Forum Energii
Analizy i dialog

The 2024+ industrial deal

Strategic pathways to modernise the Polish industry

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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 paving the way towards climate neutrality. We attain this goal through analysis, opinions and discussion on decarbonisation of major branches of the economy. All of the Forum Energii's analyses may be reproduced provided their source and authors are indicated.

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Introduction

The incoming European Commission's emphasis on industrial competitiveness contrasts sharply with the peripheral attention this issue receives in Poland. The recent years of crises heightened political tensions, and the war on Poland's eastern frontier have diverted focus from the economy – the very foundation of societal stability.

In today's rapidly shifting global landscape, it is easy to miss key inflection points. One such turning point is the decarbonisation of all economic sectors and the drive toward climate neutrality by 2050, a cornerstone of European Union policy. The agenda is not only about reducing emissions but also fostering innovation across products, services, and employment opportunities. This shift is critical for the energy and economic security of the EU, which lacks abundant indigenous fossil fuel resources and has faced an upward trend in the volume and value of imports over the years. Moreover, the EU must contend with growing global competition and frequent violations of WTO standards by major economic powers, notably China.

Poland, as one of the EU's most industrialised economies, derives more than 20% of its GDP from industry similar to economic heavyweights like Germany and France. This sector supports over three million jobs. However, foreign companies create a significant portion of these jobs, challenging the historical-right wing narrative that has recently dominated political discourse. As a result, industrial actors in Poland are far less engaged in political debates than their counterparts in France or Germany, further marginalising the sector's interests in national policymaking.

Historically, Polish industry has thrived due to factors such as low labour and energy costs, a relatively well-educated workforce, and robust domestic demand. However, these strengths are increasingly under threat from intensified global competition, political instability, and an escalating energy crisis.

Despite arguments in public discourse that Poland should decarbonise at a slower pace, such a strategy is unfeasible in an interconnected global economy and under EU regulations. The global market's rapid transition towards low-carbon economies is accelerating. Should Poland choose not to adapt, its suppliers risk being quickly replaced by more competitive producers.

Given these dynamics, the decarbonisation of industry must be elevated to a top priority for Polish policymakers. The necessary transformation is not just a matter of costs and investments but also of seizing opportunities for producing optimised goods and fostering demand for innovative services, particularly in digital technologies.

This analysis is the first in a series addressing the decarbonisation of Polish industry. Our objective is to catalyse action, encouraging Poland to develop a comprehensive national strategy for industrial decarbonisation and actively promote job creation in key clean technologies. A coordinated state effort is essential to shape resilient supply chains and ensure future energy and economic security.

We invite you to engage in discussion.
Joanna Pandera, PhD
President of the Forum Energii

1. Key findings

- Industry holds a significant economic, social, and political position in Poland. Consequently, its energy transition cannot occur without strategic oversight. Decarbonisation is unavoidable due to the rising costs of energy sourced from fossil fuels and growing pressure to reduce carbon footprints across sectors.
- Under the Emissions Trading System (ETS), the decarbonisation of Polish industry must be completed within the next 15 years. The final CO_2 emission allowances within the ETS will be allocated in 2039. An additional challenge is the EU's current industrial policy, most notably the *Net-Zero Industry Act (NZIA)*[1], which primarily supports new investments in selected industries. This places the onus on the Polish government to take a proactive diplomatic role to ensure the decarbonisation of existing industries that fall outside NZIA's scope.
- Poland's manufacturing sector exhibits 37% higher energy intensity than Germany's, 36% higher than Lithuania's, and 12% higher than Slovakia's. This is driven by the predominance of energy-intensive sectors, the persistence of outdated technologies, and the heavy reliance on carbon-intensive energy sources both in electricity generation and industry-specific fuel mixes. Coupled with rising fossil fuel costs, this threatens the competitiveness of Polish products by driving up production costs.
- The process of industrial decarbonisation is multifaceted, involving thousands of distinct processes. Fortunately, many solutions are already available and commercially viable. For example, the production of low-temperature heat – used in food pasteurisation – is among the more easily decarbonised processes.
- Large-scale decarbonisation of the industrial sector necessitates active state intervention. Initial steps should focus on improving energy efficiency–acknowledging that the most cost-effective energy is that which is not consumed. Further support is needed for transitioning industries away from coal towards the most relevant, though not necessarily the cheapest, technologies. Access to affordable capital, alongside regulatory frameworks aimed at reducing energy costs, will also be essential.
- The shift towards decarbonised production will alter global demand for products and services, particularly in clean technologies, such as wind turbines and batteries. Polish companies, integrated within EU supply chains, can seize this opportunity–provided that a coherent national strategy for the industrial sector is developed and implemented effectively.
- A comprehensive decarbonisation strategy should align with climate and environmental objectives while fostering an active industrial policy. This entails identifying priority technologies based on national strengths, efficiently allocating limited public resources, and leveraging private sector investments. Achieving this will require stable legislation, well-targeted financial flows (both public and private), and a supportive business environment conducive to long-term growth.

1 This EU initiative aims to enhance the production capacity of clean technologies within the European Union. Source: https://commission.europa.eu/strategy-and-policy/priorities-2019-2024/european-green-deal/green-deal-industrial-plan/net-zero-industry-act_en.

2. Introduction

Poland boasts a large, diverse industrial sector that contributes over 20% of the national GDP and directly employs more than 3 million people. Over the past decade, the importance of Polish industry within the EU has grown steadily, with Polish products becoming a key component in EU supply chains. Even amid challenging economic conditions, Polish exporters have successfully adapted to shifting consumer demands and filled emerging market niches. This industrial strength has helped position Europe as a global manufacturing hub, competing with the United States and East Asia.

However, the future of Polish industry faces serious risks. Polish producers may experience a significant decline in competitiveness due to high energy costs and the heavy carbon footprint of existing production methods. To sustain growth, the sector must embrace the decarbonisation of its processes, which aligns with companies' investment cycles. Leveraging major physical capital upgrades to shift from fossil fuels to renewable energy sources will enable Polish industry to make a technological leap ahead of its competitors.

Poland also stands at a pivotal moment to develop new market niches. Ursula von der Leyen's European Commission has identified the expansion of clean technology sectors as a strategic objective for the EU. Governments in Europe's largest economies are already actively pursuing decarbonisation strategies that will not only serve their industries but also enhance their value chains. Unfortunately, the Polish government has been largely absent from this critical conversation, jeopardising the future prospects of its industrial sector.

This report aims to lay the groundwork for a forward-looking strategy for Poland's industry, addressing the long-term needs of the sector. It argues that investments in decarbonisation will facilitate a smoother transformation of Poland's economic model and that transitioning to renewable energy sources (RES) will prevent asset stranding.

Poland has the potential to emerge as a beneficiary of the new industrial order–provided its national decision-makers engage effectively in European-level discussions. While the success of specific product groups and industrial assets (including production facilities, infrastructure, technology, and knowledge) is a valuable asset, political will and determination will be essential to securing their future.

In the subsequent chapters, we explore the challenges confronting Polish industry, present various decarbonisation scenarios, and illustrate how certain approaches may prove more cost-effective than others. We also outline the necessary reforms in national public policy to ensure the efficient decarbonisation of both large and smaller industrial players.

3. Poland's industrial landscape

The position of Polish industry, both globally and within Europe, is primarily evaluated through the lens of its international economic competitiveness. In the coming years, the carbon footprint of manufacturing will be a decisive factor in maintaining and enhancing this competitiveness. Countries whose manufacturers successfully reduce their carbon emissions will be better positioned to replace competitors with higher carbon intensity.

According to recognised classifications of economic activity, such as the EU's NACE and Poland's PKD classifications, the industrial sector encompasses the following areas:

- mining and quarrying,
- manufacturing, which is subdivided into 24 distinct subsections,
- electricity, gas, steam, and air conditioning–commonly referred to as power generation, gas, and district heating,
- water supply, sewage and waste management, and remediation activities.

This report excludes power generation, gas, and district heating from the analysis, as they follow a separate energy transition pathway.

3.1. Competitiveness of the sector

Industry remains a driving force of the Polish economy. In 2022, the sector:

- produced and sold goods valued at nearly PLN 2.3 trillion (EUR 486.8 billion[2]), contributing approximately PLN 627 billion (EUR 134.7 billion) in added value – accounting for more than 20% of Poland's GDP,
- employed over 3.1 million people, representing one in five workers in the country, spread across more than 226,000 business entities,
- invested more than PLN 110 billion (EUR 23.5 billion), or around 45% of total national investment, with the majority of these investments made by large and medium-sized enterprises,
- displayed significant sectoral diversification, a key feature of large economies. Notably, the three largest sections of Polish manufacturing account for only around 37% of total production and employment.

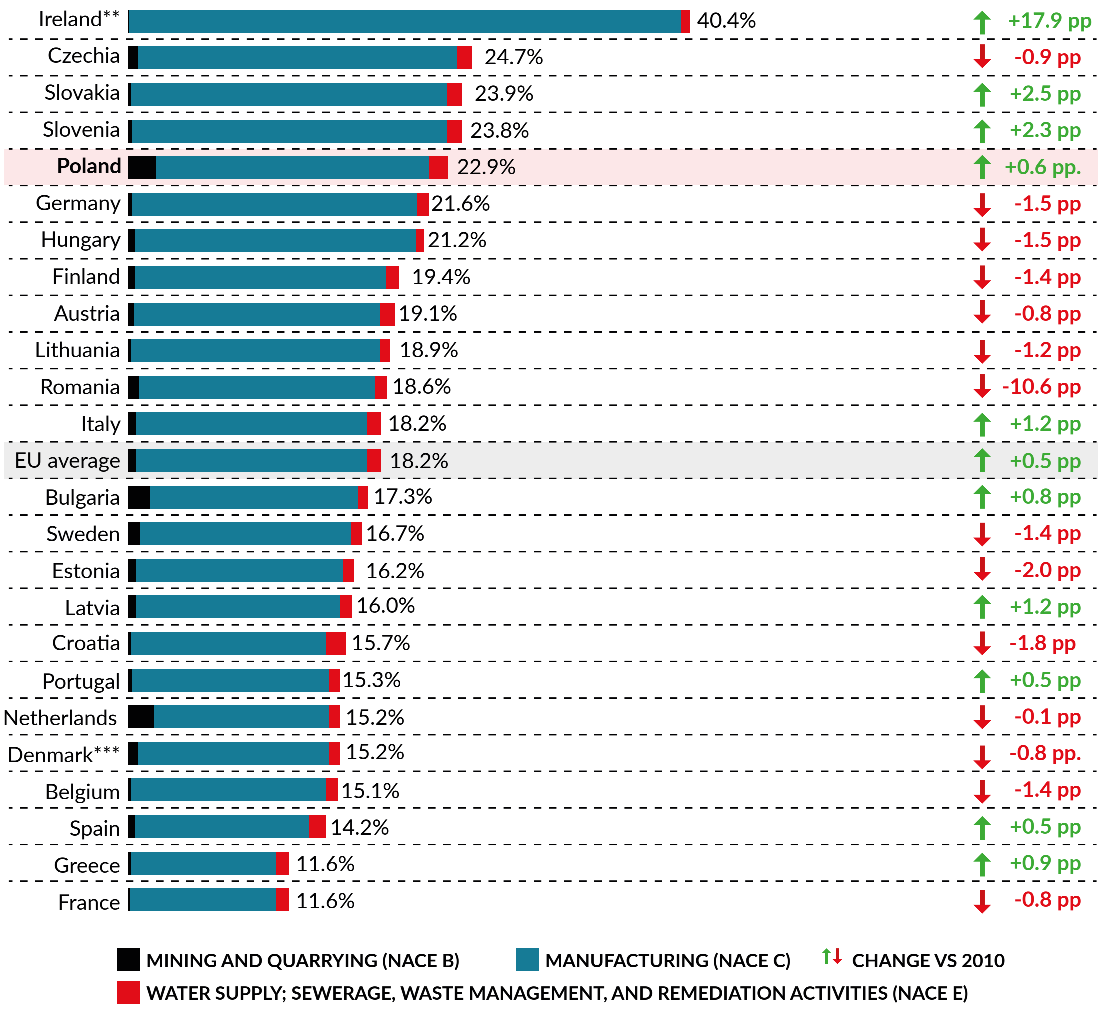
These indicators position Poland among the most industrialised nations in the EU (Figure 1). In terms of GDP contribution, Poland ranked fourth[3] in the EU in 2022, with industry contributing 22.9% of GDP compared to the EU average of 18.2%. Poland trails only the Czech Republic, Slovakia, and Slovenia in this regard. The manufacturing sector alone contributes 19.6% to national GDP, placing Poland sixth in the EU, above the EU average of 16.8%. Only the aforementioned countries, as well as Germany and Hungary, have manufacturing sectors contributing more than 20% to their respective GDPs. Additionally, Poland has the highest share of the mining sector in the EU (2%) and the second-highest share in water, sewage, and waste management (1.3%).

