Policy Brief

INNOPATHS

Decarbonising Industry

Existing technologies must be widely diffused, and new technologies developed, for EU industry to be decarbonized by 2050

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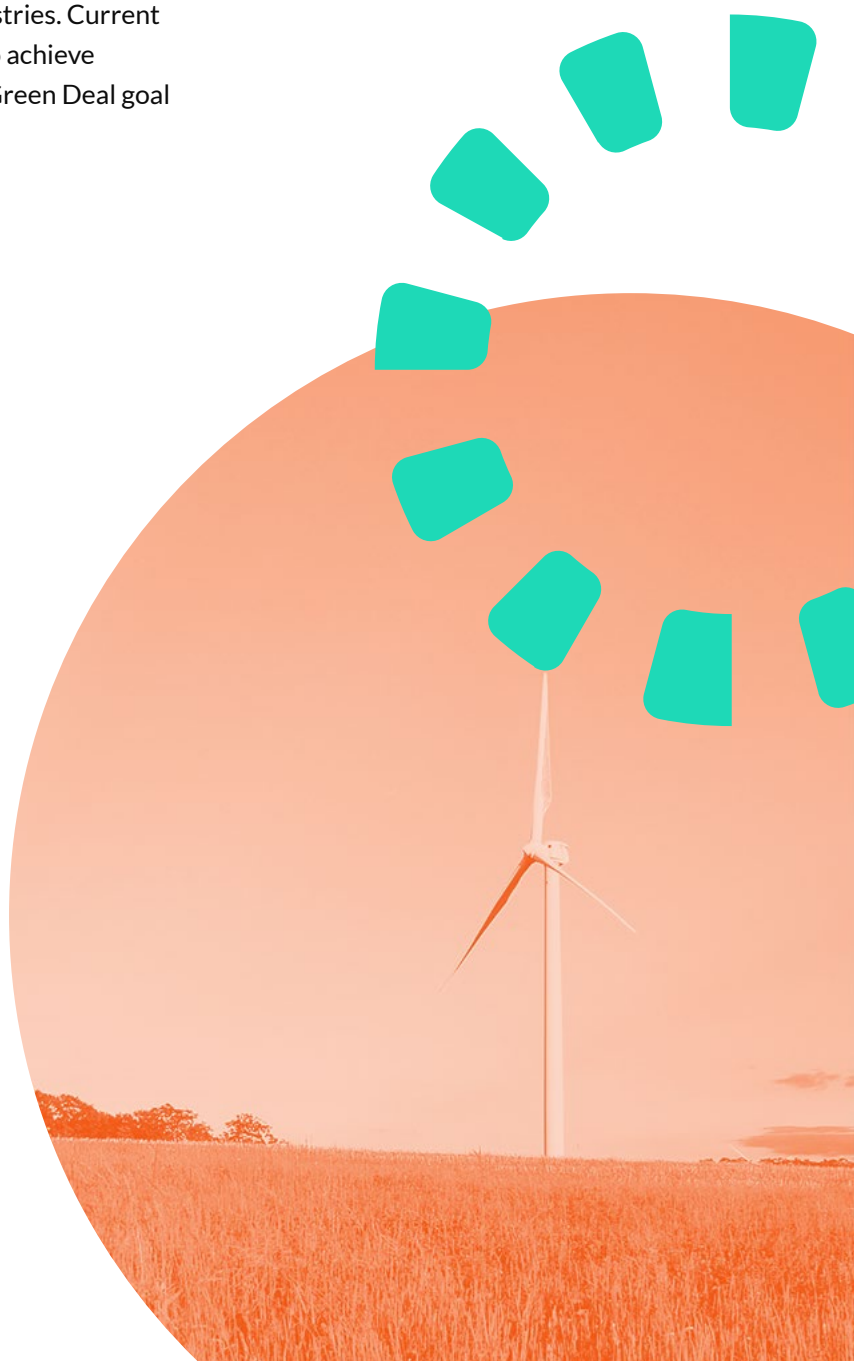
Key Messages

- Policy makers need to support technology development and diffusion in the decarbonisation of industrial sectors and address associated socio-economic issues.
- Deep decarbonisation of industry by 2050 requires an increased rate of deployment of existing technologies and the emergence of breakthrough technologies in manufacturing.
- The strong involvement of all stakeholders must be secured for the rapid diffusion and deployment of carbon-neutral technologies aimed at the decarbonisation of European industry.
- Climate policy portfolios for industrial climate-neutrality should be differentiated in their support for short, medium and long-term challenges.

