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Polishing the Pathway to Net-Zero Energy-Intensive Industries

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Key numbers

6% was the share of Polish industry in the total value of sold industrial output of the EU in 2024, more than the Polish share of EU GDP, which was equal to 4.7%.

63% above the EU average was the emission intensity of the Polish manufacturing sector in 2023, at 448 g/EUR.

5 times higher was the electricity consumption per employee in the chemical, basic ferrous metals and cement, limestone and gypsum sectors in 2023 compared to the total consumption in Polish manufacturing.

3 times higher was the energy intensity of sold production in the chemical, basic ferrous metals, and cement, limestone, and gypsum sectors in 2023, compared to the total consumption in Polish manufacturing.

Key findings

- **Polish energy-intensive industries (EIIs) are especially vulnerable to the energy transition due to the country's reliance on carbon-intensive energy sources, notably hard coal and lignite**. While this transformation is necessary, it poses distinct challenges for Poland. The main obstacle to decarbonising EIIs in Poland is the high cost of electricity, driven by coal-dependent ETS-exposed power generation and by reliance on imported fossil fuels – costs that energy-intensive firms are unable or unwilling to absorb.

- **In the short term, the structure of fees and taxes affecting energy prices for industry should be reassessed, considering the possibility of temporary reductions**. A framework should also be created to develop a market for long-term power purchase agreements (PPAs) for industry. **Although the shift towards nuclear and renewables entails substantial upfront costs, it will ultimately provide cleaner, more secure, and progressively more affordable energy for EIIs**.

- **Energy-intensive industries face decarbonisation costs that often exceed their borrowing capacity with commercial banks.** To support the decarbonisation of Polish EIIs, pipeline infrastructure is needed for the

transport of hydrogen and carbon dioxide, with additional onshore storage required for the latter. Infrastructure development should precede the expansion of demand and supply for decarbonised products, as its absence constrains the deployment of clean technologies in EIIs. However, the geographical dispersion of industrial plants in Poland poses a major challenge to developing pipeline networks for CO_2 and RFNBO hydrogen.

- **The phase-out of free emission allowances under the EU ETS, combined with the introduction of the CBAM, poses significant challenges for energy-intensive sectors**. While the CBAM is intended to create a level playing field between EU and non-EU manufacturers, PEI's interviewees expressed concerns regarding its effectiveness and integrity. **For Poland, situated on the EU's customs border, this issue is particularly relevant – both in terms of the accuracy of CO_2 emission declarations and the risk of resource shuffling**.

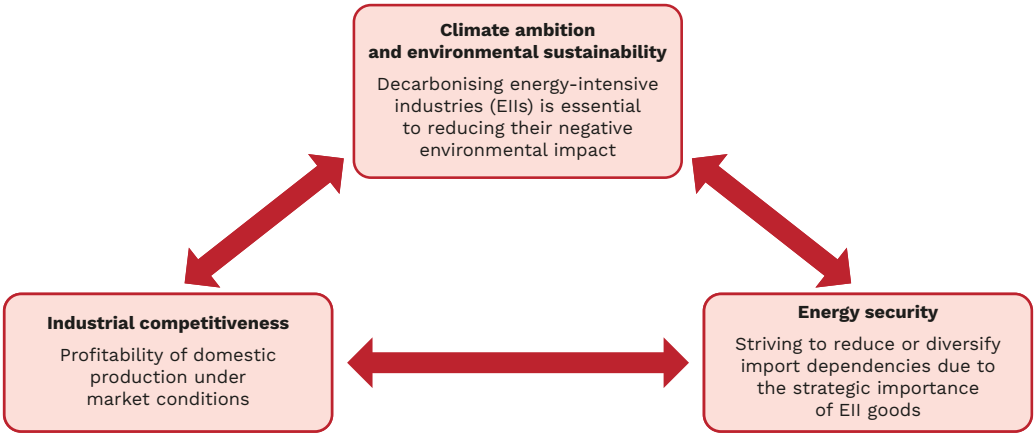
- **A legal framework for green public procurement is crucial to create demand for low-carbon goods produced by Polish energy-intensive industries**. Due to comparable technical parameters, for commodities such as steel, cement, and fertilisers, price is currently the only selection criterion. Introducing non-price criteria, such as a product's carbon footprint, would mitigate the risk associated with decarbonisation investments in these industries.