Polish industry enjoys a strong and established position within the EU. Between 2010 and 2022, Poland's share of EU GDP generated by industry increased slightly (by 0.6 pp.), a notable achievement given the declining trends in most Member States. The growth of Poland's manufacturing sector has offset the diminishing role of its mining sector.

2 In 2022, the average annual exchange rate for PLN/EUR was 4.6875, in 2021 – 4.5670 (source: National Bank of Poland).
3 Ireland has been excluded from the analysis due to its economic performance being significantly inflated by factors such as the registration of global corporations for tax purposes, which distorts a comparative assessment of industrial competitiveness across EU member states.

The above-average industrialisation seen in Poland and other Central European economies can be traced back to historical factors. Under the socialist regime, industrial development was a key metric of national progress, while services were regarded merely as a means to maintain public satisfaction. Industrialisation efforts were particularly focused on energy-intensive industries, such as steel production, due to the availability of cheap coal. Exports of raw materials and products to Western Europe provided hard currency, which, in turn, reinforced the political commitment to deepening industrialisation.

Figure 1. Contribution of the industry sector to the GDP by countries*, 2022 (excl. NACE D)



* Smallest EU countries have been excluded.

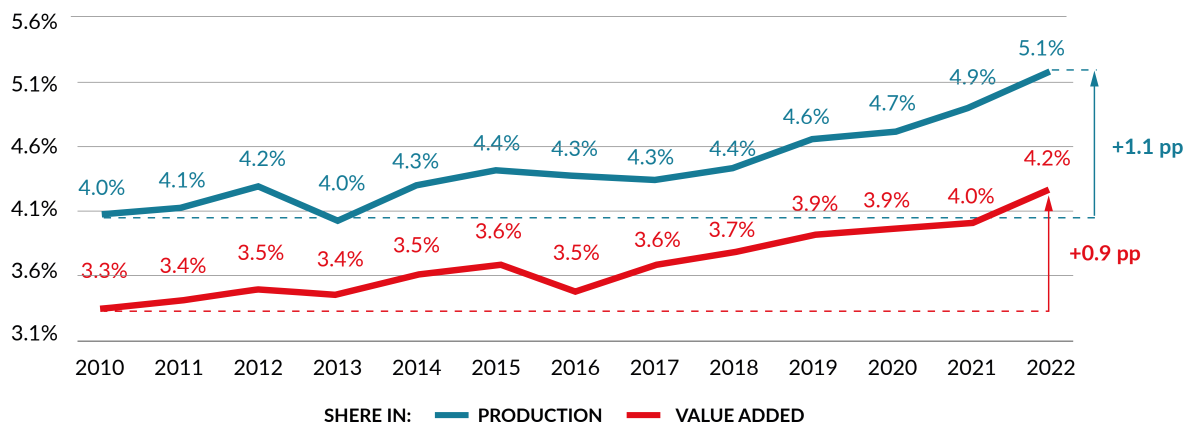
** The value for Ireland is unreliable – see footnote 3.

*** Data for 2021.

Source: Forum Energii, based on Eurostat data.

Despite the political transitions of recent decades, Poland's industrialisation, driven by exports, remains a central component of its development model. Poland's integration into European value chains has strengthened considerably. In 2022, Poland accounted for 5.1% of EU manufacturing output, contributing 4.2% to the EU's total value added (i.e., Poland's net contribution after costs) in the industrial sector (Figure 2). Both indicators have grown by approximately 27% since 2010. While this upward trend is encouraging, the persistent gap between production and value added suggests that Polish firms are predominantly supplying lower-value, simpler goods, typically positioned at the initial stages of the value chain.

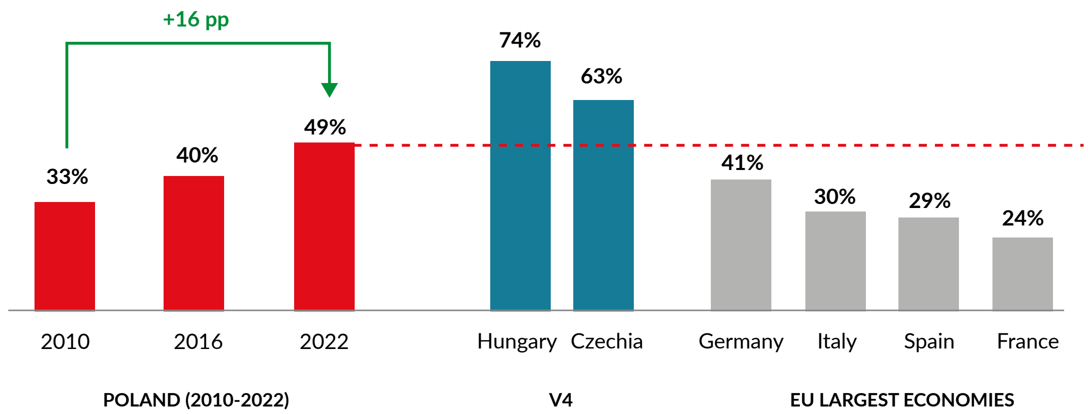
Figure 2. Poland's share in EU industrial production and value added, 2010–2022



Source: Forum Energii, based on Eurostat data.

An additional indicator of the strengthening position of Polish producers within the EU is export intensity, defined as the share of exported goods in GDP. In 2022, this percentage reached 49%, having nearly doubled since 2010 (Figure 3). This is a significant achievement given the size of the Polish economy[4] underscoring the increasing global demand for Polish products and Poland's growing integration into international markets. However, the high concentration of Polish exports in EU markets (ranging between 68-78% from 1999 to 2023) presents a potential vulnerability, as it ties Poland's economic fortunes closely to the performance of a single region (Figure 4).

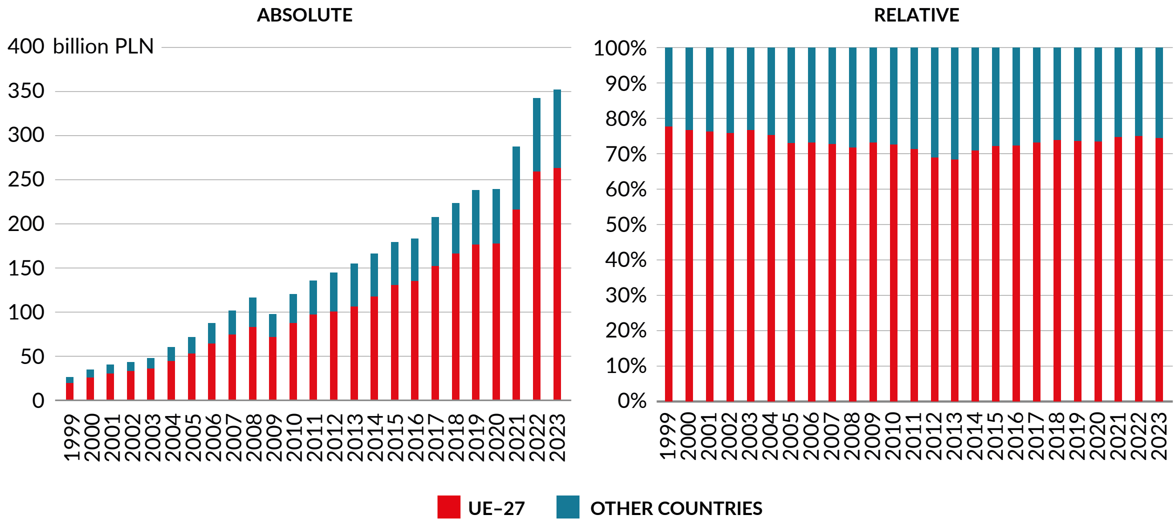
Figure 3. Share of exported goods in GDP in selected EU member states, 2021



Source: Forum Energii, based on Eurostat data.

4 In large economies, a sufficiently robust domestic market ensures absorption, making statistically significant shifts in key indicators more difficult to achieve. In contrast, smaller economies can experience substantial changes with the influx of a single major foreign investment. This explains the differences between the largest EU member states and those in Central and Eastern Europe, as illustrated in Figure 3.

Figure 4. Structure of Polish goods exports by value, 1999–2023

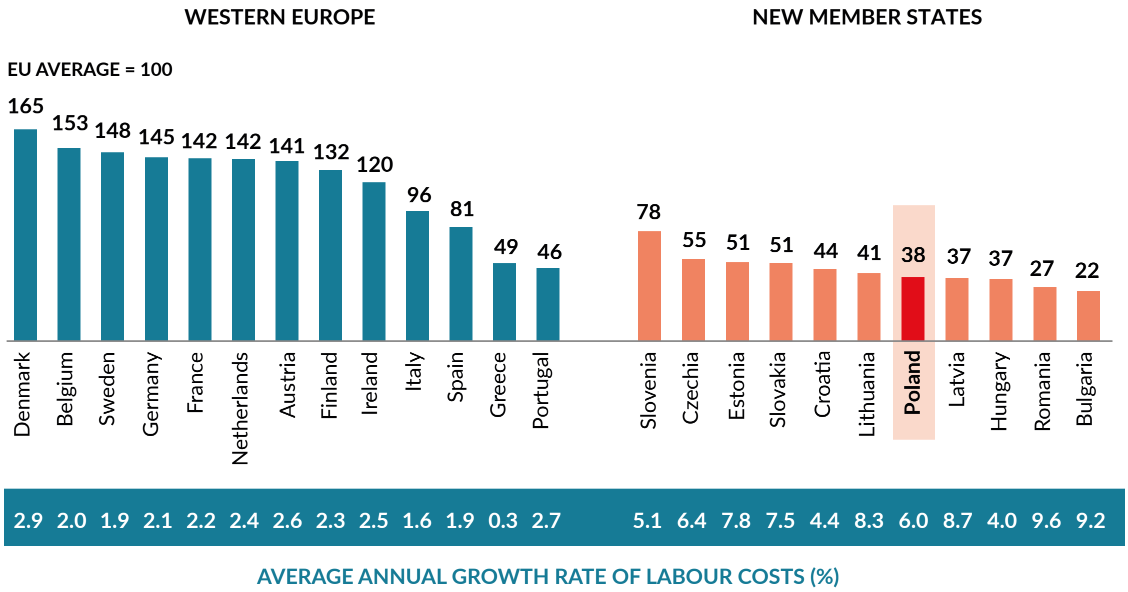


Source: Forum Energii, based on Eurostat data.

> The sustained high competitiveness of Polish industry over the years has been largely driven by low production costs. This advantage encompassed not only energy costs but, more crucially, labour costs. In 2022, labour costs per employee in the manufacturing sector amounted to only 38% of the EU average.

Although Poland continues to benefit from relatively lower labour costs compared to most Western European economies and many 2004 EU accession countries (Figure 5)–with wages standing at around 26% of German levels and 69% of Czech levels–the country is gradually narrowing the wage gap with the EU-15. That said, wage growth in Poland has lagged behind that of its regional competitors, with the exception of Hungary.

Figure 5. Labour costs per employee in manufacturing by country, 2022

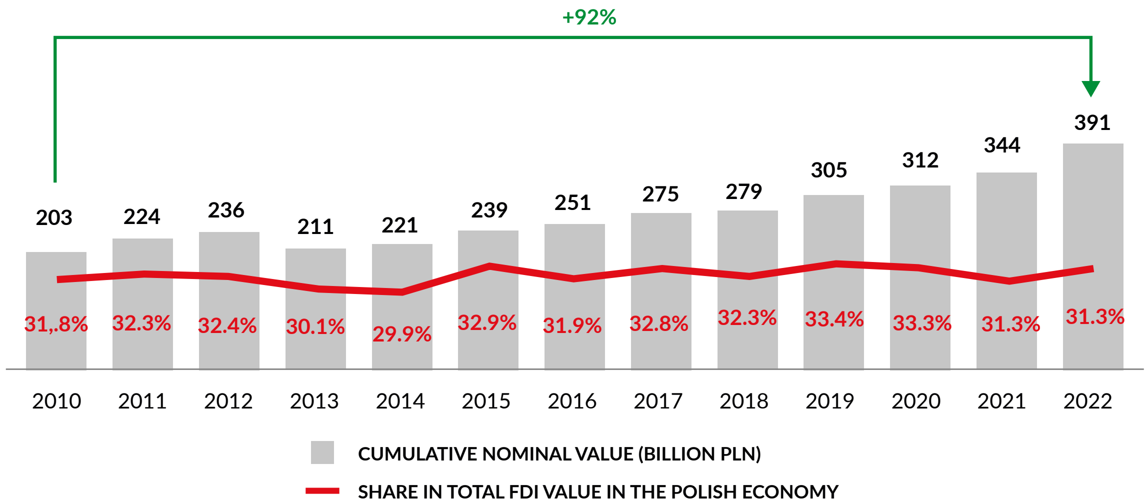


Source: Forum Energii, based on Eurostat data.

The attractiveness of Poland's labour force has been shaped by both quantitative factors (the size of the working-age population) and qualitative aspects (level of education). In 2022, 29% of the Polish population aged 25-64 held a tertiary degree, compared to 27% in Germany and an average of 24% across Central Europe. From the perspective of industrial employers, Poland's relatively high share of engineers and scientists in the workforce–8.2%, which exceeds the regional average–represents a significant competitive advantage. Coupled with relatively low wage levels, this highly educated workforce has provided companies operating in Poland with a durable competitive edge over the years.