Background and Context

Industry accounted for around 26% of energy consumption in the EU in 2018[1], with metals, chemicals, non-metallic minerals and paper industries jointly consuming about two thirds of EU industrial energy. Reducing energy consumption and increasing the uptake of low-carbon energy carriers is vital to achieve net-zero emissions by mid-century. But relatively little progress has been made towards these ends in many European countries. This Policy Brief presents some of the key lessons from the INNOPATHS project to accelerate decarbonisation of industry in Europe towards meeting the EU Green Deal target of climate neutrality by mid-century.

European industrial firms have already begun a steady progress towards decarbonisation, with direct GHG emissions in 2017 falling by 36% from 1990 levels,[2] particularly due to reductions in fossil fuel consumption in energy-intensive industries. Current mitigation efforts need to be greatly accelerated to achieve compliance with the Paris Agreement and the EU Green Deal goal of climate neutrality by mid-century.



1 Source Eurostat https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Energy_statistics_-_an_overview#Final_energy_consumption

2 Source EEA https://www.eea.europa.eu/data-and-maps/daviz/ghg-emissions-by-aggregated-sector-5#tab-dashboard-02

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Accelerating current mitigation efforts in the European industries to achieve compliance with the Paris Agreement and bring them to carbon neutrality by mid-century poses important challenges. These are both technological – i.e. linked with the timely development and scaling up of novel climate-neutral industrial technologies and processes, and economic and social – i.e. related to the importance of achieving socio-economic co-benefits such as increased competitiveness in international markets, more and better jobs, higher skills, and a fair distribution of costs and benefits of the transition. These challenges are particularly strong in energy-intensive and trade-exposed industries, which face increasing risks of carbon leakage and activity relocation away from the EU, if high carbon prices are implemented without appropriate measures to reduce trade-offs and increase co-benefits.

Several technological configurations can support emission reductions in all sectors of the economy, including (energy-intensive) industry, both in the short term (2030) and in the longer term (2050). Short-term emission reductions in industries are primarily based on increasing energy efficiency through the implementation of Best Available Technologies (BAT), heat recovery, horizontal energy management, electrification of industrial processes and reduced oil and coal consumption through fuel switching. However, achieving the "climate neutrality" target by mid-century requires transformative changes along with disruption in the value chains and business models of EU industries, as CO_2 emissions would need to be reduced by more than 95%. This is a big challenge for European industries, considering the inertia of the sector, the high investments required and the fact that there are only 1-3 investment cycles in most industries before 2050.

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Novel mitigation options include the deep electrification of industrial processes (e.g. through the uptake of high-temperature heat pumps), the switching to renewable energy carriers (e.g. green hydrogen, advanced biofuels, clean synthetic fuels), the emergence of Carbon Capture, Utilization and Storage (CCUS) options, and accelerated improvements in energy and material efficiency in industrial processes through circular economy measures.

The decarbonisation of European industries crucially depends on the provision of carbon-free electricity and hydrogen from energy supply sectors, in order to avoid both direct and indirect emissions. The European Union should focus on the development of industrial electrification (e.g. through the development and commercial uptake of high-temperature industrial heat pumps) in combination with the accelerated deployment of zero-carbon power generating technologies (mostly wind onshore and offshore and solar PV) which can provide emission-free electricity in the quantities required to decarbonise the industrial sector. The full decarbonisation of some industrial sectors may not be achievable without the implementation of CCUS technologies, requiring increased funding for research and innovation in order to ensure that related technologies and processes mature (e.g. storage of CO_2), their costs decline and their social acceptance increases so that they can be massively deployed to decarbonise hard-to-abate industrial sectors that are difficult to electrify. The technology pathways in the European iron and steel sector are largely based on two novel options offering the production of "CO_2-free" steel: i) increased use of secondary steel, coming from steel scrap and electricity (assuming that power generation has been decarbonised); ii) hydrogen-based steelmaking by shifting away from Blast Furnace, where economic viability largely depends on electricity prices, the costs of electrolysers and the price for storing CO_2.

