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Deliverable D3.2

Report on climate extension of the 2024 EIBIS

Deliverable Number	D3.2
Lead Beneficiary	EUI
Deliverable Name	Report on climate extension of the 2024 EIBIS
Type	R – Document, report
Dissemination Level	PU - Public
Due Date (month)	23
Work Package No	WP3

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LIFE COASE is co-financed by the LIFE Programme of the European Union.

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Issue Record

Planned delivery date	November 2024
Actual date of delivery	January 2024
Status and version	Final version

Version	Date	Author(s)	Notes
1	30/01/2025	Marie Raude, Lea Heinrich, Simone Borghesi	

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POLICY BRIEF

Decarbonising manufacturing firms in the European Union's Emissions Trading System

Highlights

- EU manufacturing firms face the dual challenge of decarbonisation and (international) competitive pressure. This policy brief analyses emissions and output trends in the EU ETS, sector-specific industrial innovation, the impact of uncertainty on low-carbon investments, and the need to support lagging firms.
- The European industry is not on track to meet its emissions reduction targets. The carbon efficiency and investment levels are heterogeneous, reflecting the different decarbonisation options across sectors. This calls for a sector-specific or value-chain approach to incentivise decarbonisation.
- In the short term, (carbon) contracts for difference can offer relief and effective de-risking. However, clarity is still required on the EU's carbon pricing framework beyond 2030.
- A competitive, decarbonised EU industry will lead to a new industrial landscape, requiring strategic EU coordination to ensure policy acceptance and mitigate regional impacts.

Issue 2025/04
January 2025

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EUI FLORENCE SCHOOL OF REGULATION

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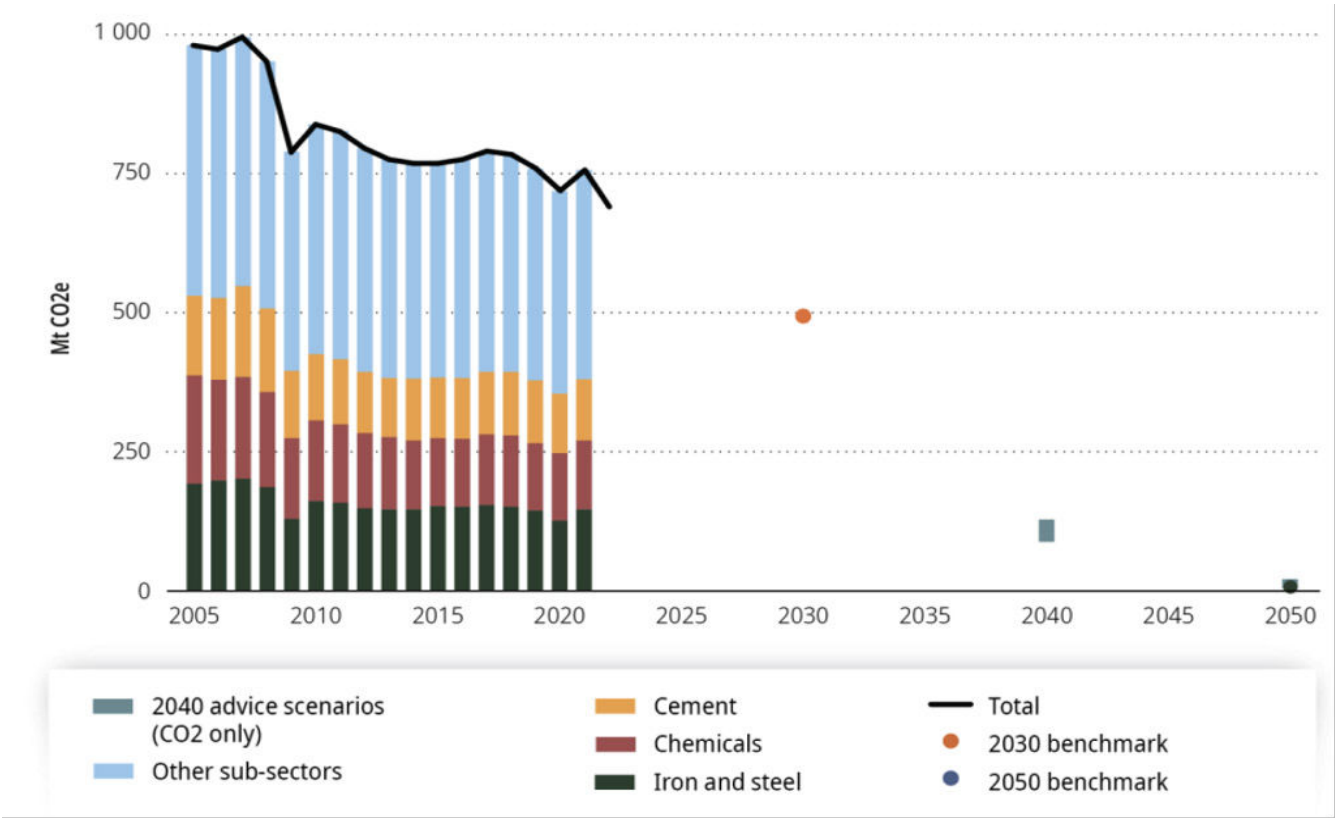
Introduction[1]