Poland's Energy-Intensive Industries in the European Context

- The global economy is changing, with more protectionism on the rise. **The EU's energy-intensive industries have seen a decline in competitiveness, reflected in output losses and a growing reliance on imports**. Energy prices remain a key factor behind the competitiveness gap between EU Member States and other major economies. Countries such as the United States, China, and Turkey benefit from lower energy costs and, in some cases, cheaper labour, while largely avoiding the climate policy costs borne by EU industries (Draghi, 2024). Energy-intensive sectors, already under pressure from these challenges, must also pursue decarbonisation in line with EU climate objectives.

- **Given the fundamental role of steel, cement, and chemicals in most areas of economic activity – including defence and food production – halting or reducing domestic output in these sectors would undermine the EU's strategic autonomy. These three, often conflicting, policy imperatives constitute a trilemma that industrial policymakers must navigate when addressing the future of Europe's energy-intensive industries**.

Figure 1. Energy-Intensive Industries Decarbonisation Trilemma



Source: own elaboration by PEI.

- It creates both challenges and opportunities, including the chance to reconsider the role of energy-intensive sectors in the EU economy. **When seeking to enhance competitiveness, it is vital to account for the strategic importance of the products manufactured by these industries for the economy, climate policy, and environmental protection alike**.

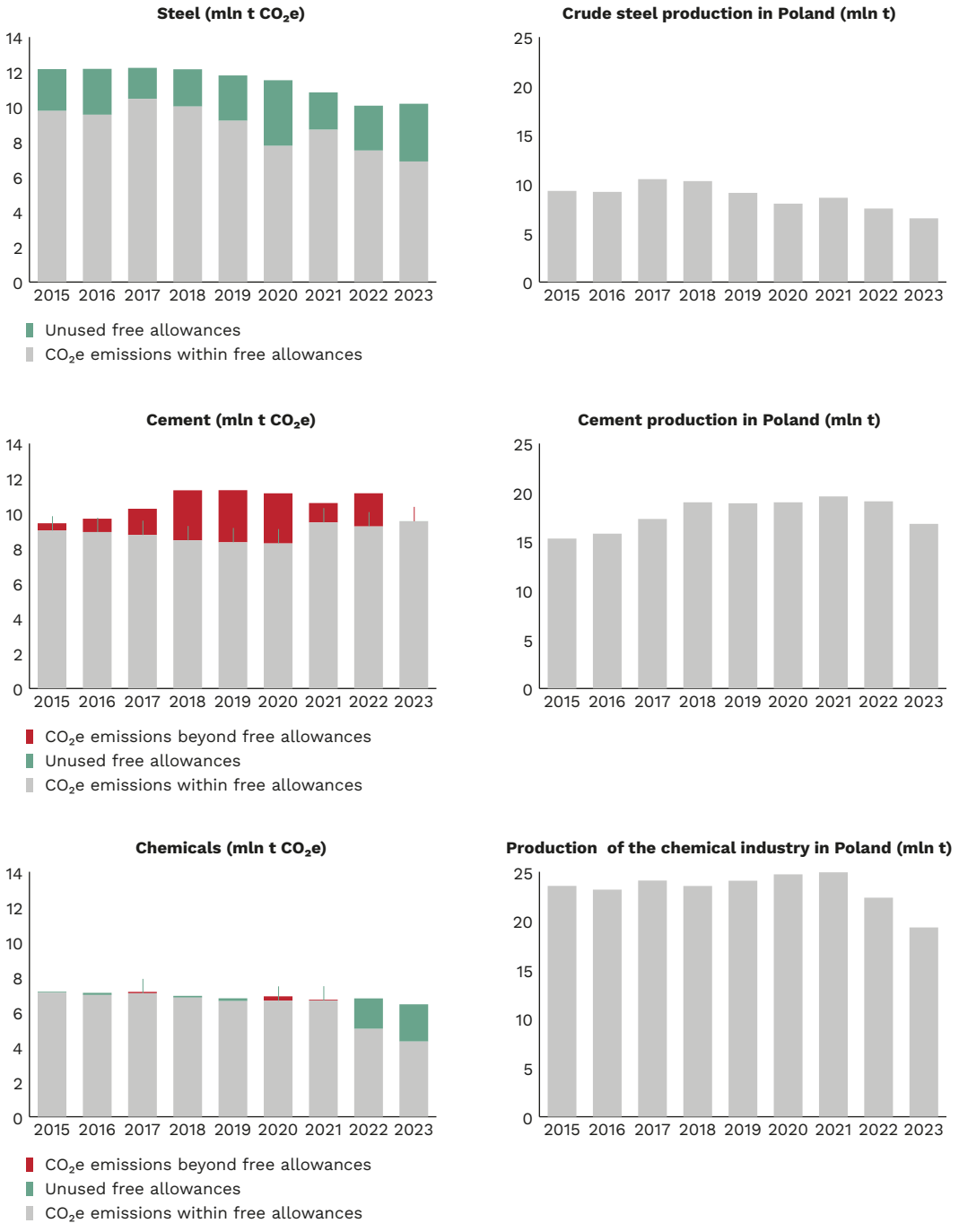
- **Industry plays a larger role in the structure of the Polish economy than in most other economies of the European Union**. The share of Polish industry in the total value of sold production of EU industry amounted to 6% in 2024, which is more than the Polish share in the EU's GDP, equal to 4.7%. (www1; www2). At 448 g/EUR, the emission intensity of the Polish manufacturing sector exceeds the EU average by 63% (www3).

