Policy Brief

INNOPATHS

Decarbonisation Pathways

Opportunities and challenges of the EU transition to a carbon neutral economy

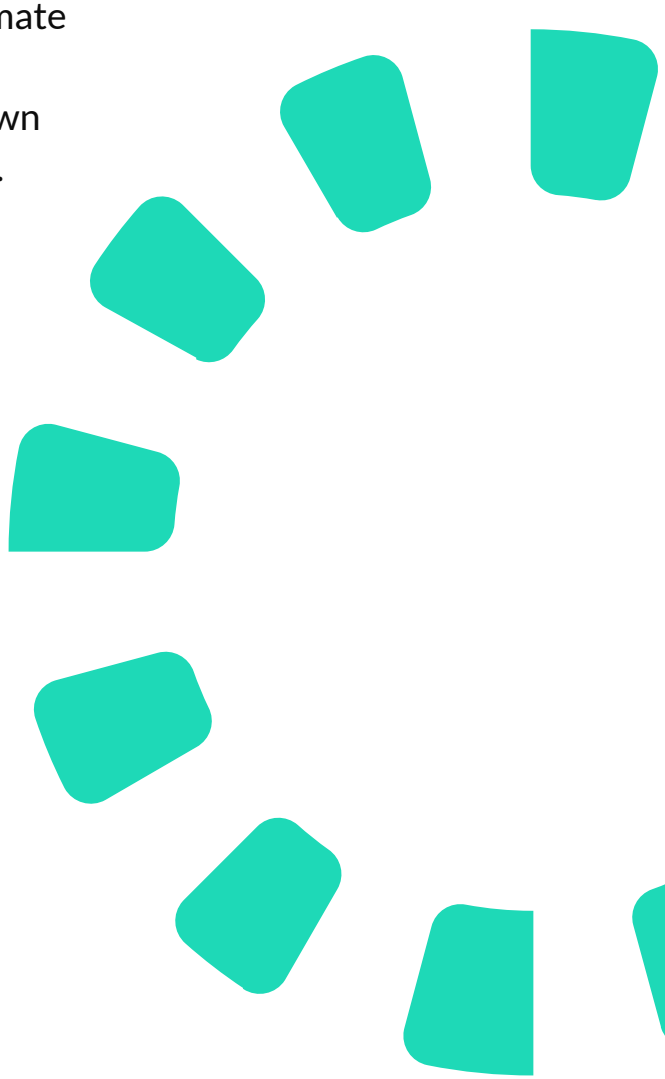
This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 730403

Key Messages

- Massive expansion of cheap renewables will provide emission-free electricity and make deep electrification of all sectors a key pillar for climate neutrality.
- Beyond electrification, innovation, development and diffusion of currently immature technologies (hydrogen, e-fuels, CDR) is required to decarbonise hard-to-abate sectors like heavy industry, freight transport and aviation.
- A substantial increase in the strength and ambition of EU climate polices is essential in order to achieve ambitious climate targets for 2030 and 2050.
- The consistency of climate policy with broader industrial and socio-economic policies will be essential if the full economic benefits are to be realised and potential negative effects avoided.

Background and Context

In the last three decades, the EU has been a clear front-runner in the fight against climate change. Structural changes in the European economy combined with policies for supporting renewables and energy efficiency have resulted in a decoupling of economic growth from emissions, with EU-28 GHG emissions declining by 24% over 1990-2019, while GDP increased by about 60%. The greatest progress has so far been achieved in the sectors covered by the EU Emission Trading System (EU ETS), in particular electricity production and heavy industry, while emissions are still increasing in the transport sector. The EU has a good track record of achieving its domestic and international climate and energy pledges. However, current efforts need to be greatly accelerated to achieve climate neutrality by mid-century and the new 55% reduction by 2030, as required by the EU's own 'Green Deal' policy, and the Paris Agreement.