Decarbonising European manufacturing firms is critical to ensuring the EU reaches its climate neutrality objective. In 2022, emissions from the manufacturing sector – which include iron & steel, mineral oil, cement & lime, chemicals, pulp & paper, glass, and non-ferrous metals- accounted for 21% of total EU emissions. Activities in the manufacturing sector contributed to the highest levels of greenhouse gas (GHG) emissions in Europe, alongside the supply of electricity, gas, steam, and air conditioning, with both reporting 745 million tonnes of CO_2-eq.[2]

Industrial emissions have decreased, but progress remains insufficient, and there is a need to increase the reduction rate to be consistent with the trajectories towards the overall 2030 and 2050 objectives. In their 2024 Assessment Report, the European Scientific Advisory Board on Climate Change highlighted "*average annual reduction in 2005–2022 (– 17 Mt CO2e per year) needs to accelerate to – 24 Mt CO2e per year in 2023–2030 and – 19 Mt CO2e per year in 2031–2050 to be consistent with the trajectories towards the overall 2030 and 2050 reduction objectives*" (Figure 1).[3]

Decarbonisation, however, must not come at the cost of economic competitiveness. The manufacturing sector is a key contributor to Europe's economy in terms of employment and output. Policies that may negatively affect activity must be carefully designed, always considering their social impacts. One challenge with decarbonisation is that the higher relative costs of decarbonised production can lead to output reduction and a higher reliance on imports. The Draghi report on European competitiveness warns: "Deindustrialisation in the EU in some of these sectors has already started and may accelerate without dedicated policies."[4]

Figure 1: Overall progress in reducing industrial GHG emissions



(source: European Scientific Advisory Board on Climate Change)

1 The authors thank Aliénor Cameron and James Kneebone for their helpful discussions and comments.

2 Estimation from Eurostat data (env_ac_ainah_r2).

3 European Scientific Advisory Board on Climate Change. (2024). 'Towards EU climate neutrality: progress, policy gaps and opportunities', the European Scientific Advisory Board on Climate Change

4 Mario Draghi, The future of European competitiveness, September 2024. (p. 92).

In 2023, the European Investment Bank (EIB) collected information on investment activities, financing requirements, and difficulties faced by manufacturing firms in the EU ETS related to their decarbonisation activities.[5] The survey confirmed firms consider the EU ETS as a driver for innovation, whilst carbon cost uncertainty is a hurdle. The survey also revealed that some firms were lagging behind their peers regarding their decarbonisation process.

Based on the key findings of the EIB survey and considering the economic importance of manufacturing firms in Europe, this policy brief is structured as follows. Section 1 provides an overview of emissions and output trends for manufacturing firms in the EU ETS. Section 2 examines the academic evidence and sectoral specificities of industrial innovation. Section 3 discusses whether uncertainty is a perceived or an actual barrier to low-carbon investments. Finally, section 4 presents a call to address industrial firms lagging in decarbonisation.