- **The dominant cost component in energy-intensive industries is materials and energy** (Statistics Poland, 2025). These costs encompass both electricity and heat, as well as raw materials – primarily natural gas. The cost of CO_2 emission allowances particularly affects countries such as Poland, where coal continues to play a significant role in the energy mix. In 2024, coal accounted for 53.5% of electricity generation in Poland, compared with the EU average of 9.6% (www4).

- **In this paper, we focus on the challenges faced by the following energy-intensive industries in Poland: steel, cement, and chemicals**. There are two main reasons why decarbonising these sectors is particularly challenging. First, fossil fuels are used in technological processes to achieve sufficiently high temperatures – for example, coking coal in blast furnaces for primary steel production or natural gas, which serves both as an energy source and as a feedstock in chemical processes. Second, the chemical nature of cement production leads to so-called process emissions – CO_2 released during the breakdown of calcium carbonate ($CaCO_3$) into calcium oxide (CaO) and carbon dioxide (CO_2). Another obstacle is the long operational lifetime of industrial plants, which typically run continuously.

- In 2023, the analysed energy-intensive sectors generated around 16 million tonnes of CO_2e (www5), accounting for 5% of Poland's total greenhouse gas emissions (www6). **In 2023, CO_2e emissions in Poland amounted to 2 million tonnes in the production of pig iron or steel, 9.6 million tonnes in the production of cement clinker, and 4.2 million tonnes in the chemical sector** (www5). Because reducing greenhouse gas emissions in these industries is particularly challenging, they are included in the pool of free allowances under the EU ETS. However, between 2024 and 2036, the number of free allowances will be gradually reduced until it reaches zero.

Infographics 1. **On the left, emissions emitted in the steel, cement, and chemicals sectors with information on free allocation in Poland between 2015 and 2023 (in million tonnes CO_2e). On the right, production in these sectors between 2015 and 2023 (in million tonnes)**



Source: own elaboration by PEI based on Statistics Poland and EEA.

- Our interviewees demonstrated **broad consensus on the necessity of decarbonising energy-intensive industries, given the negative impact of greenhouse gas emissions on the environment and society**. At the same time, respondents view EU climate policy as a significant challenge for Polish EIIs. They also highlighted Poland's delay in decarbonising the energy sector, which remains a key prerequisite for industrial decarbonisation.

- **CBAM has emerged as one of the most challenging elements of EU climate policy for energy-intensive industries**. Interviewees broadly acknowledged its rationale, recognising the need to "level the playing field" across sectors (www7). However, **both industry representatives and think-tank experts expressed concerns about the current regulatory framework, with potential loopholes cited as the main source of risk**. *Resource shuffling* – the practice of directing cleaner production to the EU market while continuing more carbon-intensive operations elsewhere – was identified as a particularly pressing issue. Poland's geographic position at the EU's external customs border was also highlighted as an additional vulnerability.

