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Tools to boost investment in low-carbon technologies

Five possible ways to create low-carbon markets in the EU

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Abstract

Objectives set by the EU in line with the Paris Agreement will, over time, lead to demands for greenhouse gas emissions reductions including, increasingly, from energy-intensive industries that can only be fulfilled by rapid deployment of breakthrough low-carbon technology. Disincentive policy measures such as carbon pricing will not in themselves be sufficient to achieve these goals. There is a need for a set of tools that can help to create and grow markets in new low-carbon technology, particularly against a background of international competition and widely varying carbon constraints. This Policy Insight reviews a number of tools that could boost investment in low-carbon technology.

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1. Introduction

EU energy and climate objectives in line with the Paris Agreement require significant reductions of greenhouse gas emissions in all sectors of the economy if the EU as a whole is to reach net zero emissions sometime in the second half of the century. These reductions must include very significant contributions by energy-intensive industries. As a consequence, new technologies have to be developed and deployed. If properly implemented, this climate policy-induced innovation could become a major contributor towards the EU's innovation, jobs and growth agenda. The European Commission argues that "Europe has the know-how, the ability and the ambition to lead the world in developing the technologies required to tackle climate change"[1].

Even as the EU's share of global greenhouse gas emissions continues to shrink, there is a general economic imperative in engaging in this industrial transformation, not least to position European industry competitively in an economic environment where other countries are likewise trying to address similar challenges.

This industrial transformation is also closely linked to the EU priorities of raising resource efficiency and moving towards a circular economy. While these latter two objectives do not obviate the need for a low-carbon transformation, they are arguably indispensable elements in reducing the magnitude of the required change: any material that is repurposed to productive ends does not need to be reproduced in an energy- and resource-intensive manner.

This report represents a further contribution to CEPS work on climate and innovation, which has previously focused on the prospects of the EU's Strategic Energy Technology (SET) Plan, carbon leakage, the need for long-term price signals for the power sector, and the EU's innovation system.

2. The policy challenge to decarbonise energy-intensive industries

Increasingly, it has become accepted that decarbonising[2] energy-intensive industries requires transformational changes to products and production processes. If greenhouse gas emissions reduction targets of 95% or more are to be achieved, then incremental innovation will not be sufficient.[3]

The European Commission is currently working on a new long-term strategy for emissions reductions in a 2050 perspective. In drafting this strategy, pathways to net zero emissions in 2050 will be explicitly examined. The European Parliament already supports a net zero target.

[1] See the European Commission page on 'Low Carbon Innovation'.

[2] 'Decarbonising' and 'decarbonisation' are intended as shorthand terms for the process of significantly reducing GHG emissions to the extent that such emissions eventually reach zero across the economy. It is not intended to imply that the carbon contents of all products should reach zero. Sometimes, the expression low-carbon economy is used; we will use the two terms interchangeably.

[3] Napp, Gambhir, Hills, Florin and Fennell (2014), A review of the technologies, economics and policy instruments for decarbonising energy-intensive manufacturing industries, *Renewable and Sustainable Energy Reviews*, Vol 30 pp. 616-40.

However, the 280 million tonnes that separate a 95% reduction target from a zero (notwithstanding the 'net') target do not meaningfully change the technical requirements for sectors to bring such climate goals into reach.

Achieving 2050 targets therefore requires new and often breakthrough low-carbon technology along with subsequent deployment. Many of the technologies that energy-intensive industries require in a near-zero emissions world have already been conceived at a small scale (e.g. hydrogen-based steel making or zero-carbon fuels). Rather than about invention, the challenge here is one of scale and of diffusion of innovation.[4]

This is about more than just changing production processes. The increased use of, for example, green (or blue[5]) hydrogen as an industrial feedstock and carbon capture and storage requires extensive new and upgraded infrastructure as well. The innovation systems literature considers innovation diffusion and infrastructure development a necessary condition for industrial transformation. This goes beyond 'optimising' (how to move to the best, already available, products and processes) and 'satisfy' (to ensure smarter choices are made on energy efficiency, for example (Grubb et al, 2018[6]). According to the literature, this will require strategic investment first and foremost (such as that described by Mariana Mazzucato[7]), while tools such as price signals and standards may serve as a complement.