1. Emission reductions of manufacturing firms in the EU ETS – decarbonisation or output reduction?

Emissions from the manufacturing sectors are covered by the EU ETS, the pillar of Europe's decarbonisation strategy: the coverage rate is above 75% of the total emissions for these sectors. Overall, the EC reports a 7.5% drop in emissions from the manufacturing sectors in the EU ETS in 2023 compared to 2022. The EC reports this drop to be due to a combination of reduced output and efficiency gains without specifying the ratio between these two levels.[6]

In aggregate, European industrial production fell by 1.2% in 2023 compared to 2022, with a recorded decrease in production in about two-thirds of all industries. This can be explained by European firms' higher relative energy costs compared to their global competitors.[7]

Although to a limited extent, emissions costs havealso pressured European competitiveness. The increase in carbon prices in the last 5 years has indeed led to an increased production cost. This impact is limited as carbon costs represented a small share of total production costs: 2% for European steel producers in 2019 and around 10% for cement producers in 2021. Firms at risk of carbon leakage have received free permits to limit the negative repercussions of carbon cost increases and support European producers' competitiveness.[8] With the recent Fit for 55 reforms to increase ambition, including the tightening of the cap and the gradual move away from free permit allocation, regulated firms are expected to feel more pressure from the EU ETS. In this context, future EU carbon prices are expected to reach up to 250 €/tCO_2 by 2030, and future carbon costs are thus expected to play a higher share of total production costs.[9]

5 This information was collected by the EIB for the 2023 extension of the annual EIB Investment Survey (EIBIS). The questions were designed in collaboration with the EUI, as part of the LIFE COASE project. A complete overview of the main results can be found in the EIB Investment Report: Transforming for competitiveness (Box A Manufacturing firms in the EU Emissions Trading System – what makes the leaders stand out from the rest? P.209 – P 214).

6 The EC specifies that at the time of publication of their report, production levels from installations in the scope of the EU ETS is not available. EC. (2024). Report from the Commission to the European Parliament and the Council on the functioning of the European carbon market in 2023. For the coverage rate of the EU ETS, refer to Raude, M., Mazzarano, M., & Borghesi, S. (2024). EU Emissions Trading System sectoral environmental and economic indicators. European University Institute.

7 Mario Draghi, The future of European competitiveness, September 2024. Production data comes from the production of industry index on Eurostat (sts_inpr_a).

8 Carbon leakage occurs when a firm relocates its production to a country with less stringent climate policies. The volume of free permits distributed to industrial sites depends on expected exposure to carbon leakage and on defined sectoral benchmarks. Note that in 2023, some sectors have received a net surplus of permits compared to their total reported emissions. It is the case for pulp & paper, cement & lime, and iron & steel (Sandbag data viewer). This is because the volume of free permits to be distributed is defined based on previous output and does not fully adjust to count for changes in production levels from one year to another. For information on carbon costs, refer to the estimations from Medarac et al (2020) for steel, and Cembureau (2021) for cement.

9 Cameron & Garrone (2024) already identify that after 2018, changes in emissions intensity led to opposite changes in corporate performance, showing the importance of the increased regulatory stringency of the system. Cameron, A., & Garrone, M. (2024). Carbon intensity and corporate performance: A micro-level study of EU ETS industrial firms. For price projections, refer to Raude, M., Heinrich, L., Ferrari, A., Ekins, P., Osorio, S., & Borghesi, S. (2024). Climate neutrality: policy scenarios for emissions trading. European University Institute.