- Interviewees hold a prevailing belief that the state's fundamental role in governing decarbonisation is to design strategies and define their objectives. At the same time, respondents noted the **absence of strategic, forward-looking measures by the government to address energy-intensive industries**.

- According to the interviewees, industrial policy would benefit from a designated 'process owner' – a high-ranking public official (e.g. a minister or deputy prime minister) tasked with implementing the strategy and held accountable for its outcomes.

Steel

- **The steel industry has long held a strategic role in the economy due to its broad and essential use in the production of goods in construction, infrastructure, and manufacturing. It is also of critical importance for the defence and energy sectors**.

- **However, steel production is carbon-intensive and accounts for about 5% of all emissions in the European Union** (Somers, 2022), **while globally the share is estimated to be 7%** (Koolen, Vidovic, 2022). The iron and steel industry in Poland was responsible for 4.2 million tonnes of CO_2 emissions in 2023, representing 2.7% of Polish emissions covered by the EU ETS (KOBiZE, 2024).

- **As a trade-exposed industry, the EU steel sector remains vulnerable to competition from third countries**. Global steel demand is expected to grow only marginally in the coming years, reflecting a sharp slowdown in China's construction sector, which has been the main driver of global demand in recent decades. At the same time, global production capacity is projected to increase by 165 million tonnes between 2025 and 2027, further exacerbating the existing overcapacity and intensifying pressure on the profitability of European producers (www10). **Although EU output in 2023 met around 90% of domestic demand** (European Commission, 2025), **Poland recorded a significant steel trade deficit, with domestic production covering only 54% of national consumption** (World Steel Association, 2024).

- **The Polish steel industry is highly concentrated, with only 14 firms operating in the sector in 2023, most of which are foreign-owned enterprises** (Statistics Poland, 2025). Despite an 11% year-on-year increase to 7.1 million tonnes in 2024, Poland's crude steel production has followed a sustained downtrend since 2017 – declining by 32% overall – mainly due to the 2020 shutdown of the steelworks in Cracow, leaving only one operational blast furnace in Dąbrowa Górnicza (World Steel Association, 2025; www8).

- **In 2024, steel producers in Poland utilised electric arc furnaces for 45.8% of the total output** (World Steel Association, 2025; www9). Direct employment in the steel industry amounted to 19.5 k in 2024, constituting 6.5% of EU employment in the steel sector (Eurofer, 2025). The value of production sold in the basic metals sector in 2023 was EUR 6.9 billion, which accounted for 1.5% of the total sold production of Polish manufacturing (Statistics Poland, 2025).

- For the European steel industry to successfully face competition from China – where overcapacity continues to distort global markets – and other non-EU producers, it is necessary to strengthen its competitiveness through coordinated EU industrial policy, enhanced security of raw materials, and measures that prevent carbon leakage and unfair competition. Low-carbon steelmaking technologies such as electric arc furnaces (EAFs) and hydrogen-based direct reduced iron (DRI) installations are central to achieving these goals.

- Our respondents expressed scepticism about the long-term viability of maintaining blast furnaces in both Poland and the EU, highlighting that **efforts to decarbonise should focus primarily on EAFs** given their technological and market maturity as well as their existing presence in Poland. **To expand steel production using this technology, ferrous scrap needs to be classified as a strategic raw material and its export from**

Poland must be restricted. However, **the EU still exports substantial volumes of ferrous scrap that could otherwise serve as feedstock for domestic EAF-based production**. Within the EU, Poland is the fifth-largest exporter of ferrous scrap, representing approximately 3% of global exports (World Steel Association, 2025).

- Unlike some EU member states such as Sweden, **Poland is not ready for DRI commercialisation, and the framework conditions for its large-scale industrial deployment are not yet in place**. The situation will only change once Poland secures access to green hydrogen and establishes the supporting infrastructure required for large-scale DRI deployment.