Technology deployment and innovation diffusion will thus necessitate investment on a very large scale. Companies, however, will only invest if there is a reasonable expectation of a profitable market. For low/zero-carbon industrial products that compete with currently available carbon-intensive alternatives, the question is: who will buy these products?

3. Technologies exist but policy tools are missing

Many carbon-intensive industries have developed technology roadmaps with low- or zero-carbon alternatives from an industrial perspective. For steelmaking, carbon capture or avoidance (hydrogen) are options. Refineries are also looking to hydrogen and carbon capture and storage, while in the cement sector, beyond carbon capture, new cement types and clinker blends have been envisioned that result in far lower process emissions, leaving fewer residual emissions to be captured.[8]

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[4] This paper builds on the challenges of industrial transformation described here: CEPS Policy Insight 2017/44 *Transforming Energy-Intensive Industries: Reflections on innovation, investment and finance challenges*.

[5] Green hydrogen is produced by electrolysis using renewable energy; blue hydrogen uses carbon capture.

[6] Grubb, McDowall, Drummond (2018). On order and complexity in innovations systems: Conceptual frameworks for policy mixes in sustainability transitions. Forthcoming in *Energy Research & Social Science*.

[7] In the EU, this idea has been taken up in the discussions about 'mission-oriented innovation' following Mariana Mazzucato's work in "*The Entrepreneurial State – Debunking Public vs Private sector Myths*". 2013. Anthem Press.

[8] See Lehne & Preston (2018). Making Concrete Change: Innovation in Low-carbon Cement and Concrete Chatham House Report.

The industrial roadmaps show that low-carbon technologies carry very high abatement costs, often well in excess of 100 EUR per tonne. This well exceeds the visible carbon price in the EU generated by the EU emissions trading system today, even after the precipitous rise observed throughout 2017 and 2018.

For society as a whole it is important to look at functionalities as well. It may not be necessary, or even desirable, to decarbonise all of contemporary industrial production if some products can be substituted. Likewise, circular economy policies, which tend to focus on the demand-side by incentivising recirculation of materials, can reduce emissions from industry as well,[9] thereby making less daunting the scale at which zero-carbon technologies need to deliver.[10]

Low- and zero-carbon technologies are also at different stages of development. Even if the technology already exists in pilots, much more is needed to allow production at scale, and to enable learning effects which can bring down capital costs of highly capital-intensive investments. For companies, this implies a need for sustained free cash flow. On the other hand, climate policy exacts costs on industry by design.

All this points to the need for policy support that helps to create a market for low-carbon products. Only if there is a market will companies be willing to invest. While there is always a legitimate desire to keep such policy tools as neutral as possible, the fact that some technologies come with significant infrastructure requirements when scaling up (in essence, network externalities) means that some interventions will still be focused. The principle, however, that any technology that can efficiently contribute to a net zero economy should not a priori be excluded from public support is a good one. At the same time, this does not imply that the outcome has to be equal for all options.

4. What possible policy tools?

The most prominent European climate policy tool is the EU emissions trading system (ETS). While carbon pricing can be a tool in creating a market for low-carbon products by making the carbon-intensive alternatives more expensive, the key question – until a global climate framework is in place – is how the level of carbon constraints that are required can be made politically feasible. For that, climate policy and industrial competitiveness will need to be considered in tandem.

Squaring the conundrum between carbon constraints and competitiveness is also linked to the different distributional impacts that disincentive policies such as carbon prices have, versus incentive, market-making/demand-side policies, which are discussed below. Whereas a carbon-pricing mechanism diffuses the benefits while concentrating the costs on emitting

[9] Material Economics (2018). The Circular Economy: A Powerful Force for Climate Mitigation.

[10] See the CEPS Task Force report on The Role of Business in the Circular Economy: Markets, Processes and Enabling Policies.

industries, other policies envisioned may diffuse costs (through the fiscal system) while concentrating the benefits on recipient industries and the regions where they are located.

The tools that could be adopted to diffuse and scale up innovation should be market and trade compatible. Some may raise issues from a state-aid control perspective, although these rules can also be accommodative and supportive of policies that pursue a larger EU economic interest. Some may also run into other regulatory barriers, but addressing such barriers is in any case essential to grow low-carbon investments.