An indicator of the attractiveness of Poland as a location, and an important driver of industrial development, has been the steady inflow of foreign direct investment (FDI)[5]. One-third of Poland's total FDI is concentrated in the manufacturing sector, and between 2010 and 2022, the cumulative value of FDI in this sector nearly doubled (Figure 6). However, it is important to note that FDI remains highly competitive at the regional level, with countries offering lower labour costs (e.g., Romania) or more favourable tax and legislative environments (e.g., Hungary, Slovakia) representing strong competitors for foreign investment.

Figure 6. FDI in Poland's manufacturing sector, 2010–2022



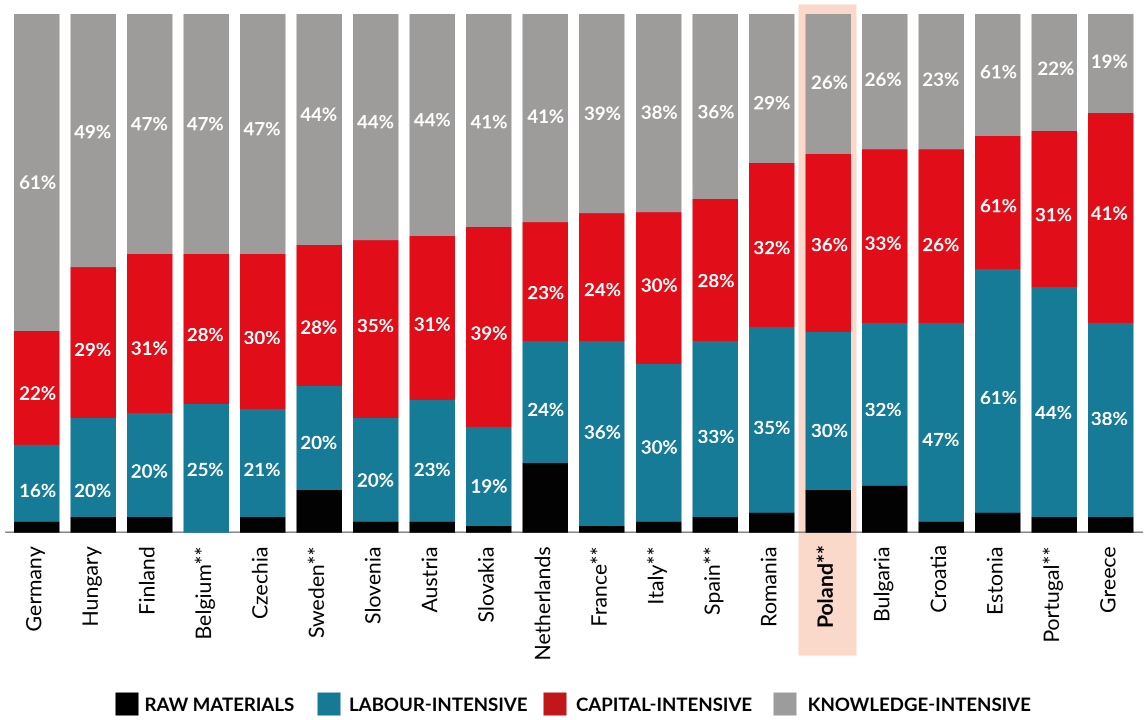
Source: Forum Energii, based on Eurostat data.

The significant role played by foreign investors in the development of Polish industry, coupled with the absence of a national sectoral strategy, has resulted in the dominance of labour- and capital-intensive industries at the expense of knowledge-intensive sectors (Figure 7). In Poland, labour and capital-intensive industries account for 66% of the total value added in industry–well above the average of 38-58% seen in the most industrialised European economies. Conversely, knowledge-intensive industries contribute only 26% to the total value added of Polish industry, compared to up to 60% in leading countries like Germany and Denmark.

In practice, it is the presence of knowledge-intensive industries that offers the greatest potential for improving the competitiveness of a national economy. However, the positioning within the value chain–i.e., the specific roles and processes for which these industries are responsible–is equally crucial. A relevant example can be found in the Czech Republic, Hungary, and Slovakia, which have attracted significant foreign investment in knowledge-intensive sectors, particularly in the automotive industry. This has led to a high share of sectoral value added (41-49%) in these countries. Nevertheless, it is important to note that much of this investment has been directed towards labour-intensive and technologically simpler processes.

5 Foreign direct investment (FDI) refers to the creation of subsidiaries by foreign entities to run long-term businesses, with the direct investor having a major role in managing the subsidiary.

Figure 7. Structure of industrial* value added in selected EU member states by branches, 1999–2023



* Mining and Manufacturing.

** Data for 2021.

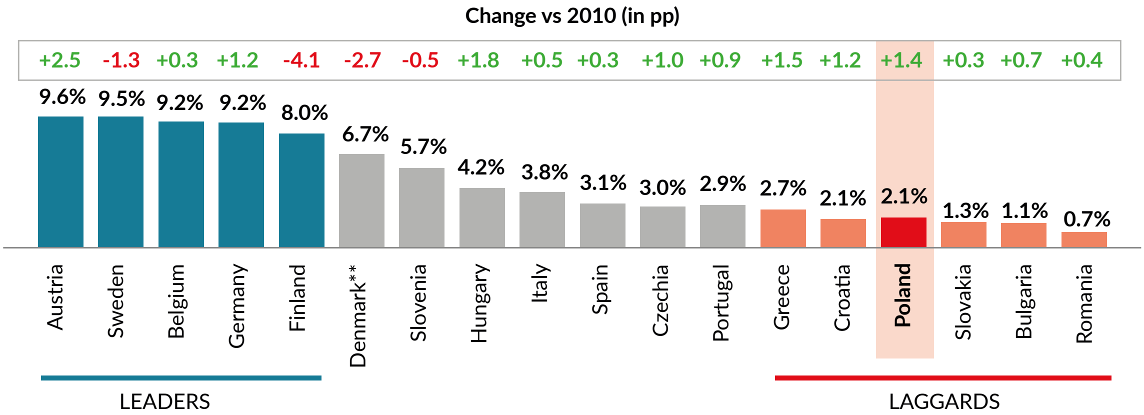
Industry Descriptions: Raw Materials: (B) Mining and quarrying. Labour-intensive sectors: (13) Textiles, (14) Apparel, (15) Leather, (16) Wood, (31) Furniture, (32) Other Manufacturing, (33) Installation, Repair, and Maintenance of Machinery. Capital-intensive sectors: (10-12) Food, Beverages, and Tobacco, (17) Paper, (18) Printing, (19) Refinery and Coking, (22) Plastics and Rubber, (23) Minerals, (24) Metals, (25) Metal Products. Knowledge-intensive sectors: (20) Chemicals, (21) Pharmaceuticals, (26) Electronics and Precision Instruments, (27) Electrical Equipment, (28) Machinery, (29) Automotive, (30) Other Transport Equipment.

Source: Forum Energii, based on Eurostat data.

The research and development (R&D) segment of manufacturing is typically regarded by multinational corporations as the most critical and valuable component of the supply chain. As a result, R&D activities are generally concentrated in the home countries of these corporations, leaving Poland outside this core function in the context of foreign direct investment (FDI). For Polish industry to become more innovative and competitive, it is essential to scale up R&D efforts and enhance the capacity to commercialize the resulting innovations. **Without a robust R&D foundation, it is challenging to develop a modern, high-value-added industrial sector.** The ability to create and test innovative solutions, rapidly respond to market shifts, and optimize production processes remains constrained, as these decisions are often driven by the primary foreign investors.

While R&D expenditure in Poland has been increasing, the ratio of R&D investment to the added value of manufacturing remains relatively low, standing at 2.1% (Figure 8). This places Poland well behind the EU leaders, whose R&D intensity is nearly five times higher. Notably, even countries with a strong R&D base continue to expand their investment in this area, making it increasingly difficult for Poland to close the gap with the most technologically advanced economies.

Figure 8. R&D expenditures relative to manufacturing value added*, 2021



* For Sweden, Denmark, and Greece, the comparison vs 2011 due to data availability.

** Data for 2020.

Source: Forum Energii, based on Eurostat data.

The current state of Poland's industry faces significant competitive challenges. Shrinking labour pool, steadily increasing wages, and relatively high interest rates–factors that reduce investment appetite–are all undermining the sustainability of a cost-competitive model. Meanwhile, Polish brands remain relatively unknown on the global stage, which results in Polish subcontractors operating anonymously, making it easier for competitors to undercut their prices. In contrast, knowledge-intensive sectors and processes are less vulnerable to rising costs. In these industries, quality becomes the key differentiator, with product innovation, unique features, and technological advantages gaining prominence. Moreover, the pool of qualified suppliers is smaller, further insulating these sectors from competitive price pressures. As a result, knowledge-intensive industries are better positioned to create attractive, high-quality jobs.

3.2. Energy intensity of Polish industry

The cost competitiveness of Polish industry is facing a downward trend. This decline can be attributed to four key factors:

1. what we produce – the sectoral composition of the economy,
2. how we manufacture – the technologies employed in production processes,
3. what energy sources are used in manufacturing – the energy mix,
4. costs of energy sources employed – the unit prices of different energy types.

These factors will be explored in greater detail in subsequent sections of the report.

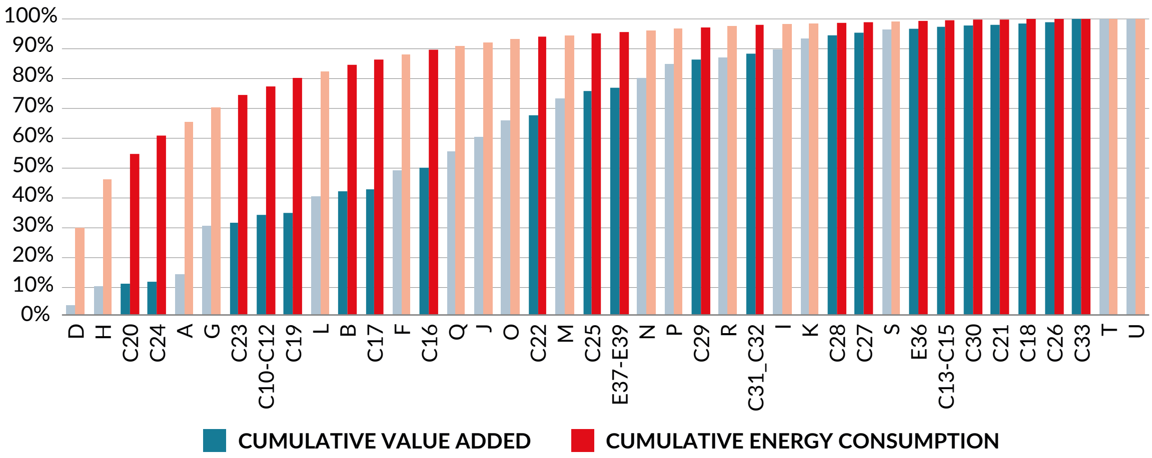
Over-representation of energy-intensive sectors

The Polish economy is heavily concentrated in sectors that operate at the initial stages of the supply chain, such as raw material pre-processing and the production of simple components. While these sectors are essential for the production of more complex goods, they contribute relatively little in terms of added value. Instead, they are marked by high consumption of raw materials, intermediates, and energy (Figure 9). Key industries in this category include:

- mining,
- fuel processing,
- chemical and petrochemical manufacturing,
- mineral products manufacturing,
- basic metals manufacturing.