Considering the evolution of emissions and output levels together is key to analysing the extent to which these industries are on their path to decarbonisation (Table 1). The aim is to see a decrease in emissions intensity, indicating a decoupling between the emissions and output levels. Since 2005, estimates suggest that the emissions intensities of steel, cement and chemicals in the EU have been relatively stable or even slightly increasing. However, an accelerated reduction in industrial emission intensities has been noted since 2020, with considerable heterogeneity in the rate of decline across sectors. In 2023, pulp & paper decreased their GHG intensity the most, while chemicals increased theirs.[10]

2. The EU ETS as a driver for industrial innovation? Academic evidence and sectoral specificities.

The EU ETS is intended to incentivise firms to invest in and adopt low-carbon or carbon-neutral technologies to reduce their emissions intensity. Manufacturing firms in the EU ETS surveyed by the EIB perceive carbon pricing or taxation as important drivers for investment in green technologies and processes.[11] However, the investment gaps that remain to decarbonise heavy emitters and the lack of adoption show the current policy framework has not been effective enough to spur the needed changes for the uptake of clean production.[12]

The academic literature found limited impact of the EU ETS on low-carbon technological change during the system's infancy from 2005 to 2013. Further, the literature also indicates that the EU ETS had a more significant effect in spurring low-carbon innovation than adoption. During these years, the

Table 1: Manufacturing sectors' emissions and production for 2023

Industry	Total CO2e emissions (in millions tco2e)	Annual rate of change of emissions (between 2022 and 2023 in %)
Iron & Steel	144.6	-7.5%
Cement & Lime	106.7	-10.0%
Chemicals	92.3	-7.2%
Pulp & Paper	19.2	-15.0%
Others	165.6	-5.9%
Manufacturing	*527.4*	*-7.7%*

Industry	Annual rate of change of production (between 2022 and 2023 in %)
Iron & Steel	-5.5%
Cement & Lime	-7.9%
Chemicals	-10.2%
Pulp & Paper	-11.0%
Manufactured goods production	*-1.2 %*

(Source: Sandbag, Eurostat, author's calculations)
Note: A reduction in emissions is recorded across all manufacturing sectors. Iron & Steel is the heaviest emitting sector among the manufacturing sectors regulated in the EU ETS. The 7.7% reduction in emissions and the 1.2% reduction in output suggest a decrease in emissions intensity of the manufacturing sector in 2023 compared to 2022. An important caveat of this analysis is that the scope of the reported emissions data does not directly align with the one from the production activity.

10 Emissions intensity can be measured by taking the ratio between GHG emissions and gross value added or GHG emissions and tonne of product. For more refer to European Scientific Advisory Board on Climate Change. (2024). 'Towards EU climate neutrality: progress, policy gaps and opportunities' (P.92), or 2024 State of the EU ETS report (P.19). Among other reasons, the trade dependency of the chemical sector has negatively affected the industry in times of geopolitical disruptions with the Russian war in Ukraine. Cefic (2024).

11 EIB Investment Report: Transforming for competitiveness (Box A Manufacturing firms in the EU Emissions Trading System – what makes the leaders stand out from the rest? P.209 – P 214).

12 The Advisory Board estimates that investments in mitigation technologies in energy and transport need to increase by at least a factor of four. Note that carbon emissions from transports are not currently covered by an ETS (ETS2 will become fully operational in 2027). The lack of investments in this sector cannot be ascribed to a limited effectiveness of carbon pricing. European Scientific Advisory Board on Climate Change. (2024). 'Towards EU climate neutrality: progress, policy gaps and opportunities' (P.236)

system was also ailed by the overallocation of free permits to emitters, negatively affecting low-carbon investments. Some evidence based on data after 2013 is more encouraging and points to the fact that the system-induced investments. Overall, however, it is unlikely that the EU ETS alone will unlock the investments required for the development and application of low-carbon technologies. In this context, relying on multiple policy instruments is necessary to achieve decarbonisation: carbon pricing, along with other policies such as technology mandates and targeted research subsidies for inducing and/or diffusing clean innovation, is necessary to avoid path dependencies and lock-in of long-lived high-carbon assets. The coherence of such a policy mix must be carefully assessed, considering synergies, complementarity, and spillover and interaction effects. [13]

Furthermore, there appear to be significant differences between companies regarding their willingness or ability to invest: the EIB survey finds that the percentage of the total 2022 investment budget dedicated to decarbonisation varies from 30% to 50% across the surveyed sample. This result reflects the disparity in decarbonisation pathways of the different EU industries. For example, whilst the main emissions reduction pathway for iron & steel is transitioning to electric arc furnaces, the most promising avenue for cement is the usage of carbon capture and storage (CCS) to capture the unavoidable process emissions.[14] Both of these firm-level technological changes also depend on systemic changes such as increased green electricity supply and large-scale deployment of infrastructure. At the firm level, when the commercial viability of the most promising technology is not guaranteed, investments are made to decrease emissions at the margin. In the case of the cement industry, for example, as CCS is still not deployed at scale, decarbonisation has implied changing the cement formulations with lower quantities of clinker.

