

Commentary

Perspectives on an effective design of industry transformation

Stefan Lechtenböhrer

An active systemic industrial policy for climate-neutral process industries in Europe

To achieve climate neutrality, as envisaged in the Paris Agreement and the European Green Deal, the energy-intensive process industries play a key role. However, shifting their energy base to non-fossil sources and to reduce non-energy related emissions, is a major challenge. For this transformation to succeed, new forms of cooperation between industry, society and politics are needed. Next to a policy mix including market-based instruments (e.g., the ETS), faster planning processes and public investments in infrastructure are necessary. Moreover, policies should as well accompany “ex-innovation” processes. For process industries, this means that in addition to product and process innovation and improving market access, they need to proactively engage with their communities.

Introduction

Process industries are key to achieving climate neutrality and circularity. The most energy-intensive industrial processes are the transformation of raw materials such as ores, limestone, sand, oil and gas into basic materials such as steel, cement, plastics, aluminium, glass, etc. These processes are physically linked to high energy demand, which is the main reason why the steel, cement and chemical industries alone directly emit about 20% of global CO₂ emissions, plus significant indirect emissions, e.g. from electricity consumption.

Their high and, to a large extent, unavoidable energy demand places the processing industries at the centre of all efforts to achieve climate-neutral industrial production. The European Green Deal, with its ambition to fully implement the Paris Agreement and make Europe the first climate neutral continent, therefore puts a strong focus and pressure on these industries to shift their energy base to

non-fossil sources and to take significant measures to avoid non-energy-related process emissions, e.g. from cement, glass and lime production. For the petrochemical industry, this means not only decarbonising its energy supply but also shifting its feedstock from oil and gas-based fossil carbon to non-fossil sources, such as plastic waste and biomass. Often these changes will require process industries to move to entirely new, sometimes disruptive, technological pathways - such as hydrogen-based iron direct reduction instead of conventional blast furnaces (Bataille et al., 2018). For European process industries seeking to maintain their technological and environmental leadership as a key unique selling point in their often highly competitive global markets, these challenges to transform their energy base have been made even more urgent by the recent energy crisis triggered by the Russian war in Ukraine. The war has put European manufacturers at a significant energy cost disadvantage to their competitors, with no prospect of this situation being fully reversed in the near future.

* Prof. Dr. Stefan Lechtenböhrer, Wuppertal Institut für Klima, Umwelt, Energie, stefan.lechtenboehmer@wupperinst.org

Main part

Against this background, **European process industries are under strong pressure** to transform towards climate neutrality and circularity, which are the most powerful levers to reduce the energy demand of material production.

The transformation of these industries is therefore highly challenging due to their high capital intensity and long investment cycles in plants and infrastructure (Wesseling et al., 2017), as well as their links to public (energy) infrastructure. In particular, the transition from the current fossil energy supply to a future renewable energy supply will only be possible if investments in clean energy and the corresponding infrastructure for the transport of clean electricity and hydrogen, but also the necessary infrastructure for carbon transport and storage, are available.

All of these points make it clear that industrial companies will not be able to make the transformation on their own. They will need strong public support to develop and invest in entirely new technologies, public planning and frameworks to accelerate clean energy supply in a timely manner, and to create more circular value chains. In all these crucial areas, new stakeholders from different sectors, as well as customers and the general public, will need to be involved to make the transition possible. In short, an active, integrated climate industry policy with a clear strategic focus on climate neutrality and circularity is indispensable, which means: streamlining and supporting the forces of markets and innovation systems by combining them with broader societal actors.

However, industrial policy or a strong role for governments has long had a protectionist/conservationist focus. Only recently has there been a call for an active systemic rather than traditional industrial policy for the transition to climate neutrality. This is consistent with a similar evolution in innovation policy, which has shifted from a goal of supporting all types of economic development to more mission-oriented and transformative goals (Nilsson et al., 2021).

A transformative industrial policy focused on emission-intensive basic industries requires above all systemic innovation, which requires an active role of the state and a targeted technology policy. According to Nilsson et al. (2021), such a policy should be based on six closely interlinked pillars:

1. Directionality, to create a very important certainty of direction with regard to climate neutrality and resource efficiency. This can be achieved through political goals and strategies, but also through infrastructures, and should always be based on participatory processes, as only strategies with broad social support can create the necessary stable framework conditions in the long term. The main elements of such a policy for directionality are:
 - Rigorous emissions trading, climate change legislation and industrial strategy, as well as strategies on hydrogen, carbon management, circularity and the future design of the electricity market, are essential approaches that must work together to provide the necessary direction, and this requires a common mission for climate neutrality and resource efficiency - as set out in the European Green Deal.
 - Innovation support and market introduction of the necessary technologies and infrastructure through targeted instruments such as climate protection contracts.
 - Targeted and broad participation through activating instruments, ranging from more regional actions such as the IN4climate.NRW initiative involving industry, science and government in the heartland of the European manufacturing industry, to a national "industry consensus", which should aim at enabling a broad understanding of the challenges of the transformation, but also of the important role of a climate-neutral industry for the sustainability transformation. This understanding is important both for the acceptance of the necessary infrastructure and investment and as a basis for the future recruitment of motivated skilled workers, e.g., in STEM professions.
 - Finally, all this needs to be embedded in relevant European policies and instruments, as an industrial strategy ultimately needs to be understood and supported on a pan-European basis.