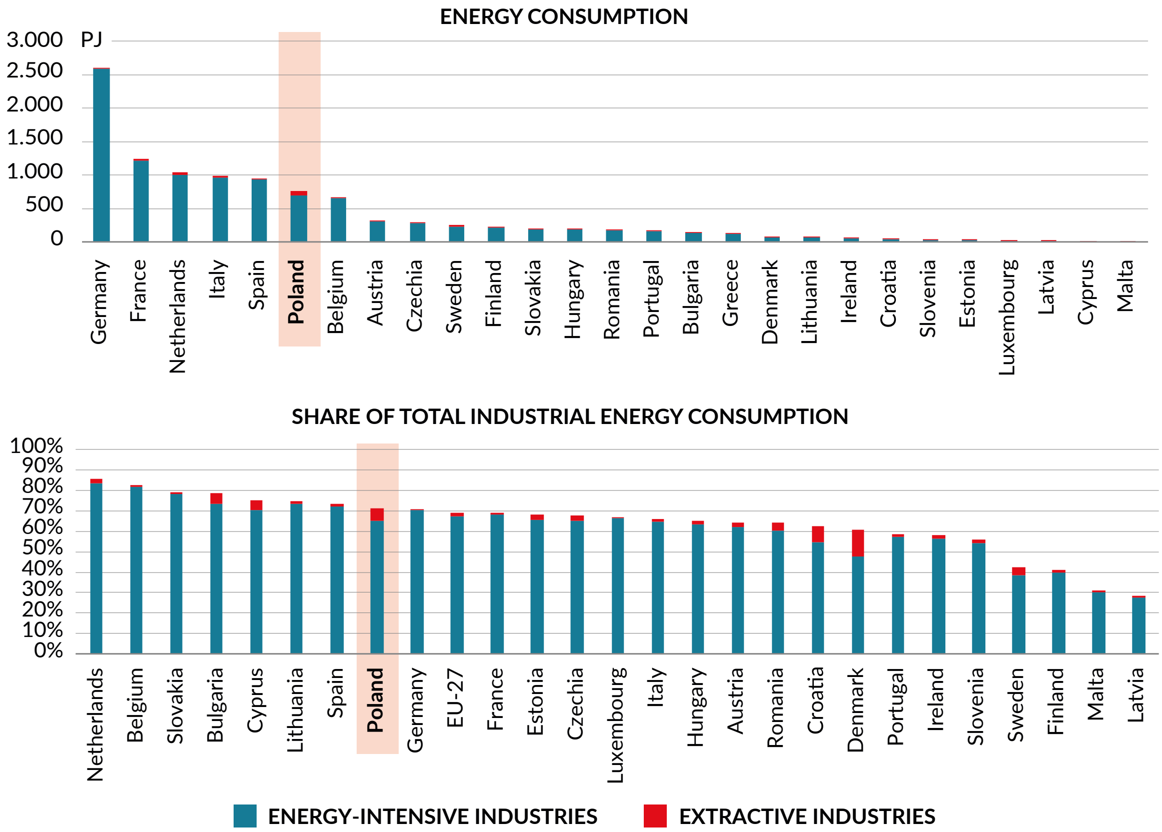
Together, these five sectors account for 71% of the total energy consumption in Polish industry, a figure comparable to Germany, while the EU average is 2 pp. lower. In absolute terms, the energy consumption of these sectors in Poland in 2022 was 761 PJ, placing Poland sixth in the EU and representing 7.1% of the EU's total energy consumption in energy-intensive industries (Figure 10).

Figure 9. Contribution to value added and energy consumption by sectors in Poland, 2021



Dark bars represent industry (NACE B, C, E), while light bars refer to other sectors.
Source: Forum Energii, based on Eurostat data.

Figure 10. Energy consumption by energy-intensive and extractive sectors in the EU and their share in total industrial energy use, 2022



Source: Forum Energii, based on Eurostat data.

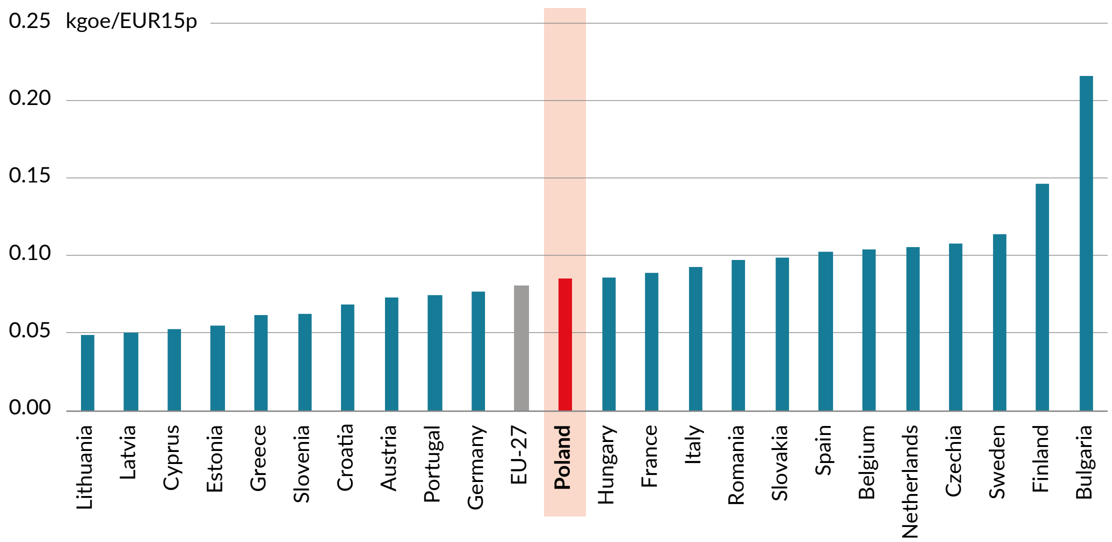
The high energy intensity of Polish industry may be attributed to two main factors:

- high energy consumption in each industrial sector (relative to value added) resulting from low energy efficiency,
- over-representation of the most energy-intensive sectors.

To better understand the relative contributions of these factors, we can conduct a counterfactual analysis. If Poland's industrial structure mirrored the EU average, with a lower proportion of energy-intensive sectors, the energy intensity of Polish industry would place Poland near the middle of the European rankings, only 5.7% above the EU average (Figure 11).

This analysis has clear implications for public policy. Firstly, reducing the energy intensity of Polish industry will require the modernisation of energy-intensive sectors. Ensuring their competitiveness under current energy prices will be particularly challenging. Additionally, there remains significant potential for improvement even in sectors with lower energy intensity, as Polish industries still exceed the EU average in terms of energy consumption.

Figure 11. Energy intensity in industry assuming the fixed EU sectoral structure – a counterfactual analysis, 2021



Source: Forum Energii, based on Odyssee data.

Reduction of the energy consumption by shutting-down energy-intensive industries would be a very short-sighted approach. These sectors supply essential materials and intermediates to the broader economy, such as steel, cement, glass, and hydrogen, which are irreplaceable. Shutting down domestic production would not decrease demand for these goods but instead increase reliance on foreign suppliers. Moreover, these imports would likely come from countries with similar or less advanced production technologies that rely on fossil fuels and have less stringent climate and environmental regulations. As a result, shifting production abroad would fail to address the issue of GHG emissions–it could even exacerbate it, especially when factoring in emissions from transportation. Additionally, offshoring production would heighten economic risks for the EU, notably by significantly lengthening supply chains. Given Poland's substantial role in the production of energy-intensive goods, the closure of these industries would have serious socio-economic consequences for local communities. Therefore, the preferred solution is to modernise production processes domestically, rather than relocate them outside EU.

Energy-intensive Industries

Energy-intensive industries derive their name from the technological processes that require vast amounts of energy, typically in the form of high-temperature heat, to manufacture products. These industries produce a wide range of intermediate goods, such as:

- steel, which requires smelting ore at temperatures exceeding 1,500°C,
- cement, involving clinker firing at temperatures around 1,500°C,
- glass, for which production necessitates maintaining furnace temperatures up to 1,600°C,
- hydrogen, where temperatures of 800-1,100°C are required for steam reforming, a process in which H_2 is extracted from hydrocarbons (primarily methane).

The prominence of energy-intensive industries in the Polish economy is largely a legacy of the communist era. The large-scale industrialisation projects of the Gierek decade (1970-1980), which required enormous quantities of steel and cement, led to the establishment of numerous steel mills and cement plants. Following 1989, these industries continued to thrive due to dynamic economic growth, low energy costs, and public support for the development of heavy industry.

Poland remains a leader in the production of energy-intensive goods within the EU[6]:

- #1 in nitrogen fertiliser production[7] (2.1 million tonnes, 18% of EU production),
- #2 in flat glass production (1.6 million tonnes, 15% of EU production),
- #3 in hydrogen production (mainly from natural gas; 0.8 million tonnes, 11% of EU production),
- #3 in cement production (19 million tonnes, 11% of EU production),
- #6 in crude steel production (7.4 million tonnes, 5% of EU production),
- #6 in container glass production (1.8 million tonnes, 7% of EU production),
- #7 in oil refining[8] (1,133 PJ, 5% of EU production).

Any efforts to phase out the production of these goods in Poland would have a detrimental impact on both domestic manufacturers and EU-wide value chains.

Technological gap to industry leaders

The same product or raw material can be obtained through processes that vary in energy intensity and by using equipment with either high or low efficiency. Additionally, the technological process can be designed to maximize the use of waste heat, reducing the need for fuel to achieve the required temperature. Each of these factors–the technological process used, the age and quality of equipment, and the level of waste heat utilization (or, more broadly, energy efficiency) – influences the overall energy intensity of industry.

An illustrative example of this disparity is cement production, which can be achieved through either the wet (older) or dry (newer and over 50% less energy-intensive) methods. Even within the same production method, variations

6 Source: Forum Energii based on the data from the Food and Agriculture Organisation (FAO), Eurostat, Odyssee, Glass Alliance Europe, Glass for Europe, Polish Glass Manufacturers Federation, the World Steel Association and the European Hydrogen Observatory.

7 A key example of this is in the production of nitrogen fertilisers, which requires the synthesis of ammonia (NH_3) via the Haber-Bosch process. This process relies on nitrogen (N_2) from the air and hydrogen (H_2), which is primarily sourced from natural gas.

8 Hydrogen also plays a critical role in other industrial processes, such as hydrotreating, which reduces the sulphur content in fuels, and hydrocracking, which breaks down long hydrocarbon chains into shorter, more valuable fractions.

in energy intensity can arise due to differences in equipment efficiency. A similar case is the production of refined salt, which can be produced using steam supplied by a coal-fired combined heat and power (CHP) plant or via an evaporator powered largely by electricity.

The energy intensity of Polish products in these industries remains slightly above the European average, and there is still a considerable gap compared to the leaders. For example, cement production in Poland requires approximately 7% more energy per tonne than the EU average and 16% more than in Belgium (Figure 12). In the case of steel, Poland's energy intensity is 4% higher than the EU average but 53% higher than that of Italy. This indicates that while Polish industry operates with technologies comparable to the EU average, catching up the top performers will necessitate a thorough review of current processes and targeted investments in more efficient technologies.

Figure 12. Energy intensity of cement and steel production in selected European countries, 2021

Source: Forum Energii, based on Odyssee data.

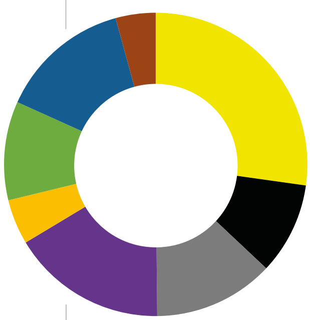
Heavily carbonised energy mix

While the technological processes involved in producing a given product – such as heating, cooling, moving materials, or achieving specific pressures and temperatures – are generally consistent regardless of location, the means by which these requirements are met can vary significantly. This variation is influenced by factors such as the type of fuel used and the origin of the electricity and heat supply, which differ not only between countries but even among individual production facilities.

The choice of energy sources in the industrial sector is shaped by a range of factors, including the characteristics of the business, availability of raw materials and fuels, familiarity with new technologies, openness to innovation, and the historical development of the plant (or so-called technological entrenchment). Additionally, companies may generate electricity in their own CHP plants or renewable energy installations, or purchase it externally, potentially through power purchase agreements (PPAs)[9] or with guarantees of origin. Each of these decisions directly impacts both the energy intensity and the carbon footprint of the products manufactured.

Poland's industrial energy mix remains heavily reliant on fossil fuels, with natural gas accounting for 27% and coal and its derivatives comprising 23%. RES represent just 10% of the energy consumed in industrial production (Figure 13). Moreover, the electricity and heat purchased by Polish industry from external sources are also highly carbonised. In 2022, 78% of the electricity in the Polish Power System and 90% of the heat in district heating systems were derived from fossil fuels, compared to EU averages of 38% and 54%, respectively.

Figure 13. Industrial energy consumption in Poland*, 2021



* The figure only includes categories with positive values. The vast majority of consumed heat comes from the combustion of the fuels shown, while purchased and recovered heat constitutes only a small portion. In terms of electricity consumption, most is purchased externally, though around 22% is produced on-site using the fuels depicted on the Figure. Source: Forum Energii, based on Statistics Poland data.

