWh. By 1998, transmission and distribution losses had risen from 10.6 TWh to as much as 18 TWh, but after this period this process was stopped and the losses were reduced to only 9.5 TWh. Demand in the energy sector remains relatively stable at the level of 25 TWh.

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IOŚ-PIB
INSTITUTE OF ENVIRONMENTAL PROTECTION
NATIONAL RESEARCH INSTITUTE

Institute of Environmental Protection - National Research Institute

ADDRESS
Krucza 5/11D
00-548 Warsaw

PHONE
+48 22 37 50 511
+48 22 37 50 556

E-MAIL
sekretariat@ios.edu.pl
www.ios.edu.pl

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for Environmental Protection
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