- **Think-tank interviewees noted that the dominance of multinational corporations in Poland's steel sector may not fully align with the country's long-term economic interests. They cautioned that such a structure could increase the risk of deindustrialisation and carbon leakage**. This is mainly due to the significantly greater flexibility of international corporations in adapting to changing competitive conditions, as well as their ability to easily enter or exit individual markets. This is supported by their extensive financial, human, and logistical resources within capital groups. Respondents also expressed the opinion that Polish companies could exert greater pressure on policymakers to support the decarbonisation of steel production than is currently the case. Policymakers could, for instance, introduce a green public procurement framework for low-emission products.

- **Poland holds comparative advantages in certain steel products; however, a mismatch persists between the structure of domestic production and that of domestic consumption**. The country is a net exporter of long products, such as rods and rails, but runs a trade deficit in flat products, which are essential for industries like automotive manufacturing. **Despite the unprecedented increase in defence spending, interviewees remain largely sceptical about the potential impact of the military industry on steel demand growth**. While they noted that profit margins on defence-related steel products tend to be relatively high – a rarity in an industry where competition is seldom based on quality – the overall volume of steel required for arms production in Europe is too small to have a meaningful effect on total demand.

Cement

- Cement is widely used in construction as a key component of concrete, as well as in mortar and plaster. Unlike steel – another essential construction material – the cement industry is less exposed to

international trade. **While significant trade takes place within Europe, the EU cement sector faces relatively limited competitive pressure from imports originating outside the continent**. In the case of cement, the extent to which domestic production can be substituted by imports depends primarily on production scale, institutionalised demand, and the distance over which the material can be economically transported (Dumez, Jeunemaftre, 1998).

- Cement is among the largest industrial sources of CO_2e emissions under the EU ETS. In 2024, cement clinker production accounted for 26% of all emissions from industrial installations in Poland (www5).

- The key challenge in decarbonising this sector stems from the nature of its emissions: cement production is dominated by process emissions – those resulting from chemical reactions primarily from the calcination of limestone to calcium oxide – which represent around 60% of the industry's total emissions in the European Union. Heat generation accounts for roughly 30% of emissions, while electricity consumption contributes only about 10% (Marmier, 2023).

- **Poland produced 16.8 million tonnes of cement in 2023 (of which 14.9 million t was Portland cement), making it the third largest cement producer in Europe**. Cement production was in the range of 15-20 million tonnes between 2015 and 2022. In the cement, lime, and gypsum sector, employment in 2023 amounted to 5.7k, while the value of total production sold equalled EUR 2.5 billion (Statistics Poland, 2025).

- Due to the process-related nature of emissions, deep decarbonisation of cement production can only be achieved through the deployment of carbon capture and storage (CCS) technologies at industrial plants. However, **limited access to financing and the absence of regulatory support for onshore CO_2 storage along with problems with planning and constructing pipelines for CO_2 transport remain the main barriers to CCS implementation in Poland**. As CCS installations substantially increase a plant's electricity demand, the cost of energy plays a crucial role in determining their economic viability. Additionally, the price of EU ETS allowances will be a key factor in determining the profitability of these investments (Miniszewski, Pilszyk, 2024).

- The experts surveyed point to **the lack of social acceptance as a major barrier to CCS investments in Poland, potentially due to concerns about the safety of underground CO_2 storage facilities**. As with onshore wind and nuclear power, CCS projects may face NIMBY ("not in my backyard") opposition to the siting of infrastructure close to residential areas. A related reaction is referred to as WIMBY ("why in my backyard?"), a more

sceptical and passive stance that nevertheless seeks short-term benefits associated with local investment (Svartdal, Kristoffersen, 2023).

- **Providing direct benefits to host municipalities, for instance in the form of royalties, may help mitigate these attitudes among local communities**. Furthermore, representatives of the cement industry believe that the state should be responsible for running public education campaigns on CCS technologies to further enhance social acceptance.

Chemicals

- Unlike the technologically homogeneous steel and cement sectors, the chemical industry in Europe is far more diverse. The structure of the Polish chemical industry is based on four key branches (Polish Chamber of Chemical Industry, 2024): **Bulk chemicals** (plastics, fertilizers and nitrogen compounds, industrial gases, dyes and pigments, chemical fibres, and synthetic rubber), **chemical manufacturing** (end products manufactured from bulk chemicals), **fuels and refined petroleum products** and **specialty chemicals** (pharmaceuticals, household chemicals or crop protection products).