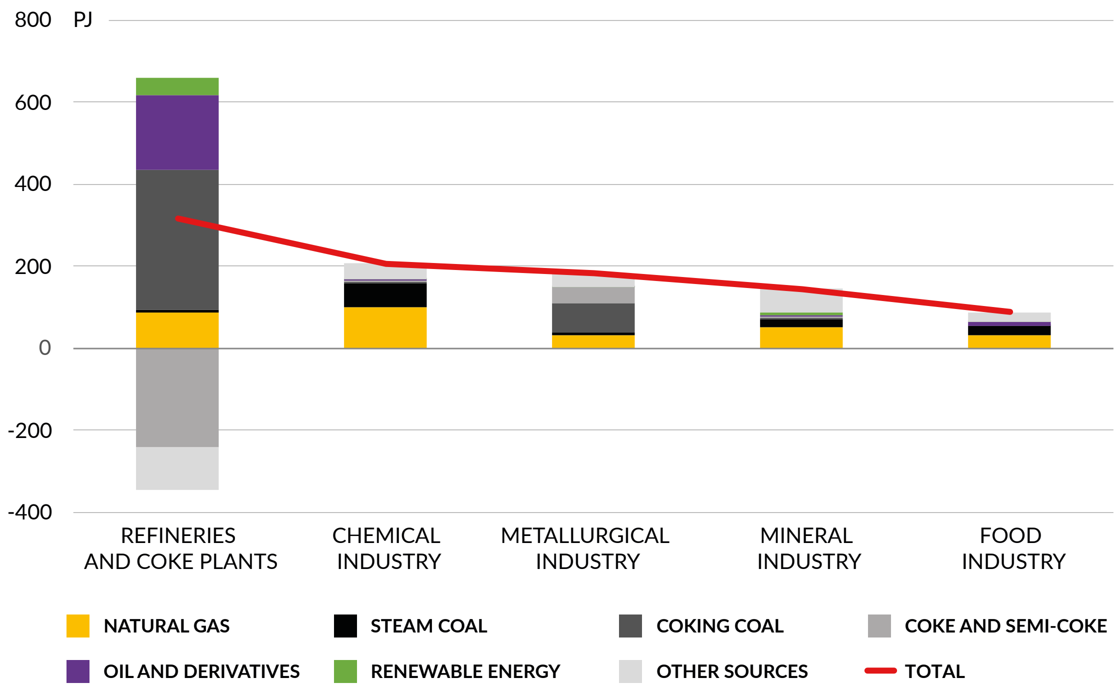
Polish industry is a major energy consumer, accounting for the use of approximately 10.5 billion cubic meters of natural gas, 12.5 million tonnes of coking coal, and 6 million tonnes of steam coal (with virtually no lignite consumption). Additionally, the industrial sector is responsible for approximately 27% of Poland's renewable energy consumption. As such, industry plays a significant role in the nation's overall energy demand.

9 PPA (Power Purchase Agreement) - a long-term power purchase contract between the owner of a RES installation and a customer (e.g. a production facility).

Energy consumption in Polish industry is highly concentrated, with just five sectors accounting for 72% of total industrial energy use. These key industries are:

- manufacture of coke and refined petroleum products (NACE C19) – this sector primarily consumes coking coal, crude oil, and natural gas,
- manufacture of chemicals and chemical products (NACE C20) – approximately half of the energy consumed in this industry is natural gas, much of which is used for non-energy purposes, such as the production of ammonia,
- manufacture of basic metals (NACE C24) – predominantly relies on coke, coking coal, and natural gas,
- manufacture of other non-metallic mineral products (NACE C23) – such as cement, glass, and ceramics – requires extremely high temperatures for their production processes, typically powered by natural gas and industrial waste,
- manufacture of food products (NACE C10) – this sector mainly utilizes natural gas and steam coal.

Figure 14. Energy consumption structure in top 5 sectors, 2021



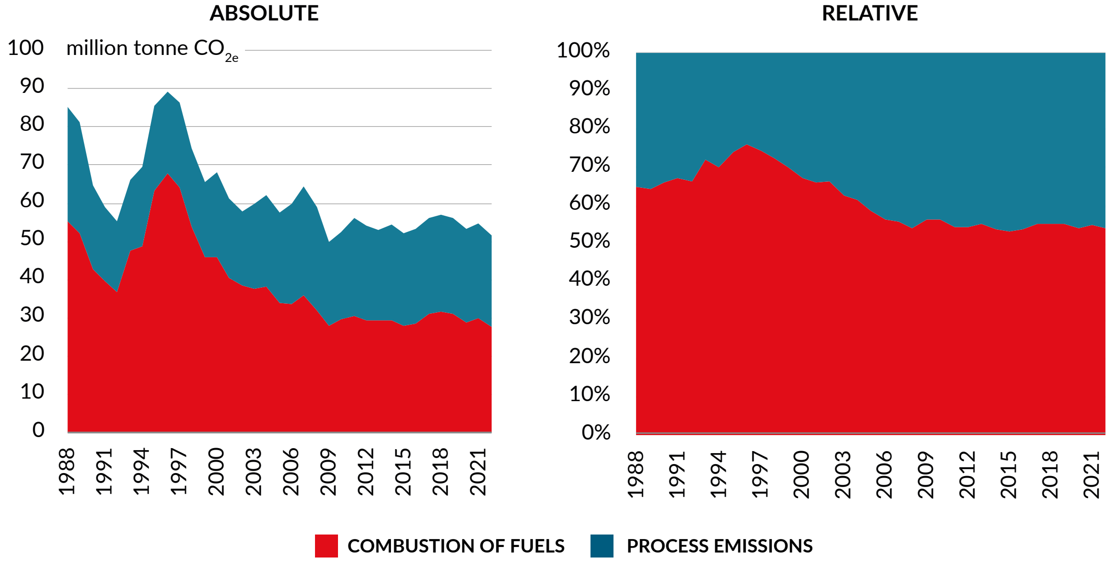
Negative values indicate net production from a given energy source.
Source: Forum Energii, based on Statistics Poland data.

A key consequence of Poland's coal-dominated energy mix and the high proportion of energy-intensive products in its industrial output is the elevated carbon intensity of its domestic industry. Notably, only 54% of industrial emissions are attributable to fuel combustion (Figure 15). The remaining 46% are process emissions, primarily CO_2, which are an inherent part of certain technological processes. For instance, CO_2 is a by-product of hydrogen production from natural gas[10], as well as the calcination of calcium carbonate necessary for cement production[11].

10 $CH_4 + H_2O \rightarrow CO + 3H_2$ (Stage 1: steam reforming reaction–production of syngas from methane and steam)
$CO + H_2O \rightarrow CO_2 + H_2$ (Stage 2: reaction to enrich syngas with hydrogen using steam; by-product: CO_2)

11 $CaCO_3 \rightarrow CaO + CO_2$ (Reaction to produce quicklime from calcium carbonate; by-product: CO_2)

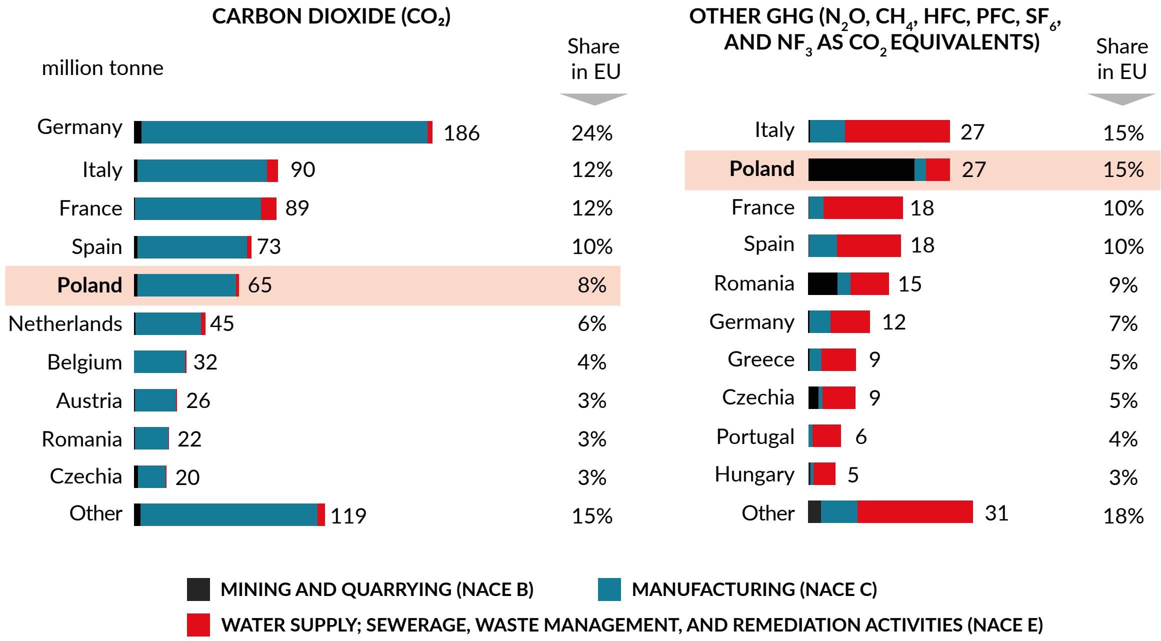
Figure 15. GHG emissions of Polish manufacturing and construction divided into process and combustion emissions, 1988–2022



Source: Forum Energii, based on EEA data.

Both factors – the highly carbon-intensive energy mix and Poland's significant share of EU production in sectors with substantial process emissions (e.g., cement, hydrogen, steel) – contribute to Polish GHG emissions accounting for 8% of total EU industrial CO_2 emissions (Figure 16). Moreover, due to Poland's extensive hard coal extraction – particularly from deep seams – its emissions of other GHGs, primarily methane and nitrous oxide, represent 15% of the EU's industrial emissions of these gases, placing Poland second in the EU for these emissions.

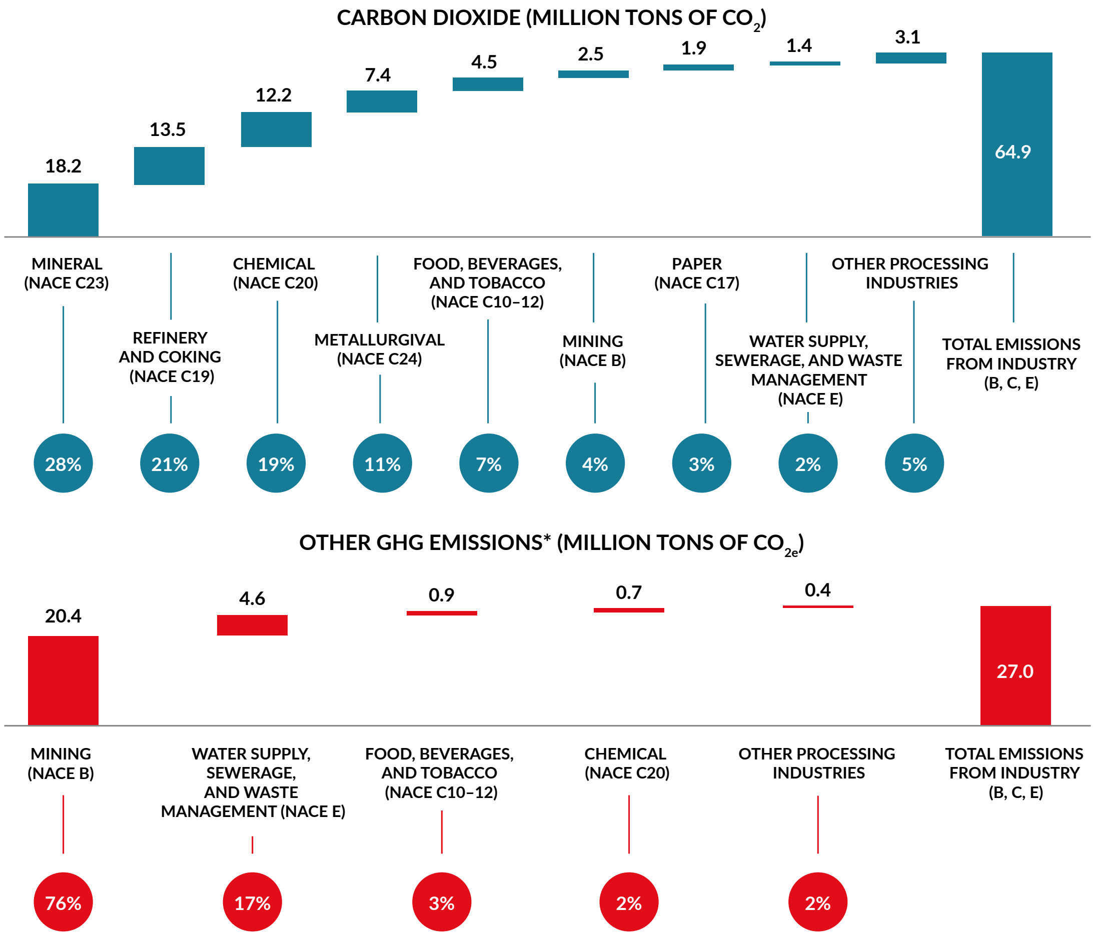
Figure 16. Industrial GHG emissions by EU member states*, 2022



Source: Forum Energii, based on Eurostat data.

Emissions in Poland are concentrated within a few industrial sectors. Currently, 67% of CO_2 emissions come from the following sectors: mineral (NACE C23), refinery and coking (NACE C19), and chemical (NACE C20) industries (see Figure 17). In terms of other GHG, the mining industry (NACE section B) dominates, accounting for 76% of emissions.