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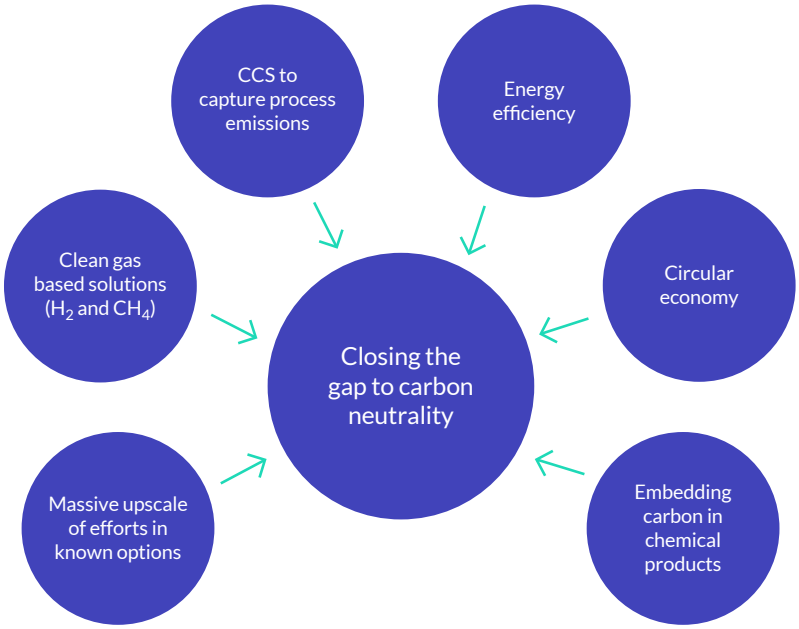
The road towards climate neutrality by mid-century can be achieved through: i) the significant upscaling of current mitigation efforts (i.e. energy efficiency, fuel switch), ii) The deployment of innovative options, including: green hydrogen, e-gas, deep electrification, circular economy, CCUS, embedding CO_2 in products and industrial symbiosis. Strong electrification of industrial processes should be combined with clean gas and green H2 technologies to decarbonize hard-to-abate energy- intensive industries (i.e. iron and steel), while CCUS is also required to eliminate remaining emissions in some industrial sub-sectors. Each technological mitigation option has pros and cons, but their combined development (together with the implementation of circular economy measures) is a cost-efficient way towards ensuring "climate neutrality" of European industries by mid-century.

Figure 1 – Technological options to achieve carbon neutrality in EU industries by 2050



The strong involvement of all stakeholders must be secured for the rapid diffusion and deployment of carbon-neutral technologies aimed at the decarbonisation of European industry.

Low-carbon innovation and technology diffusion in industry sectors needs a strong push beyond traditional innovation support to successfully achieve climate neutrality in a cost-efficient manner by 2050 (see innovation policy brief). Investment in technology development and diffusion will not bear the expected fruits unless all relevant stakeholders in the decarbonisation process are strongly involved. Building on such a shared vision, the EU can increase the diffusion and deployment of low-carbon technologies in industries and thus promote what needs to be a fast transition.

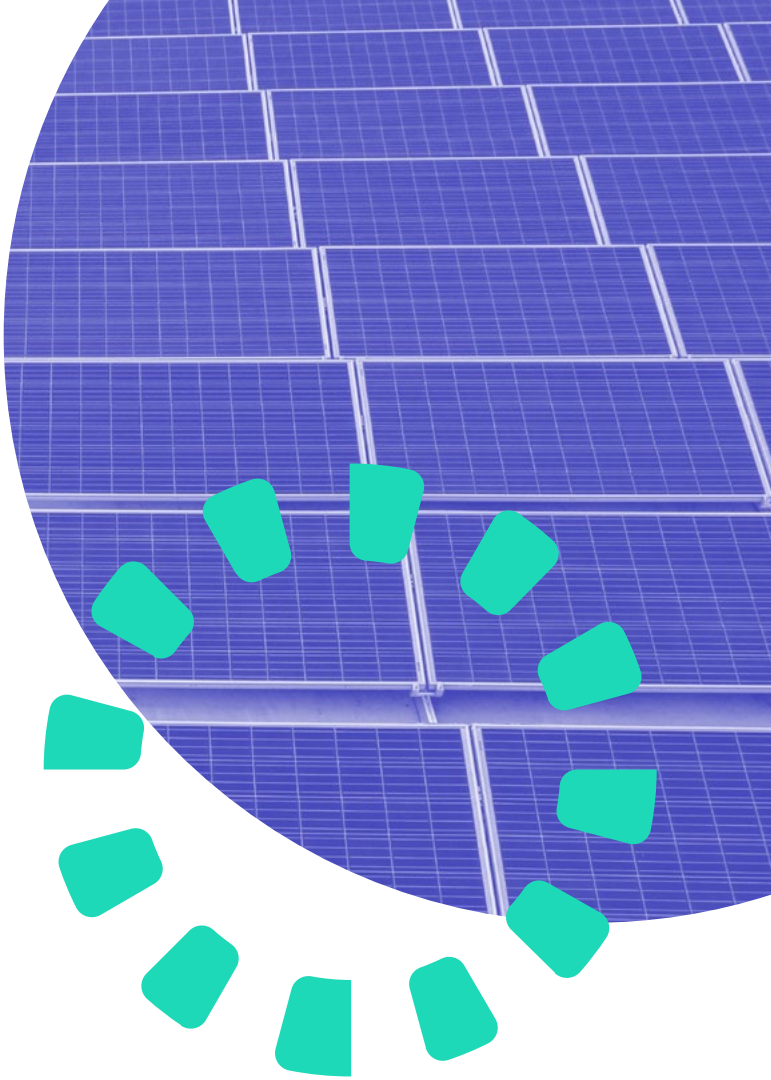
The decarbonisation costs to society and consumers are low, but investment needs for basic industries and production costs of materials may increase significantly. This poses increasing risks related to the reduced competitiveness of European energy-intensive trade-exposed industries, which may relocate to non-abating regions causing severe adverse socio-economic impacts on European countries. Appropriate policy measures, such as Border Carbon Adjustment proposed in the EU Green Deal, should be implemented to protect the domestic manufacturing activity, especially if major trade partners do not implement climate policies of comparable ambition as the EU.