Massive expansion of cheap renewables will provide emission-free electricity and make deep electrification of all sectors a key pillar for climate neutrality

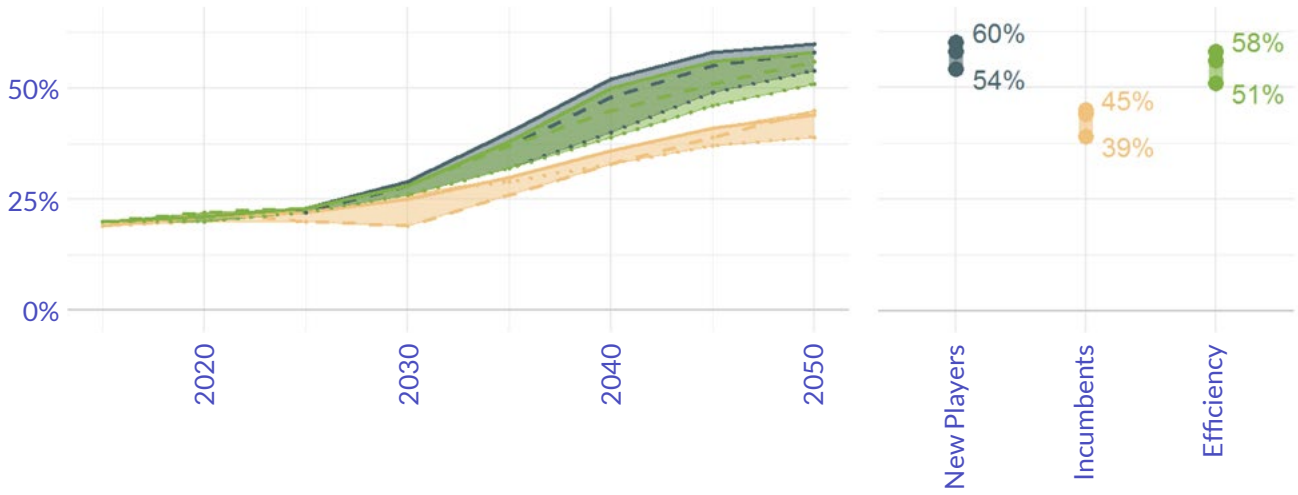
Following substantial cost reductions of more than 80% over recent years, wind and solar power are now the most cost-efficient source of electricity in large parts of the world. Accelerating their deployment is a cornerstone of the drive toward climate neutrality in Europe in the coming years. The extensive availability of emission-free electricity from wind and solar in combination with the high efficiency of direct electrification compared to other conversion routes means that direct electrification is a key pillar of any deep decarbonisation strategy.

In fact, deep decarbonisation crucially depends on power generation being almost fully decarbonised by 2040 (see Policy Brief on Power). This also enables the production of green hydrogen and e-fuels, for use in sectors and processes that are difficult to electrify directly. Such deep electrification of energy end uses will also help balance a power sector increasingly dominated by variable renewable energy, as it may provide large amounts of flexible demand, reducing the need for short-term storage in the form of batteries, for example.

While the past decade has already seen an impressive growth of power generation from wind and solar in the EU, with a more than three-fold increase over the last ten years, their deployment needs to be substantially accelerated in order to achieve an emission-free power sector by 2040, a prerequisite for climate neutrality in 2050. The sizeable cost reductions and currently favourable financing conditions mean that this expansion of wind and solar can be achieved at low costs to customers, and will furthermore quickly alleviate negative health impacts of high-polluting electricity generation from coal in some Member States. Maintaining these favourable financing conditions (see INNOPATHS policy brief on Finance) is an important priority for policy in all EU member states.

INNOPATHS modelling of different decarbonisation scenarios shows that electrification of end-uses needs to be at least doubled to achieve climate neutrality by 2050 (see Figure 1). In one of the scenarios (New Players) with high electrification, electricity shares in final energy demand would increase three-fold, with electricity covering about 60% of EU's final energy requirements in 2050. Such a strong increase means going beyond the services and technologies that are relatively easy to electrify (such as electric vehicles and low-temperature heat pumps), to include those such as freight transport and heavy industry use, where stronger policy support is needed in order to bring the relevant technologies to market readiness and economic competitiveness.

Figure 1: Share of electricity in EU final energy consumption in demand sectors in INNOPATHS decarbonisation scenarios



INNOPATHS modelling shows that under all analysed strategies, electrification of end-uses needs to be at least doubled versus today to achieve climate neutrality by 2050.

Beyond electrification, innovation, development and diffusion of currently immature technologies (hydrogen, e-fuels, CDR) is required to decarbonise hard-to-abate sectors like heavy industry, freight transport and aviation.

Short-term emission reduction (to 2030) in the EU can be best achieved through increased deployment of wind and solar power, which are already cost-competitive with fossil fuels. Similarly, acceleration is also needed for energy efficiency improvements and electrification of end uses in buildings, industries and transport, where the technologies, such as electric cars and low-temperature heat pumps, are already available and nearing competitiveness.