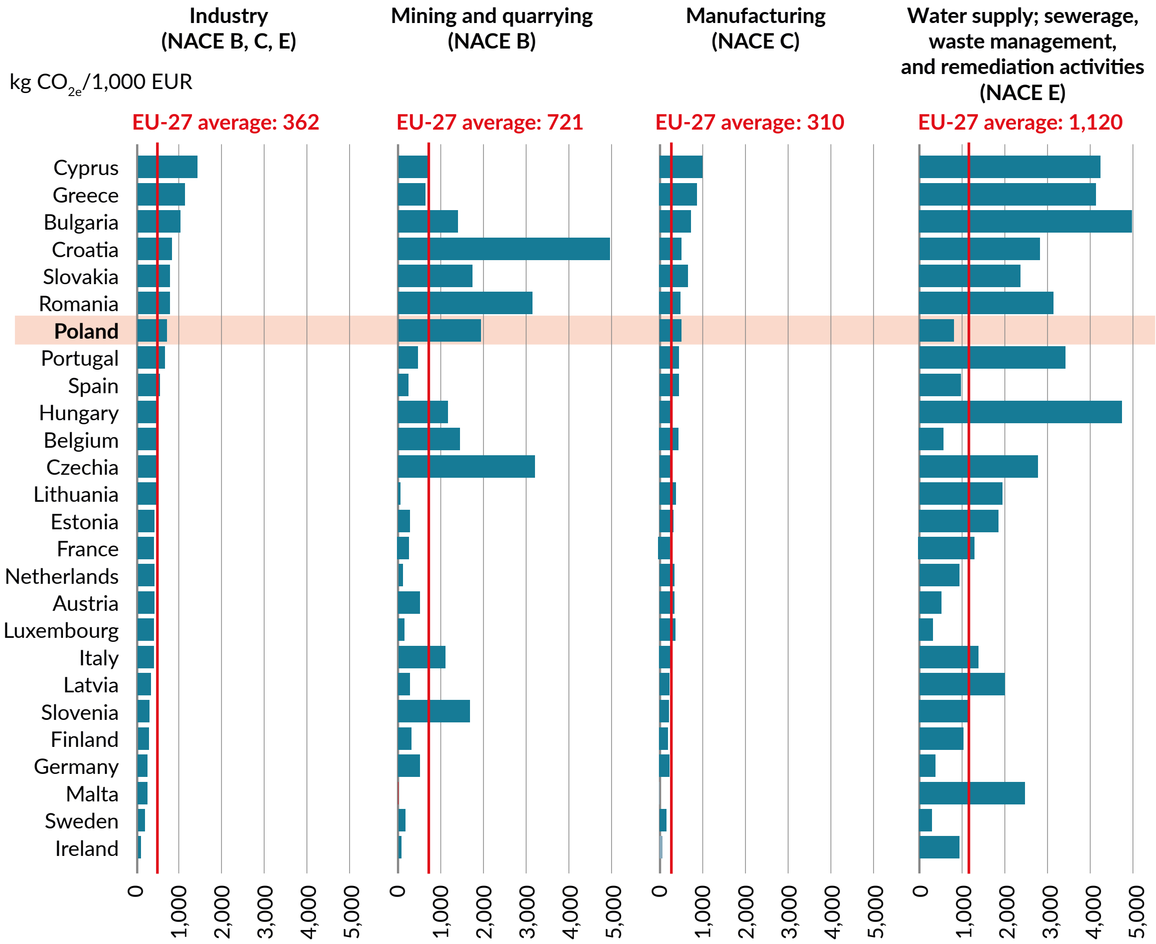
Figure 17. Industrial GHG emissions by sectors in Poland, 2000–2021



This includes both CO_2 and other GHG such as N_2O, CH_4, HFCs, PFCs, SF_6, and NF_3, calculated as CO_2 equivalents.
Source: Forum Energii, based on Eurostat data.

Polish industry is among the most carbon-intensive in the EU. This is illustrated in Figure 18, which shows the volume of GHG emitted per unit of added value across various industrial sectors in EU countries.

Figure 18. Industrial GHG emission intensity relative to value added, 2022



Source: Forum Energii, based on Eurostat data.

High energy prices

Polish industry is facing significant pressure from rising energy costs, not only on the international market but also within the EU. Poland currently ranks among the most expensive wholesale energy markets in the EU, creating substantial challenges, particularly for companies operating across borders.

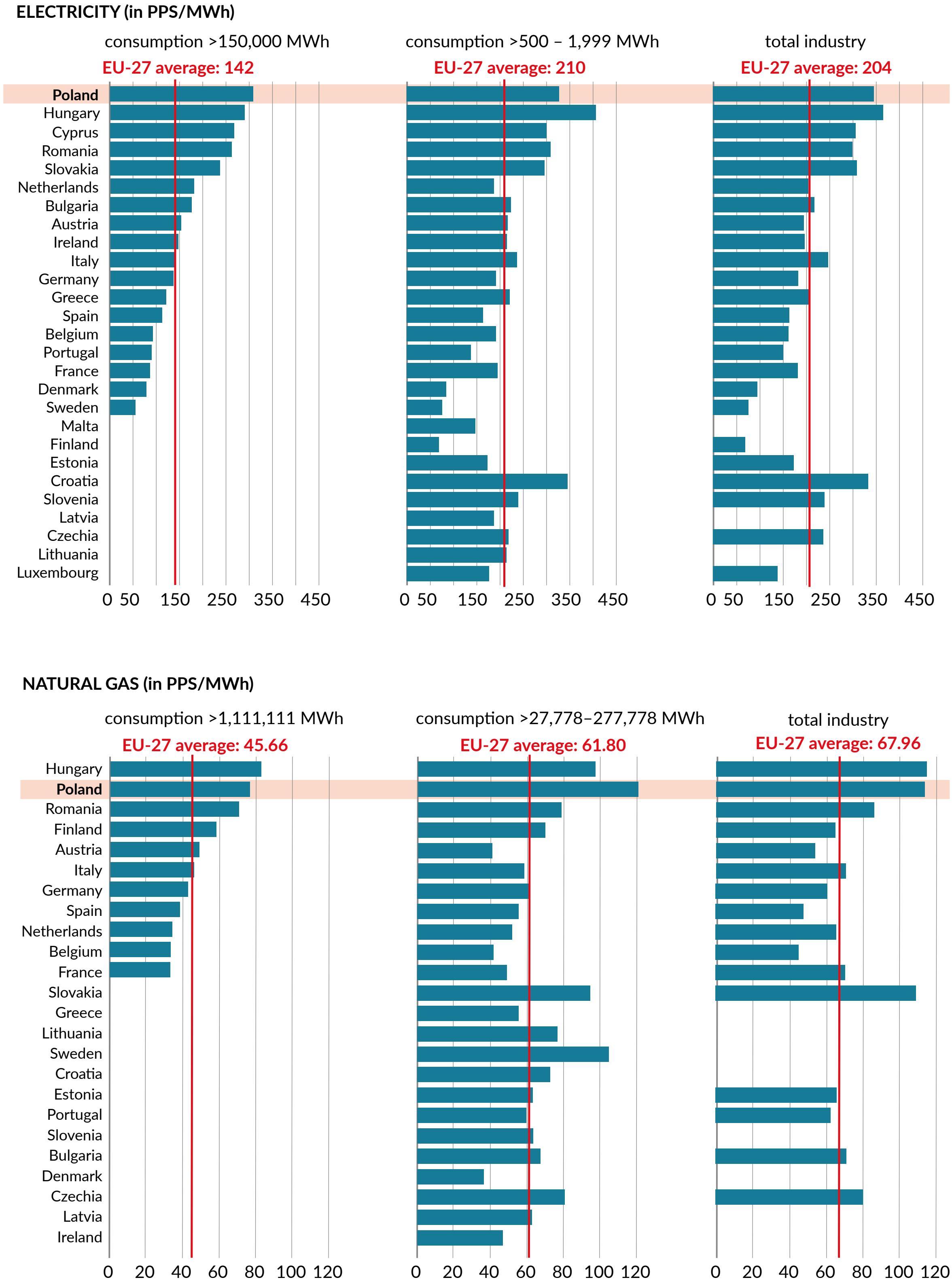
For energy-intensive industries, the cost of electricity and energy-related raw materials (such as natural gas and coal) can account for a large portion of production costs. High energy prices also impact the financial performance of other industries, albeit to a lesser extent.

The actual cost of electricity for energy-intensive industries in Poland[12], adjusted for purchasing power, is the highest in the EU and more than double the average (see Figure 19). When considering the entire industrial sector – not just energy-intensive industries (i.e., comparing the average cost across all levels of consumption) – Poland ranks second in terms of electricity costs.

A similar trend is observed with natural gas supply costs. In the second half of 2023, the actual unit cost of natural gas for energy-intensive industries in Poland, adjusted for purchasing power, was the second highest in the EU (just behind Hungary). Across all industrial sectors, Poland had the highest natural gas costs in the EU, with unit costs approximately 70% above the EU average. Poland has consistently ranked among the highest in Europe in terms of electricity and gas supply costs, a position that has persisted for several years.

12 In this report, the term *actual cost* refers to the price that includes the sale and distribution of electricity or natural gas, along with all taxes and levies that cannot be deducted.

Figure 19. Actual prices of electricity and natural gas for industry, end of 2023



Source: Forum Energii, based on Eurostat data.

The average price of steam coal for manufacturing (NACE section C) in Poland in 2022 stood at PLN 869 (EUR 185.3) per tonne (compared to PLN 342 (EUR 74.9) in 2021), while the median price reached PLN 1,486 (EUR 317.0) per tonne (PLN 699 (EUR 154.1) in 2021). In comparison, the median price of PSCMI2[13] coal in 2022 was PLN 751 (EUR 160.2) per tonne (PLN 310 (EUR 67.9) in 2021). On European markets, such as the ARA ports, the price for 2022 was PLN 1,295 (EUR 276.3) per tonne (PLN 465 (EUR 99.2) in 2021).

Looking ahead, the high GHG intensity of industrial sectors makes the price of CO_2 allowances in the ETS a critical cost factor. Currently, to prevent the offshoring of energy-intensive industries to regions without stringent carbon pricing, most allowances are allocated freely. However, the upcoming Carbon Border Adjustment Mechanism (CBAM), which imposes additional costs on imports based on their carbon footprint, will help balance the competitive landscape between EU producers and external competitors. As the number of free emissions allowances declines, reaching zero by 2034, industrial sectors will face increasing financial pressure, particularly as CO_2 allowance prices are forecasted to range between EUR 90-290/t CO_2 (depending on the projection[14]). This will significantly burden the highly carbon-intensive Polish industry in comparison to its decarbonized European competitors.

From a competitive standpoint, remaining within the ETS remains more favourable than being subject to CBAM in a non-EU scenario. The EU framework offers access to key financial support mechanisms such as the Modernisation Fund, Innovation Fund, and national resources like the Transformation Fund, all supported by ETS revenues. Exiting the EU would entail the loss of access to the common market, placing Polish industry at a competitive disadvantage, especially when competing with global players such as China.

4. Future of the Polish industry

European industry is facing growing challenges. Recent events, including the COVID-19 pandemic, as well as financial, energy, and trade crises, have made volatility and unpredictability the norm to which modern businesses must adapt. However, the role of the state remains crucial in stabilizing the situation and sending clear investment signals where the state has influence. This requires action in key areas where the state has influence, including:

- shaping the energy mix and electricity market,
- training the future workforce,
- promoting a robust innovation policy.

Doubtlessly, the trend towards emissions reduction is here to stay, driven by international agreements like the Paris Agreement under the United Nations framework. Virtually all major global economies have committed to achieving these targets within the set timeframes.

In public discourse, however, the argument frequently resurfaces that Poland faces insurmountable challenges in decarbonising by 2050. There is a temptation to argue that Poland's starting position is unique and that the energy transition should be pursued at a slower pace. However, such an approach comes with significant drawbacks:

1. **The energy transition is a global macrotrend** – Poland cannot stop or even delay it.
2. **Regional competitors have already started their transformations** – even in countries where conditions are challenging, such as deep reliance on fuel imports.

13 PSCMI (Polish Steam Coal Market Index) – an index reflecting the price of steam coal mined and sold in Poland. It does not account for insurance or transport costs. PSCMI1 refers to coal prices for electricity generation, while PSCMI2 covers prices for the heating market. Coal indexed under PSCMI2 is of higher quality, characterized by higher calorific value and lower sulfur content.

14 The price pathways referenced in the following documents: the draft Energy Policy of Poland until 2040 (Ministry of Climate and Environment), the Heating Strategy until 2030 with a perspective until 2040 (Ministry of Climate and Environment), the World Energy Outlook 2022 (IEA), as well as the analyses conducted by the National Centre for Emissions Management and the Centre for Climate and Energy Analysis (KOBiZE/CAKE).

3. **Industrial transformation creates an opportunity for future competitive advantage** – Polish subcontractors, deeply embedded in EU value chains, must adapt to the standards set by their clients or risk losing markets to more adaptable competitors. Those positioned in economic niches have a better market outlook due to prioritisation of low-carbon solutions.
4. **Cost competition puts pressure on efficiency** – the dominant model in Poland's industrial sector relies on cost competitiveness. The prices of fossil fuel-based energy, which have risen sharply in recent years (and will continue to rise due to the phasing out of free emissions allowances), have become unpredictable and are thus a natural candidate for cost optimization. As long as Polish industry does not begin to compete on product quality, such optimization will remain necessary.
5. **Expensive products struggle to find buyers in a competitive global marketplace** – consumers vote with their wallets. In the era of global trade, the idea that costly, heavily carbonized products will find buyers is increasingly unrealistic.