Against this competitive background, we can identify a number of theoretical instruments that could support deployment of low-carbon technologies at scale; these instruments could apply to various technologies in different ways.[11]

1) **Public procurement** is one – somewhat crude – policy approach that could apply to several different sectors: setting standards for carbon efficiency whenever public authorities procure goods creates an immediate inroad for low-carbon products. Examples include a minimum share of low-carbon materials in public construction projects, the purchase of low-carbon vehicles or vehicles with embedded low-carbon materials, or mandates for the use of low-carbon fuels in public transport.

   In the EU, 14% of GDP can be attributed to government spending on goods and services.[12] So far, public procurement provisions in trade agreements have focused on ensuring equal access for trade partners' businesses.

   Public procurement can support innovation along different stages. An OECD study on the subject refers to Edquist and Zabala-Iturriagagoitia (2012), who identify three different types of public procurement use in innovation: the first is pre-commercial procurement for the R&D stage by supporting research through financial instruments; the second is 'adaptive public procurement of innovative solutions', where procurement is used to diffuse existing products already available on other markets; the third is 'developmental procurement', where procurement is specifically targeted at creating markets and diffusing new products and services.

   This latter type, i.e. developmental procurement, is most pertinent to transforming energy-intensive industries, as it creates exactly the market-creating impacts for zero-carbon products that are desirable. Public procurement of innovative solutions also has the effect of aggregating demand and thereby boosting economies of scale (OECD, 2016).[13]

   The EU already has a regulatory framework for 'green public procurement' that is based on procurement Directives and is compatible with provisions in the WTO and in other trade agreements ensuring equal access to procurement for trade partners.

[11] The DIW (2018) report "Filling Gaps in the policy package to decarbonise production and use of materials" proposes some similar options "to create markets for climate-friendly options".

[12] European Commission. (2016). Buying Green - A handbook on green public procurement, 3rd ed.

[13] Richard Baron (2016). The Role of Public Procurement in Low-carbon Innovation. OECD Background Paper.

2) **Public-private partnerships** (e.g. long-term contracts with public counterparties), such as capacity auctions or contracts for difference (CfDs), would be an explicit way to bridge the gap in prices between 'conventional' carbon-intensive products and more expensive low-carbon alternatives. Tenders and auctions allow for price discovery. Contracts for difference are already applied in the electricity sector in the UK[14] and for low-carbon fuels in California and work best for relatively homogenous products and commodities.

   The capacity auctions for renewables in the UK are the most prominent example of creating long-term contracts between suppliers of low-carbon technology and public bodies. The main role of the public body is to pay the difference between a reference price for a given product and the 'strike price' for the low-carbon alternative. Somewhat less known is that contracts for difference have also been employed in California, where low-carbon fuel projects were given long-term support through such contracts, with the strike prices being set through competitive reverse auctions (reverse, as it is suppliers competing for the buyer).[15]

   The benefits of using contracts for differences, compared to other support mechanisms such as per-unit subsidies or grants to cover capital costs, are their competitive nature in the form of competition *for* the market. This can reduce the costs. Beyond this cost-effectiveness advantage, it can also spur new production, not just benefitting already existing production; this is especially important if scaling-up is desired.[16]

3) **Industrial partnerships** (e.g. long-term contracts with private counterparties). While long-term contracts will often be backed by public counterparties, one can also envision long-term low-carbon contracts with private counterparties. The private counterparty may be another enterprise or consumers. This happens, for example, when energy-intensive companies conclude long-term power purchase agreements with renewable electricity generators. However, this case may well be special, in that renewable electricity is already competitive with conventional sources in many cases. In cases where there is a cost differential, it can theoretically be bridged by mandates or subsidies. The benefit of mandates is that they also allow companies that do not have a climate policy compliance obligation of their own to contribute to climate objectives by ensuring that demand for products shifts towards low-carbon alternatives. One current example is the procurement of renewable electricity facilitated by Guarantees of Origin (both for electricity as well as gas), although the current EU system may not be the best example to follow (see Jansen, 2018[17]).

[14] See also: http://www.ceps-ech.eu/publication/eu-power-sector-needs-long-term-price-signals.