2. Knowledge creation and innovation for industrial transformation should promote whole-system innovation and learning, in addition to mission-driven technological innovation and the acceleration of its market readiness.
 - The key strategies of electrification, hydrogen economy and carbon management can only be successful if they are considered in a holistic and integrative way and therefore require an active role of the state and a wise integration of societal actors.
 - In addition to socio-technical aspects, this systems perspective should also take into account dimensions of sustainability in an integrated manner in order to be successful.
 - Examples of such approaches are participatory scenario processes, such as those carried out for the NRW Climate Protection Plan (Lechtenböhmer et al., 2015), or the multidisciplinary research programme of the IDRIC in the UK.
3. Today's market structures have been created - with strong government influence - in parallel with the structures of fossil-based industries. The paradigm shift towards climate neutrality now requires a corresponding transformation of core markets and the creation of new ones. This applies both to markets for renewable energy and to the creation of markets for 'green' industrial products, e.g., through standards or quotas to stimulate demand, based on setting definitions for 'green' products and processes.
4. Building capacity for governance and change.
 - Climate change mitigation has been primarily an energy policy issue (and to some extent a housing and transport policy issue). Industrial decarbonisation is a very new area that requires appropriate institutional capacity at all levels of governance, not only for adoption processes. In particular, its high technical and economic complexity and its close links with resources, innovation, foreign trade and geopolitics require the creation and development of specific institutional structures and expertise in policy and administration.
 - Such an institutional component, linking different policy areas, should play a central role in the Industrial Strategy and related strategies.
5. International coherence is particularly necessary for industrial transformation, as there is a strong need for international coordination in addition to global climate and trade agreements.
 - International coordination is needed both to mitigate the problems of global commodity markets for the transition, and to build new international partnerships that enable developing countries to leapfrog to clean industrial structures rather than replicate unsustainable fossil development patterns and to seize the development opportunities offered by often abundant renewable energy and resources (Hermwille et al., 2022).
 - In addition to existing initiatives such as the Glasgow Breakthroughs, Mission Innovation, LeadIT and the Industrial Deep Decarbonisation Initiative, sectoral climate clubs (e.g. an international steel club) can be fruitful approaches to internationally coordinated policy.
 - Just Energy Transition Partnerships, concluded with South Africa and currently being negotiated with Indonesia, could be a vehicle to catalyse clean industrial development in the partnership between Europe and developing countries.
6. Finally, it is important to take action on the downside of the transition: An industrial strategy should also take into account necessary technology or market exits and their socio-economic impacts in an integrated way.
 - Industrial transformation will entail structural changes in certain companies, industries and particularly regions. In addition, in a more climatefriendly world, challenges will arise from better production conditions in other regions of the world where, for example, large and cost-effective renewable energy potentials can be tapped. This "renewables pull" effect could trigger industrial relocation ("green leakage") (Samadi et al., 2023).
 - Like coal mining, process industries are often spatially concentrated and their transformation can have similar consequences and trigger similar resistance. It is therefore important to contribute to the development of instruments and to integrate the reorientation of companies and industrial regions into the industrial strategy. This also applies to employment relationships, collective agreements and codetermination in companies, some of which are threatened by

transformation. At the same time, the innovative capacity and competence of the industrial workforce can be integrated and used constructively through appropriate integration, which also makes an important contribution to the human capacity and expertise required for transformation.

This means that Europe has the opportunity, based on its technological competence and its ability to align market forces with societal goals, to successfully implement an active systemic industrial policy and to lead the transition to climate neutrality and make it a success. The European Green Deal is a bold first step in the right direction.

Conclusion

The manufacturing industry faces major and unprecedented challenges as it transitions key processes to non-fossil energy and feedstocks. These changes will require new forms of cooperation between stakeholders from industry, society and governments, which can be created by an active systemic industrial policy for the transition to climate neutrality. Such a new industrial policy needs to consist of an integrated policy mix, including a range of market-based instruments such as the ETS, the adaptation of market rules, e.g., in electricity markets, and the creation of new green markets. However, it will also require a strong emphasis on faster planning procedures, public investment in infrastructure, e.g., for new green energy supply, research and subsidies for the market entry of new production processes, as well as active stakeholder engagement policies. Finally, strong policies are needed to accompany the necessary “ex-innovation” processes, especially in heavily industrialised regions, and, last but not least, the creation of strong public institutions.

Such a much more active cooperation between public and private actors is not only challenging, but may also fail, or at least be insufficiently successful, in some areas. Such a risk is particularly daunting given the complexity and urgency of the challenges ahead. The creation of strong and capable (public) institutions, including strong scientific underpinning, and a strong involvement of societal stakeholders, together with flexible policy design, can be means to enable such a new industrial policy to be flexible and adaptable to mistakes. For European companies, particularly those in energy-intensive manufacturing industries, this means a major innovation challenge. In addition to the need to innovate their products and processes and their competitive access to markets, they need to be much more actively engaged with their communities, ranging from their employees to the communities in which they are located to those that need to support infrastructure. This means that companies need to actively develop and focus on their societal value as one of their core outputs and business objectives.

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