A key challenge for Poland is to design its industrial energy transformation in a way that ultimately benefits the economy and society. Poland's economic transformation after 1989 provides some useful lessons–while it improved the overall position of the industrial sector, not all businesses or workers benefitted equally. Today, however, we are in a stronger position, and those who may be at risk during the energy transition can be better protected.

The energy transition is a global process that will continue for decades, and Poland is a beneficiary of funds designated for countries with challenging starting positions. However, it appears that we have not fully learned the lessons regarding the consequences of conducting the transition without oversight, in an unregulated manner.

Poland's delay in making key decisions regarding the energy transition implies that the scale and structure of its industrial sector will not result from a deliberate economic policy, but rather from market dynamics. This also limits the ability to properly mitigate the negative impacts of these changes, particularly in areas such as employment. As a result, adverse social consequences–such as job losses–cannot be effectively addressed or managed.

The decarbonisation of national economies, including Poland, has two critical implications for the design of strategic industrial policies:

1. The emissivity of its industrial sector must be lowered, regardless of the future economic structure.
2. The need to reduce production emissions will reshape global demand for products and services. Decarbonisation will lead to increased demand for renewable-based solutions, while fossil fuel-based products and services will see a decline.

This necessitates the development of industry transformation strategies in two areas, aimed at creating favourable conditions for both:

1. decarbonisation of all energy producers (demand side),
2. creating and filling the market niches in clean technologies (supply side).

4.1. Reducing the production emissions

Decarbonising industry is a monumental undertaking, given Poland's distance from achieving net-zero emissions, the time pressure involved, and the need to maintain the competitiveness of domestic products at every stage of the process. Unlike sectors such as power generation, heating, or transportation, industrial decarbonisation requires addressing thousands of processes that use various fuels[15] to produce electricity and heat at different temperature levels, delivered either directly or indirectly (e.g., through steam).

Not all of these processes have decarbonized alternatives[16], and it is difficult to predict when such alternatives will emerge. In some cases, while the technology is known, the solutions have yet to be scaled up or introduced to the market[17]. This means that when these technologies do become available, they will initially be expensive. Only as the market grows–through wider adoption and the emergence of competitive producers–will their prices decrease. The strategy of acquiring emerging technologies carries more risk than mature ones. Higher capital and operating expenditures may not pay off if a more market-friendly solution quickly gains acceptance.

> Many of the technologies necessary for industrial decarbonisation are already known and mature. In principle, with the technologies available today, it is possible to decarbonize electricity production, low-temperature heat (up to 100°C), and heating for industrial use. This accounts for 26% of the final energy consumed by the industrial sector in Poland.

High-temperature heat pumps, which will soon be commercially available, will enable partial decarbonisation of medium-temperature heat (100°C–200°C), accounting for an additional 9% of final energy consumption in Polish industry. Focusing on technologies already available today provides time for more affordable decarbonisation technologies, such as high-temperature heat, to emerge. In practice, each investment should undergo a cost-benefit analysis, considering both the investment and life-cycle capital costs.

It is essential to remember that net-zero refers to reducing net emissions. In sectors where no technological pathway has yet been identified to bring process emissions to zero (e.g., quicklime production), solutions capturing residual GHG from flue gases (e.g., CCUS[18] – carbon capture, utilization, and storage) or capturing emitted CO_2 directly from the atmosphere (DAC[19] – direct air capture) will be necessary.

Among the possible solutions is also the so-called offsetting, which involves investing in projects or activities that reduce GHG emissions elsewhere, such as tree planting or forest conservation. However, it is important to note that previous experience with such projects has shown a minimal, if any, impact on reducing GHG emissions.

A notable shift in decarbonisation strategies is the growing emphasis on emissivity–the total carbon footprint of materials, intermediates, and processes that contribute to the final product. This represents a fundamental departure from traditional practices. Today, manufacturers are increasingly required to trace emissions throughout their entire supply chains[20], and advancements in technology are making this type of verification progressively feasible. Consequently, manufacturers that fail to actively participate in decarbonisation will see their competitiveness decline.

15 Oil and its derivatives, natural gas, industrial gases, coking and steam coal, coke and semi-coke, waste, non-energy products.

16 Processes for which no alternative has been found include the firing of Portland cement and the production of ethylene and propylene from crude oil.

17 Among these are high-temperature heat pumps and the replacement of coke with hydrogen in the reduction of iron ore.

18 CCUS (Carbon Capture, Utilisation/Storage) involves the chemical capture of CO_2 from flue gas streams, which can then be transported and either stored (e.g., in geological rock formations) or utilized in industrial processes (e.g., in abattoirs, carbonated beverages, or fertilizers), either unchanged (as CO_2) or chemically transformed (e.g., $CaCO_3$). As of the end of 2023, there are 41 CCUS facilities worldwide with a total capture and storage capacity of 49 million tonnes of CO_2 annually.

19 DAC (Direct Air Capture) can be classified as a subgroup of CCUS technology, but with a significant difference–CO_2 is captured not from flue gases (which have a high concentration of CO_2), but from the air (with a very low concentration of CO_2). As of the end of 2023, there is one DAC facility globally–a plant launched in Iceland in 2021 with a capture and storage capacity of 0.004 million tonnes of CO_2 per year.

20 Using ESG terminology, companies must be able to report all scopes of GHG emissions–including indirect emissions from suppliers, service providers, and product users (known as Scope 3 emissions).

Historically, producers have primarily competed based on production costs. However, in the near future, competition will increasingly centre around carbon footprint. More carbon-intensive subcontractors will be replaced by lower-emission competitors due to escalating emission costs or regulatory pressures. This shift is expected to place significant pressure on entire supply chains. It is also important to recognise that certain subcontractors may face emission challenges that are beyond their control, particularly those whose emissions are tied to the carbon intensity of the energy mix provided by the country's major energy generators. This underscores the critical need to decarbonise Poland's electricity and heating sectors.

4.2. Low-carbon technological change

In recent years, clean technologies have emerged as a highly attractive economic niche, with the EU increasingly competing in the global market against the US and China. Simultaneously, individual EU member states are vying to strategically position themselves within the community's supply chains to maximise their share of this growing market.

Several factors contribute to the perception of clean technologies as a critical area of opportunity:

- **Strategic economic and political role** – access to affordable, sustainable energy is fundamental to the future of economic growth and prosperity. Without it, maintaining–let alone enhancing–competitiveness against more developed economies, such as the US, or countries like China that heavily subsidise their industries, becomes increasingly difficult. Consequently, the clean technology sector is now recognised as a strategic industry. Its development is seen as essential to bolstering the EU's industrial sovereignty. Even in cases where natural resources are scarce, the development of technology, infrastructure, and production capacity remains vital. A key implication of this is the trend towards nearshoring–keeping production close to the market within EU value chains, even if this results in higher production costs.
- **High priority among decision-makers** – the recognition of the current historical juncture has placed the transition to clean technologies high on the agenda for policymakers. This sense of urgency is reflected in formal policy commitments, prioritised implementation, and robust support mechanisms designed to accelerate change.
- **Potential for large-scale transformation** – the pursuit of climate neutrality is not merely an environmental objective; it represents a fundamental shift in how the economy operates. This transition emphasises the efficient use of existing resources and the generation of carbon-free energy. The scale of change extends beyond the transformation of selected sectors, implying a wholesale reconfiguration of economic functions. However, the pace and intensity of this transformation will vary across industries.
- **Prospects of large and sustained demand** – the global energy transition will unfold over several decades. For manufacturers it means a large and growing market for clean technologies that will accommodate both innovators and imitators.

Economic changes resulting from decarbonisation

Decarbonisation leads to a qualitatively different way of producing and consuming goods and services, specifically:

- **reimagining familiar products:**
  - old production process, new technology – e.g. vegetable concentrate pasteurised using a heat pump instead of a gas boiler; ammonia produced via the Haber-Bosch process using green hydrogen rather than steam-reformed natural gas.
  - new production process – e.g. concrete made from cement produced through electrochemical reactions rather than the thermal treatment of calcium carbonate (pilot phase); steel produced from scrap metal instead of iron ore smelting.
- **emergence of new products:**
  - directly in the field of clean technologies – such as residential battery storage systems and heat pumps.
  - indirectly – resulting from technologies with desirable properties (e.g., the increasing number of portable devices due to enhanced battery power) or accessories (e.g., tools).
- **emergence of new services:**
  - directly in the clean technology sector – such as digital twins (digital replicas powered by data) of energy sector solutions or systems to optimise energy usage, like dynamic demand management or early fault detection powered by artificial intelligence.
  - indirectly, especially complementary services to new and improved products – for example, mobile rental systems for electric scooters.
  - financial services, where the characteristics are linked to the achievement of environmental goals by the user – a category distinct due to its unique role in the economy compared to non-financial services.
- **declining role of certain supply chains:**
  - related to the consumption of fossil fuels – from extraction to transport, processing, and trade.
  - reduced fuel demand – for example, less hydrogen needed for oil desulphurisation due to a decrease in oil processing.
  - decreased demand for pipeline transport or coal (by sea) due to lower fossil fuel requirements.

As these technologies are adopted, the demand for two production factors changes: capital and labour. On the capital side, rising demand is anticipated, as the transformation requires private capital mobilisation, and there is a shift toward large-scale or higher-risk investments. On the labour side, there will be an increasing need for new worker skills.

5. Framework for public intervention

As outlined earlier, there is a critical need for a two-pronged strategy for Polish industry to create favourable conditions for both the decarbonisation of all manufacturers and the development of a clean technology manufacturing base.

5.1. Decarbonisation of manufacturing sector

Effective decarbonisation is essential for Polish industry to maintain or increase its competitiveness while contributing to the EU's value chains. To achieve this, both current and future needs of the sector must be clearly defined. Key needs include:

- **Easy access to clean energy at a reasonable price**:
  - increasing the share of renewable energy in the energy mix,
  - accounting for the need to oversize renewable energy production to generate green hydrogen for industrial use (as an alternative to natural gas),
  - facilitating the construction of independent clean energy sources,
  - simplifying the purchase of clean energy directly from producers (including through Power Purchase Agreements or PPAs),
  - promoting actions that improve energy efficiency and optimise industrial energy consumption, which would lead to reduced and more consistent energy demand, ultimately lowering prices.
- **Access to primary products and raw materials at competitive prices**, including the development of a circular economy that enables the reprocessing of waste into new products (e.g., recycling steel scrap into steel profiles).
- **Access to decarbonisation technologies**, particularly for:
  - electrification of heat,
  - electrification of hydrogen production,
  - carbon capture and storage (CCS),
  - minimising the impact of technology bottlenecks.
- **Access to skilled labour resources**, necessary for advising on decarbonisation investment directions and implementing these investments.
- **Access to capital at attractive rates**, facilitated by:
  - risk transfer mechanisms (e.g., guarantees) that lower capital cost.
  - expanding the range of financial instruments, including those that offer a decarbonisation premium.
  - directing external public funding (e.g., EU funds) toward high-quality decarbonisation projects.
  - implementing universal economic measures such as controlling inflation, to lower interest rates across the economy.

- **Mechanisms to maintain competitiveness**:
    - subsidising low-carbon solutions, particularly capital investments, and operational costs if justified.
    - protecting the European interest in production competitiveness vis-à-vis non-EU competitors, using mechanisms like the CBAM or green public procurement.

5.2. Advancing the clean-tech industry

The decarbonisation of industry is creating significant demand for low-emission technologies, goods, and services. It is essential that as many of these as possible are developed within Poland. These solutions should be:

- **key to the transition** – considering the scale of the emerging market (it is important to recognize that individual governments will fiercely compete for these solutions),
- **linked to the needs of domestic consumers** – contributing to environmental goals, reducing reliance on fossil fuel imports, and providing an opportunity to test the local market before potential foreign expansion,
- **building on existing strengths** – before acquiring the necessary expertise in many low-emission technologies, it is worth leveraging experiences from other successful sectors in Poland, such as household appliances. While it is generally advantageous to focus on value-added segments of the supply chain, the level of ambition must be aligned with the available labour resources and infrastructure.

To effectively program the development of low-emission technology sectors in Poland, the following steps should be taken:

1. **Methodically identify promising technologies** and the conditions under which unknown or niche technologies could become strategic. To achieve this:
    - regularly update the technology map, coupled with a reflection on the reasons behind the successes of certain sectors of the Polish economy in the past (e.g., household appliances, windows and doors, construction materials, car batteries) and their failures (such as the PV panel gigafactory).
    - continuously monitor sectoral developments, allowing for timely updates to the national industrial strategy with new technologies. It is crucial that these strategic areas exhibit different levels of market maturity–this ensures that the decline in demand for certain products coincides with growing demand for others, reducing volatility (e.g., in labour demand).
2. **From the pool of promising technologies, select those that will receive limited public resources.** There is no guarantee that the chosen technologies will succeed, but without concentrated resources, the likelihood of success decreases significantly. This requires forgoing many interesting solutions in favour of a few state-identified strategic technologies that are adequately supported. Promising, yet non-strategic, sectors will likely be developed by the market. It is important to monitor these areas and remove any potential barriers to their growth.
3. One criterion for selecting strategic sectors is **market size**, which helps mitigate the risk of insufficient demand. However, it is possible that in the early stages of technology development, it may be necessary to initiate demand from the public sector:
    - This could involve imposing minimum standards on goods, which would have implications for producers–a high standard would facilitate exporting to countries with higher environmental ambitions (and, therefore, higher margins)–as well as for domestic consumers, making it easier to achieve national environmental goals without abandoning assets.