However, reducing EU emissions to net zero by mid-century implies transformative changes across all sectors of the European economy. This requires innovation to stimulate the development and diffusion of immature or completely new technologies to reduce emissions from hard-to-abate sectors, where few options currently exist. Such technologies include Carbon Capture, Utilization and Storage (CCUS) and other Carbon Dioxide Removal (CDR) options, the deployment of liquid or gaseous renewable energy carriers (e.g. green hydrogen, clean e-fuels, advanced biofuels), the deep electrification of industrial processes (e.g. through the uptake of high-temperature heat pumps), and accelerated improvements in energy and material efficiency. Green hydrogen and synthetic fuels, produced from renewable-based electricity, along with advanced biofuels, can deliver significant emission reductions in sectors that are difficult to fully decarbonize through electrification (e.g. parts of heavy industry and freight transport, aviation, shipping).

Low-carbon innovation and technology diffusion in the energy, transport and industrial sectors need a strong push beyond traditional innovation support to pave the road towards a successful and cost-efficient EU transition to climate neutrality by 2050. Increased funding for research and innovation in disruptive technologies (e.g. electrolysers, CCUS, CDR) is required to ensure that they reach industrial maturity by the end of this decade, their costs decline and their social acceptance increases so that they can be massively deployed after 2030. While rapid energy system decarbonisation should be the most important priority for EU climate policy makers in the next decades, CDR technologies will also be required to compensate remaining emissions from specific sub-sectors by 2050, so their development and deployment should be strongly supported.

A substantial increase in the strength of EU climate polices is essential in order to achieve ambitious climate targets for 2030 and 2050

The transition to carbon neutrality is a challenge that can be overcome only if the current climate policies are stepped up and made more ambitious to support short- and long-term decarbonisation. To guide the transformation in the next decade and prevent further lock-in into emission-intensive infrastructure, immediate tightening of existing policies as well as implementation of new comprehensive and consistent policy instruments is required. These ambitious climate policies should include a mix of carbon pricing and regulatory policy instruments in order to combine the strengths of both approaches.

Carbon pricing has a key role to play, as it a) gives all climate-friendly technologies a competitive advantage versus incumbent fossil technologies, b) is one of the few instruments that also influences the use phase of a technology, and can thus reduce potential rebound effects, and c) provides revenues that can be used to recompense vulnerable, low-income households that otherwise do not have the means to change to emission-free technologies.

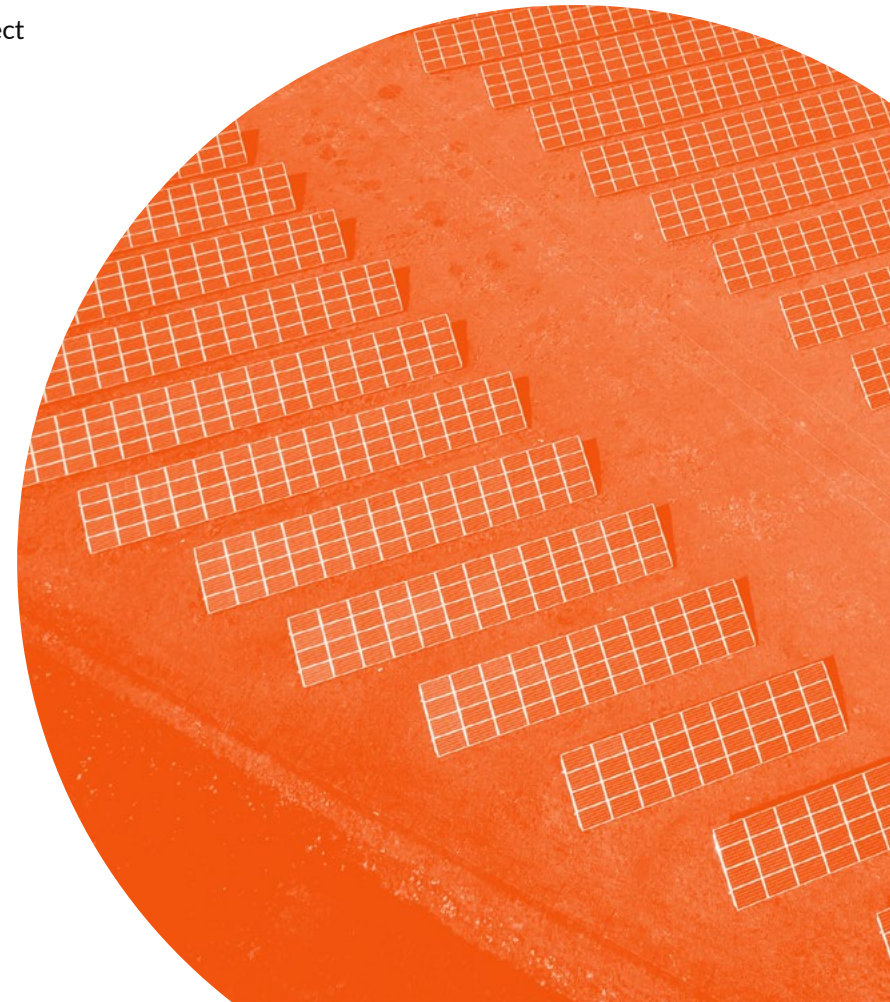
However, carbon pricing alone cannot coordinate an accelerated transformation especially in sectors involving decisions by millions of individuals (e.g. transport, buildings). These sectors will also require strict regulatory measures. Strong policy support, in the form of technology standards, fuel mandates, or sectoral emission targets, combined with large R&D funding will also be required to develop the industry and the entire supply chain for new clean fuels (e.g. advanced biofuels, hydrogen, synthetic fuels) to deliver these to the market at the scale required by mid-century.