To incentivise the decarbonisation of EU manufacturing sectors, it is important to take a sector-specific or a value chain approach rather than a technology-focused approach. The risk of having the latter is to structurally create an over-reliance on a certain technology and overlook alternative options that would result in deeper and faster decarbonisation.[15] The design of the free permits distributed to industrials in the EU ETS should be reassessed in this direction to ensure it effectively rewards decarbonisation. Taking the example of the Cement sector, the benchmark used for free permit allocation is defined based on clinker production. In that way, the design favours the established production method: currently, a producer does not have an incentive to change its cement production process by reducing clinker for a less emitting alternative as it would decrease the volume of free permits it receives. Switching to a product benchmark instead would correct this perverse effect and push decarbonisation in a technology-neutral manner.[16]

13 See for example Borghesi et al (2015) on eco innovation; Verde et al (2019) and Green (2021) for a review of the empirical literature; Aghion et al (2019) about innovation economics applied to climate change; Kalentzis et al (2024) and Hagendorn et al (2024) for analysis exploiting recent data; Rosenbloom et al (2020) for a carbon pricing criticism; Tvinnereim and Mehling (2018) and Grubb et al (2023) for considerations about carbon pricing as part of a policy mix.

14 Refer to JRC and Marmier, A (2023) for cement, Garcia Higuera and Van Woensel (2021) for steel.

15 In their report, Sandbag shows that the push for CCU/S deployment is not the best solution to reach the steel sector's decarbonisation and calls instead for a push to alternative steel production routes(Sandbag, 2024). Owen (2012).

16 This is a short-term measure as free allowances are foreseen to be phased out and replaced by the CBAM. Refer to Delbeke et al (2022) and Branger and Sato (2017).

3. Uncertainty, a hurdle for low-carbon investments? When perceptions meet reality.

Firms often cite uncertainty about future energy and carbon costs and about regulation and taxation as the main barriers to decarbonisation. The responses given in the EIB survey confirm this: more than 90% of surveyed firms self-reported that uncertainty is hampering their investment in low-carbon technological change. European industrial firms, however, benefit from one of the clearest and most structured regulatory environments compared to their international competitors. This includes a commitment to climate neutrality by 2050 and measures to prevent carbon leakage, supported by long-standing strong climate policies. This questions whether uncertainty is a perceived barrier used to deflect responsibility or a real hurdle for these firms. It also underlines the limits of self-reported information.

Environmental innovation is a process that requires a long-term commitment from firms in terms of strategy and organisation, decision-making processes, and R&D spending. Therefore, the stability of policies and regulations is crucial.[17] The EU ETS is an example of a policy tool which has been reflecting the climate ambitions of the EU for twenty years. Regulators have addressed policy uncertainty by setting long-term emissions reduction targets. Following the revision of the EU ETS Directive in 2023, the target is to reduce covered emissions by 62% by 2030 compared to 2005 levels. To achieve this, the reduction factor will be raised from 2.2% to 4.4% by 2028.

The predictability of the carbon price evolution is also key. There is indeed evidence that carbon price uncertainty negatively affects decarbonisation investments at the same magnitude as the effect of a decline in the carbon price. Reforms were implemented to address this and improve the credibility of the system. For instance, the EC introduced a Market Stability Reserve (MSR) in 2019 to address the surplus of allowances in the market, thereby stabilising the carbon price and reducing the risk of extreme price fluctuations. To further reduce price volatility, a minimum price floor or a price collar has been discussed, as well as Carbon Contracts for Difference (CCfDs), which could provide financial certainty to firms making low-carbon investments by guaranteeing a stable carbon price.[18] For instance, Germany is now offering its industries a combination of CfDs and CCfDs, which hedge against both energy and carbon price risks, respectively.[19]