- Demand initiation by the state may take place through market challenging (such as those organized by the National Centre for Research and Development (NCBR)) or green public procurement. In this context, it is important to efficiently manage state aid (in most cases, however, market-driven demand should prevail).

4. **Focus on removing barriers to scaling up production:**
    - Common barriers across industries include a shortage of skilled workers, limited access to affordable capital, or challenges in accessing knowledge.
    - It is also crucial to remove barriers to organic (natural) company growth. Supporting small businesses solely because they are small may keep them small as long as it remains profitable. Organic growth is desirable, especially since as a company grows, its productivity, wages, and investment rate tend to increase.

5. **Leverage the potential of foreign subsidiaries** of Western companies located in Poland. Many benefits of the presence of such companies remain in the country (e.g., wages, taxes), and some allow for future advantages to be built up, such as through technology transfer.

Table 1. Economic benefits of industrial development by entity type

Criterion / Entity	Polish company, domestic production	Polish branch of a foreign company, domestic production	Foreign company, production abroad
Benefits for Poland			
Transfer of knowledge	Yes, held both institutionally and by staff	Yes, held primarily by staff	No
Transfer of technology	No	Yes	No
Profits	Mostly reinvested in Poland	Partially transferred to the parent company	No
Wages	Yes	Yes	No
Tax revenues	Directed to both national and local budgets	Likely partial outflow to the parent company	No
Company development	Organic growth within the domestic market	Aligned with the parent company's strategy	Occurs abroad
Demand for local services	Relatively high	Frequently sourced from the parent company's home market	Primarily limited to non-tradables

*Note: Foreign branches tend to be larger than domestic companies, leading to higher productivity and wages.
Source: own study.

Competitive industry as a priority for the European Commission (2024-2029)

Enhancing the competitiveness of the EU's industrial sector has been designated a central objective for the European Commission's 2024–2029 agenda, led by Ursula von der Leyen. The published policy guidelines emphasize strategic priorities aimed at industrial transformation, particularly focusing on decarbonisation. Among the key initiatives are:

- **Supporting the decarbonisation of industrial processes** through measures such as the *Industrial Decarbonisation Accelerator Act* and the *Circular Economy Act*.
- **Strengthening the EU's role in clean technology production** under the *Clean Industrial Deal*, positioning Europe as a leader in this sector.
- **Addressing global competition imbalances** through initiatives like *Clean Trade and Investment Partnerships*, ensuring fair competition for EU industries.

This approach is fully aligned with the recommendations in this report, reflecting a cohesive commitment to decarbonisation, innovation, and enhancing industrial competitiveness across the European landscape.

6. Future of the Polish industry

6.1. Exploring potential pathways for change

The future of Polish industry will be shaped by several key factors:

- the accuracy of the diagnosis of Poland's current competitive position,
- the quality of the strategy for guiding Polish industry towards net-zero,
- the creation of a conducive environment for such an industry to thrive,
- the willingness and capability of the public sector to implement planned initiatives.

The evolution of Poland's industrial sector can be envisioned through three distinct scenarios, based on the level of public administration involvement.

1. **Market-based decarbonisation**: In this scenario, the state neither sets the direction nor the pace of decarbonisation. Decarbonisation is driven solely by individual business decisions. Companies whose owners choose to decarbonise will proceed at their own pace, while those that delay face the risk of losing competitiveness and potentially going bankrupt. Over time, this will reshape the structure of the industrial sector, favouring companies that adapt early.
2. **Passive industrial policy**: Here, the state signals the need for decarbonisation but does so without a strong strategic foundation or ambitious targets. The policy is not focused on a few key areas, making it difficult to achieve economies of scale. While some decarbonisation will occur, it will be fragmented and less effective, with companies left to choose their own paths, often without sufficient guidance or concentrated support.
3. **Active industrial policy**: In this scenario, the state takes an assertive role, clearly communicating decarbonisation goals and prioritised technologies. Public support is concentrated in strategically important areas, and the state fosters the development of the clean-tech sector. Legislative efforts are focused on facilitating transformation in key sectors, and private financing increases as investment risks decrease. This leads to a comprehensive transformation of the industrial sector, with broad participation from all actors.

Table 2. Comparative pathways of Poland's industrial decarbonisation strategies

Aspect / Scenario	Market-based decarbonisation	Passive Industrial Policy	Active Industrial Policy
Industry decarbonisation	Bottom-up decarbonisation, carried out with difficulty and often against state strategies.	Moderate pace, initiated bottom-up, occurring in parallel with minimal state action.	Top-down implementation based on established priorities, complemented by bottom-up market-driven initiatives.
Industrial strategy	No strategy emerges.	Strategy either poorly developed, incoherent, or inadequate to the scale of the challenge. Fails to address clean technology production effectively.	Strategy clearly developed, including decarbonisation directions, key technologies, and clean tech industry priorities. Well-targeted areas for improvement.
Targets	No targets or targets are unambitious and poorly communicated.	Unambitious targets with too much room for interpretation, providing weak market signals; poor communication.	Targets are well-defined, aligned with economy-wide decarbonisation goals, and communicated effectively to all relevant stakeholders.
Government efforts	EU actions are largely obstructed (postponing deadlines, passive role in negotiations). Polish industry receives minimal funding.	Limited action in non-controversial areas; some support through EU funds and ETS revenues, but investments are small and fragmented.	Dual-track approach: rational decarbonisation across sectors and development of industrial sovereignty. The state allocates significant resources to ensure complementarity in investments.
Legislative adequacy	Low - legislation either delayed or inadequate, with limited stakeholder consultations.	Moderate - slow legislative progress due to lack of clear priorities. Stakeholder input has little impact on removing barriers.	High - prioritised passage of legislation in key sectors, with a strong focus on quality and responsiveness to industry needs.
Investments	Far below optimal – investments are hindered by unclear objectives, reactive sector behaviour, and deteriorating financial conditions.	Suboptimal - some areas are neglected, and relatively few resources are allocated to expanding clean tech capacity.	High - significant investment in both demand (modernisation of industrial assets) and supply (development of clean-tech niches).
Private funding	Limited - high perceived risk discourages financial institutions.	Suboptimal - due to unclear priorities, private investments receive limited support or preference.	Adequate funding for all sectors, with strategic sections receiving enhanced support. Perceived investment risk is low.
Public funding	Suboptimal - small, under-utilised, or misallocated, hindering achievement of desired outcomes.	Suboptimal - funding is driven more by company interests than state objectives.	Optimised funding for sequencing investments, enabling maximum involvement of domestic producers in key value chains.
Transforming entities	Limited to businesses receiving a strong boost from the supply chain and those able to secure funding.	Companies benefiting from supply chain stimulus, with a few transformational leaders emerging.	The vast majority of companies experience transformation, supported by clear state guidance and resources.
Technology manufacturers	Limited growth, constrained by lack of incubation and support in the domestic market.	Growth occurs primarily in technologies where individual companies self-identify as leaders of change.	Strong growth in key technologies identified in the national strategy, with strategic support for development.
Market share of Polish clean-techs	Declines as domestic competitiveness erodes.	Maintained at a similar level, with possible shifts towards leader sectors.	Increases, particularly in key sectors, driven by strategic investment and decarbonisation efforts.

Jobs	Employment falls drastically and unpredictably.	Declines in neglected sectors, with some stability in strategic areas.	Employment is maintained or increases, particularly in sectors prioritised by the state.
Position in supply chains	No significant advancement, as companies struggle to decarbonise independently.	Unlikely, with limited progress unless complemented by broader policies (e.g., labour market reforms).	Advancement is possible, particularly with supportive policies that facilitate the transition and minimise skill mismatches.

Source: own study.

6.2. State action: shaping the future of decarbonisation

For the decarbonisation of Polish industry to proceed smoothly and benefit the economy, various areas of state functioning must be considered:

- **Strategic**: Poland needs to have a clearly defined pathway towards zero-emission with technologies linked (at least for the next 10–15 years), outlined by sector. This will provide industrial consumers with a clear direction of the desired changes, while suppliers will be informed about the future demand for these technologies. The decarbonisation strategy should be ambitious enough to prevent domestic sub-suppliers from being excluded from EU value chains. For climate commitments to translate into the development of individual industries, government credibility and proper communication of the necessary changes must be ensured.
- **Regulatory**: Given the limited public resources, the sector's development (through modernisation with clean-tech or expanding production capacity) should primarily be driven by market forces. Therefore, it is worth reviewing the current regulations to ensure they do not impose unjustified barriers to development.
- **Financial support**: Public financial support is derived from taxpayers' funds. If directed towards profit-oriented activities, it should also provide benefits to society. There are two types of support with different natures and expected outcomes.
    - **Investment support**: Dominant investment support is justified by large-scale expenditures that will generate long-term benefits and cannot be economically deferred. Investment support can be directed towards high-risk but potentially high-reward projects (such as innovations) or infrastructure investments (where unit costs are significant and benefit many, making pricing challenging).
    - **Operational support**: While rare, it has recently been used to intensify green hydrogen production – a precedent worth examining.
- **Non-financial support**: This refers particularly to the creation of a business-friendly environment, not necessarily limited to the clean-tech industry. Labour market and education policies are key in this context. The ability to effectively fill vacancies, educate, reskill workers, and increase their mobility, based on anticipated needs, directly impacts the ability to fill economic niches.

7. Summary

The energy transition of Polish industry is inevitable. However, its outcomes will depend on the level of state involvement in this process. To ensure the transformation benefits the national economy and society, several key points must be considered:

1. Polish industry plays a crucial role in both the national and European economies. Its characteristics (e.g., competing primarily on cost, over-representation of energy-intensive industries with low added value) mean that further delays in the energy transition will increase risks for the sector. From a European perspective, this will hinder its ability to compete with industries in the US or China.
2. Polish industry is highly carbon-intensive. Rising energy prices will increase costs for businesses, which will, in turn, be passed on to consumers. Energy prices remain critical in energy-intensive sectors but are becoming a significant factor in other sectors as well. The ability to limit further increases in product prices will depend on the technologies used, the national energy mix, and unit energy prices. Companies can only partially influence the greening of energy sources, with many actions remaining in the hands of the state (such as permitting in the context of growing share of renewables in the energy mix).
3. Polish industry needs a dual-track industrial strategy:
   - The first pillar should outline pathways for the decarbonisation of all actors in the sector, distinguishing between energy-intensive sectors (where challenges are significant, and many products are strategic for further economic growth) and others (where the gap to low-carbon leaders is closer to the EU average).
   - The second pillar focuses on developing the domestic clean-tech industrial base – that is, the capacity to supply the European market with goods and services that will help achieve net-zero targets.

   A well-tailored strategy should pursue an active industrial policy–aligned with climate and environmental goals, identifying future priority technologies based on strengths, allocating limited public resources appropriately, and mobilising private resources. In alternative scenarios involving passive industrial policies or market-led decarbonisation, the economic losses would be significant.
4. Decarbonising the industrial sector requires state involvement in expanding access to affordable energy, resources, materials, as well as technology and capital. The state should also monitor and safeguard the interests of domestic producers in intra-EU and global competition.
5. Developing the domestic industrial base requires the strategic selection of priority technologies and setting favourable conditions for their development. This may (but does not have to) involve creating public demand for selected solutions and removing barriers to scalability in production. It is important to note that the benefits of developing a domestic industrial base are also observed when hosting subsidiaries of foreign corporations.
6. The state has an array of tools to support the decarbonisation of industry: strategies and effective communication, regulatory instruments, financial support (both investment and operational), and non-financial support focused on creating a business-friendly environment (not necessarily exclusively for companies within the clean-tech sector).

Notes

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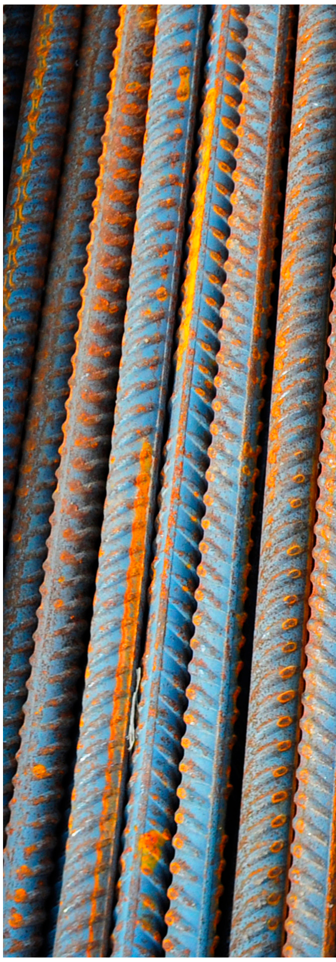
The 2024+ industrial deal Strategic pathways to modernise the Polish industry



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