To facilitate the transformation and increase the effectiveness of a CO_2 price, enabling policies are needed to ensure the removal of behavioural, market and institutional barriers that are preventing the large-scale adoption of low-carbon technologies by EU households and businesses. Such policies can push technology development and investment in energy efficiency (e.g. deep building retrofits), drive the infrastructure investments needed for new technologies and energy carriers (e.g. electric vehicle chargers, hydrogen pipelines), and incentivize the adoption of clean technologies, including by creating initial, niche markets that can help change the current habits, lifestyles and preferences of consumers.

These enabling policies include a wide range of measures that are already implemented today, including CO_2 standards in vehicles, building standards, subsidies for green investment, ban of certain high-emission technologies, R&D support, feebate systems to incentivize investments into clean technologies and others, but that need to be strengthened and extended in order to accelerate emission reductions in line with the EU Green Deal targets. Our model-based analysis shows that enacting these enabling policies and regulatory measures will significantly reduce the necessary carbon prices to achieve the EU climate goals in 2030 and 2050. As a rough estimate, weak additional measures will likely require carbon prices of 200-400 €/tCO_2 in 2030 to achieve the targets, while very ambitious enabling policies may reduce the required carbon prices to values around 100-150€/tCO_2.

The consistency of climate policy with broader industrial and socio-economic policies will be essential if the full economic benefits are to be realised and potential negative effects avoided

In addition, ambitious climate policies should be consistent with broad economic, industrial, labour market, trade and innovation policies to ensure that the potential negative impacts (e.g. on industrial competitiveness, household energy expenses) of decarbonisation would be limited, while the core options (such as renewable energy, energy efficiency, fuel switch) can be successfully accelerated. The uncertainty about future revenues that may hold back private investment in clean energy projects can be overcome with policy instruments like the carbon contracts for difference (CCfDs), which can guarantee investors a fixed price for each ton of emission reductions. In this context, appropriate policy measures such as the Border Carbon Adjustment Mechanism proposed in the EU Green Deal, should be implemented to protect domestic manufacturing activity and jobs.



Further Information

For further information, please consult the following publications:

- INNOPATHS Deliverable D3.11: Cross-sectoral analysis of INNOPATHS low-carbon pathways
- Rodrigues et al (2021), Alternative Roads to achieve CO_2 net neutrality in Europe, Energy (under review)
- Fragkos P. et al (2021), Equity implications of climate policy: Assessing the social and distributional impacts of EU's ambitious emission reduction targets, Energy (under review)
- Pietzcker, R.C., Osorio, S., Rodrigues, R., 2021. Tightening EU ETS targets in line with the European Green Deal: Impacts on the decarbonization of the EU power sector. Applied Energy 293, 116914. *https://doi.org/10.1016/j.apenergy.2021.116914*

This Policy Brief was written by:

Panagiotis Fragkos, fragkos@e3modelling.com, E3Modelling

Robert Pietzcker, pietzcker@pik-potsdam.de, PIK

Renato Rodrigues, Renato.Rodrigues@pik-potsdam.de, PIK

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Grant Agreement No 730403