However, uncertainties remain, as pointed out by the EU Scientific Advisory Board (2024, p.227): "The EU does not yet have a clear strategy to prepare the carbon market and relevant sectors for the era of very low emissions and the prospect of the allowance supply reaching zero by 2040". It is still unclear which role carbon dioxide removals (CDR) will play and if and how they will be integrated into the EU ETS to offset these residual emissions.[20] Similarly, it is still unclear how regulators will continue to address the issue of carbon leakage. So far, the EU has adopted the Carbon Border Adjustment Mechanism (CBAM), which will start operating in 2026. The CBAM will put an equivalent to the ETS price on certain carbon-intensive product imports and will be gradually introduced with a corresponding phase-out of free permits for the same products. However, the mechanism remains incomplete, and discussions are ongoing on its covered sectors and product categories and its compatibility with WTO rules. The EU should reduce the uncertainty of the emissions trajectory and policy framework where possible to avoid firms taking a wait-and-see stance with their decarbonisation investments. In particular, there is a need to rapidly clarify how the EU's carbon pricing framework will develop beyond the 2030 targets.

17 Kyaw (2022) and Berestycki et al (2022).

18 Refer to Fuchs et al (2024) about carbon price uncertainty; to Cornillie et al (2024), Borghesi et al (2022) and Richstein and Neuhoff (2022) for CCfDs; and to Neuhoff et al (2025) for a "climate contribution" approach to finance CCfDs.

19 In October 2024, the first CCfDs were signed with 15 German industrial companies.

20 Co-legislators have mandated the Commission to assess the option of integrating removals (as well as emissions from residual waste) in the EU ETS (Directive (EU) 2023/959). These assessments should be done by July 2026, with an open public consultation which will take place in early 2025. Raude et al (2024) for more information.

Lastly, carbon pricing does not take place in a vacuum. Firms' investment decisions are driven not only by the carbon price but also by the overall economic situation and other incentives stemming from EU and national fiscal, energy, digital, financial and labour market policies.[21] Overall, policy consistency and alignment are key to ensuring the credibility of the EU's climate ambition and providing a favourable investment environment.

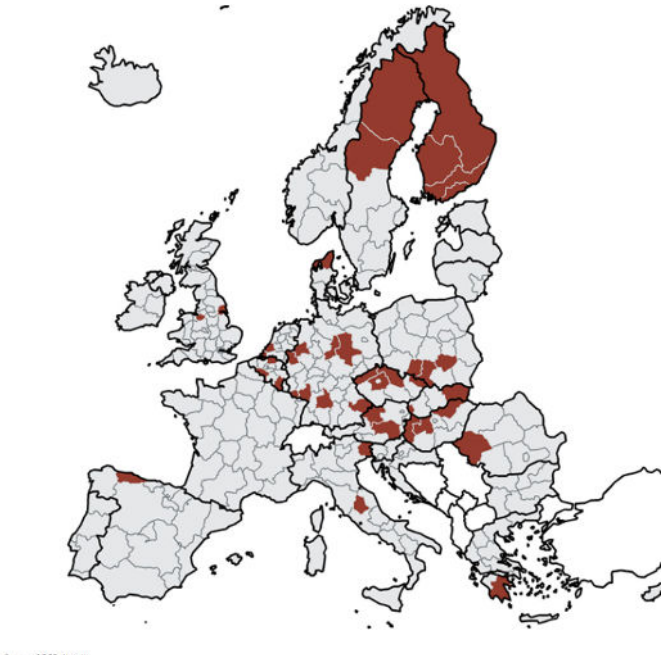
4. Laggards, by choice or despite efforts? A call to address industrial firms lagging in decarbonisation.

As the stringency of the EU ETS increased over the years, all regulated firms are expected to have undertaken decarbonisation measures to a certain extent. Interestingly, some 18% of the surveyed manufacturing firms reported not yet having a decarbonisation strategy in place in 2023. This is a sign that these firms project their business to continue as usual. Further, some firms have increased their emissions intensity relative to their sector peers.[22] These firms represent "vulnerability pockets" as they will be the most negatively impacted by the forthcoming increase in climate stringency.