Deep decarbonisation also entails opportunities for European industries as: 1) Industrial products are indispensable for low-carbon solutions, i.e. RES (especially wind turbines), electric vehicles, batteries, energy-efficient buildings – so industrial growth can accelerate as a result of energy system transformation through creating market demand for greener materials, 2) High amounts of investment are required for the transition, but fuel costs for industries will decline rapidly while appropriate anti-leakage measures can minimize the industrial relocation risk, 3) Enhanced low-carbon innovation dynamics and ambitious/predictable policies would lower the transition costs for European industries, which can also benefit from the uptake of new clean technologies and circular economy in terms of reduced production costs and enhanced international context, e.g. with increased export potential for low-carbon technologies, 4) Establishing a comparative advantage in international markets in any carbon-constrained future, as European industries can deliver industrial products (e.g. steel, cement) with the lowest energy and carbon intensity compared to major competing economies, such as China, India and the US.

Climate policy portfolios for industrial climate-neutrality should be differentiated in their support for short, medium and long-term challenges.

In the short term, policies should increase the uptake of options for increased energy efficiency and available low-carbon technologies, and encourage fuel switching in industrial processes towards less carbon-intensive fuels (e.g. electricity). European industrial decarbonisation policy must be closely connected to the renewed EU Industrial Strategy, labour market policies, innovative funding mechanisms and trade policies, and reforms of the EU Emissions Trading System, aiming to ensure consistency among different policy goals.

In the long run, R&D funding should be invested in supporting breakthrough research on zero-carbon industrial technologies (e.g. green hydrogen, CCUS, clean synthetic fuels, high-temperature heat pumps) and in embedding the circular economy approach in industrial processes. R&D investments can promote low-carbon innovation systems as they contribute to lowering the costs and improving the performance of low- and zero-carbon technologies relative to carbon-intensive incumbent technological configurations. The diffusion of zero-carbon technologies may be induced by increased innovation lowering their costs and the implementation of policy measures such as carbon contracts for difference (CCfDs) which can reduce the uncertainty and financing costs for innovative low-emission technologies by guaranteeing investors a fixed price for each ton of emissions reductions below today's best available for a contract duration of up to 20 years. In addition, policy instruments to ensure the removal of behavioural and institutional barriers currently preventing the large-scale adoption of clean energy technologies and infrastructure by EU industries is critical to ensure the cost-efficient transformation towards a zero-emission industrial system by mid-century. A robust and coherent policy framework is needed to facilitate low-carbon investments in European industries, including policy domains such as: supportive trade policy (to avoid carbon leakage), access to raw materials, low-carbon innovation, regional policy, circular economy and energy infrastructure.



Further Information

For further information, please consult the following publications:

- INNOPATHS Deliverable D2.4: Innovation system case studies. Specifically, the case study for industry.
- INNOPATHS Deliverable D3.10: Report on decarbonisation in the industry sector
- Fragkos P, Fragkiadakis K, Paroussos L. (2021), Reducing the decarbonisation cost burden for EU energy-intensive industries, Energies, 14(1), 236
- Peñasco, C., Anadon, L.D., Verdolini, E. 2021. Systematic review of the outcomes and trade-offs of ten types of decarbonization policy instruments. Nature Climate Change, 2021, 1-9

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