- **The Polish chemical industry primarily specialises in the production of fertilisers, which account for around 30% of its total output**. The sector faces significant price pressure from fertiliser imports originating outside the European Union (www11). Other key products include plastics and, to a lesser extent, nitric acid, ammonia, as well as paints and varnishes. Basic chemicals, fertilisers, plastics, and rubber represented the highest value in the sold production of the Polish chemical industry in 2023, with total sales exceeding EUR 10.6 billion (Statistics Poland, 2025).

- **After several years of stability, production in Poland's chemical industry has entered a downward trend**. The onset of this decline can be traced back to the period of the energy crisis. In 2023, the sector's output amounted to 19.4 million tonnes, marking a year-on-year decrease of nearly 14% (Statistics Poland, 2025).

- From a business perspective and in the context of maintaining competitiveness, high natural gas prices currently represent a key challenge for the fertiliser industry. **Hence, a key strategic question arises: should fertilisers be imported – and if so, at which stage of the value chain?** Since fertiliser production is directly linked to food security, the answer to this question will shape future support policies for the sector. Interview findings suggest that relocating successive stages of production to

lower-cost countries can reduce unit costs but simultaneously weakens incentives to maintain production in Europe, where competitiveness continues to decline.

- Decarbonising the chemical sector requires approaches tailored to the technical characteristics of individual installations. Given the industry's diversity, maintaining technological neutrality at both the Polish and EU levels will be key to fostering innovation and effective emission reductions. Leading decarbonisation technologies in the chemical industry are **electrolytic hydrogen, CCS technology, and electrification of industrial installations**.

- The chemical industry already makes extensive use of grey hydrogen, which is produced from natural gas through steam methane reforming. **Production and consumption of hydrogen in the refining and fertiliser sectors (particularly for ammonia synthesis) account for around three-quarters of total hydrogen use in Poland, which amounted to approximately 1 million tonnes in 2022** (Tchorek et al., 2023).

- In the context of industrial decarbonisation, progress depends on the uptake of electrolytic hydrogen: a Renewable Fuel of Non-Biological Origin (RFNBO) serving both as a fuel for industrial processes and as a feedstock for producing advanced energy carriers, including green ammonia and green methanol. **According to the RED III Directive, the sectoral targets for industry stipulate an RFNBO share of at least 42% of hydrogen consumption by 2030 and at least 60% by 2035** (www12). **Achieving the 2030 target would require 189 kt of RFNBO hydrogen, posing a significant challenge for Poland, where no hydrogen currently produced meets the EU's RFNBO criteria** (Tchorek et al., 2023).

- **CCS technology could play an important role in decarbonising the chemical industry, as some chemical installations generate high-concentration CO_2 streams that are well suited for carbon capture** (www13). The challenges of implementing CCS in the chemical sector are similar to those in the cement industry: the high energy requirements of CO_2 capture units, limited pipeline infrastructure for CO_2 transport, and the lack of a legal framework for onshore storage. In contrast to the cement industry, chemical plants offer additional opportunities for carbon utilisation, as captured CO_2 can in some cases be reused in processes such as urea production (IEA, 2019).

- **As in the steel and cement sectors, the main barrier to electrification in the chemical industry is the need to supply high-temperature heat**. Electrifying selected chemical installations, such as steam crackers, presents an opportunity to significantly reduce emissions, though it

requires substantial investment and greater access to affordable, reliable electricity – ideally from renewables (Mallapragada et al., 2023). In Poland, high hopes are also pinned on the development of nuclear energy, both large-scale and SMR.

- **Some industry representatives suggest that the sector's technological diversity leads to a divergence of interests**. This fragmentation of positions within the chemical industry makes it more difficult for the sector to exert influence on EU policymaking. Interviewees also pointed to a growing distance between the European Commission and the industry's agenda, which may stem from political and social pressures to set and consistently pursue ambitious climate policy targets.

- **Respondents displayed strong scepticism about the feasibility of achieving the revised RED III Directive's target for the uptake of RFNBOs in industry**. In this context, the absence of RFNBO production in Poland, as well as the significantly less favourable conditions for cost-competitive hydrogen production via electrolysis compared to those in southern European countries, need to be considered.

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