One interpretation of the phenomenon of the "business-as-usual firms" or the firms in the "vulnerability pockets" is that some incumbent actors do not consider decarbonisation as a strategic priority for their activity. Along this narrative, these firms are confident that their Member States (MS) will protect them from the negative effects of stricter environmental policies. As these firms often provide employment and growth opportunities on a regional or national scale, MS have an interest in shielding them at the expense of the EU's fair competition or decarbonisation objectives. The previous overallocation of free permits exemplifies this phenomenon in action. Another interpretation is that these firms lack the means to tackle their decarbonisation. Small and medium enterprises in the energy-intensive sectors have been found to lag behind larger firms in terms of environmental action, hindered by a lack of information and awareness, regulatory hurdles, innovation assets, skills gaps and financing constraints.[23] The two narratives are not mutually exclusive: these two types of firms likely co-exist

Faced with the challenge of decarbonisation, some activities are poised to decline (or even terminate) in specific locations. Indeed, shifting to new production pathways will bring new cost structures and can change the optimal locations for an industrial site. This structural change will not be uniform across Europe: regions in Central and Eastern Europe are the most exposed (Figure 2). As these regions are often relatively socioeconomically weak, distributional concerns are raised.[24] There is a need to accompany this structural change.

Figure 2: Regions most exposed to the transition to climate neutrality in key manufacturing sectors



(source OECD)

21 Baker et al (2016)

22 EIB Investment Report. (2024). Transforming for competitiveness (p 217)

23 SMEs account for more than 30% of the GHG emissions in the EU manufacturing sectors. For more information refer to OECD (2021), "No net zero without SMEs: Exploring the key issues for greening SMEs and green entrepreneurship", OECD SME and Entrepreneurship Papers, No. 30, OECD Publishing, Paris.

24 OECD (2023), Regional Industrial Transitions to Climate Neutrality, OECD Regional Development Studies, OECD Publishing, Paris.

A unified European approach seems appropriate for developing a strategy for the new landscape of the clean EU industry. As mentioned in the Draghi report, this would provide a business case for a decarbonised and competitive EU industry.[25] Such an approach could build on existing policy flagships such as the EU's Just Transition Mechanism and Net Zero Industry Act to deploy impactful measures like reskilling programmes or conditioning industrial aid to decarbonisation targets. The upcoming Clean Industrial Deal will be a key opportunity to introduce and develop these measures.

Concluding remarks

Manufacturing firms must decarbonise for the EU to reach its climate neutrality objective. The latest trends in emissions and output show that European industries are not on track to meet their emissions reduction targets. Investment levels are heterogeneous, reflecting the different decarbonisation options faced across sectors.

To incentivise the decarbonisation of EU manufacturing sectors, it is important to take a sector-specific or a value-chain approach rather than a technology-focused approach. The design of the free permits distributed to industrials in the EU ETS should also be reassessed to ensure it effectively rewards decarbonisation. One concrete example is moving from a content to a product benchmark for cement. In the short term, (carbon) contracts for difference can offer relief and effective de-risking. However, clarity is still required on the EU's carbon pricing framework beyond 2030.

Decarbonisation, however, must not come at the cost of economic competitiveness. The manufacturing sector is a key contributor to Europe's economy in terms of employment and output. Policies that may negatively affect activity must be carefully designed, always considering their social impacts.

The emergence of a new competitive and decarbonised EU industry landscape implies some manufacturing firms may have to close down. This structural change calls for increased strategic coordination at the EU level to ensure policy acceptability and mitigate the negative consequences of industrial closures in the more affected regions.

25 Mario Draghi, The future of European competitiveness, September 2024.

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Co-funded by the European Union

Published by
European University Institute (EUI)
Via dei Roccettini 9, I-50014
San Domenico di Fiesole (FI)
Italy

doi:10.2870/5220854
ISBN:978-92-9466-653-6
ISSN:2467-4540
QM-01-25-024-EN-N