[15] https://www.theicct.org/sites/default/files/publications/CfD-Cost-Benefit-Report_ICCT_Working-Paper_vF_23012017.pdf

[16] Ibid.

[17] CEPS Policy Insight on "Does the EU renewable energy sector still need a guarantees of origin market?"

An example of how long-term contracts can help deliver low-carbon technology to the marketplace is the partnership that led to the development of the first industrial power-to-gas plant in Germany. The synthetic gas created by the plant is destined for use in Audi's G-tron vehicle, which uses compressed natural gas as a fuel (which can be substituted by synthetic gas). For the consumer, the synthetic gas created is made available through a prepaid contract signed at the moment of purchase of the vehicle. This arrangement created cash flow for investment in the low-carbon technology while creating certainty for both producer and consumer.

In this case, the potential environmental benefits are twofold: the G-tron vehicle lowers CO_2 emissions in road transport (and helps a vehicle producer to comply with climate targets in that sector), while the development of a low-carbon synthetic fuel can benefit climate policy more broadly as power-to-gas technology can be part of decarbonisation strategies in various sectors. While this specific example may not necessarily be relevant in the context of achieving net zero targets, as the delivered technologies are still CO_2-emitting, the cooperative framework that led to the power-to-gas/syngas-vehicle development can just as well apply to zero-carbon technology.[18]

In terms of partners, long-term contracts can be a flexible construct that are easily combined with other forms of financing, including, if desired, public financing. It also allows for the inclusion of various research institutes and technology providers, which can further help diffuse learning effects. Keeping in mind the number of sectors that require deep reduction efforts over the coming decades, and the potential for sector integration[19] and interaction, private counterparty partnerships could help with market-making and technology proliferation in many energy-intensive industries.

4) **Carbon cost integration mechanisms**: such a mechanism introduces elements of regulatory flexibility, by transferring a liability, or a part thereof. The motivation to transfer is to reduce compliance costs while at the same time deploying low-carbon investments. This can be achieved if one party, which may have trouble achieving its climate compliance obligation due to high costs, finds another willing party to ensure compliance, at a lower cost. An example would be an agreement between vehicle manufacturers (which face high abatement costs) and fuel suppliers (where a market for low-carbon fuels could be created through the transfer of liability).

   This approach would introduce flexibility for obligated industries in a somewhat similar way to member states having flexibility in regard to the transfer of part of the annual emission allocation (AEA) under the Effort-Sharing framework.

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[18] A further examination of technology options is found in the CARISMA project D3.3. publication: (forthcoming; see the CARISMA project website).

[19] This describes the idea of interconnecting (integrating) the energy consuming sectors - buildings (heating and cooling), transport, and industry - with the power producing sector.

Such a mechanism requires having two obligated parties with an interest to cooperate. The general concept behind the mechanism is also akin to crediting systems, where abatement is externalised by an obligated party in return for fulfilment of a policy obligation. This kind of system can also lead to market creation for low-carbon products, provided that the abatement is concentrated in a single effort, not spread out.

One condition which needs to be fulfilled if there is to be an incentive for two parties to cooperate is that they should face different obligations, and as a result, different abatement costs. This means that alternative compliance mechanisms are most likely to work if they involve a sector included in the emissions trading system (where incidentally much diffusion of low-carbon technology innovation is required) and sectors outside the EU's carbon market that face other sector-specific policy obligations. Beyond the already mentioned transport sector, the largest emitting sector outside the emissions trading system is the buildings sector, with most of the emissions generated by heating.

A risk of alternative compliance mechanisms is that, just as with crediting mechanisms, they delay action in one particular sector, which can be argued is incompatible with long-term climate goals. In the long run, this is invariably true. Nevertheless, for shorter policy horizons, when reductions targets of 40-80% are to be met, alternative compliance could still help with the crucial deployment of low-carbon technology, while offering flexibility to sectors facing high abatement costs in the short run.

5) **Technology choice mechanism:** such a mechanism (proposed by Bruegel in 2015) would create a transparent framework and set of criteria to select which technologies would receive financial support to help their deployment. It represents an institutional approach, as it involves a public body, which would lead and coordinate efforts to boost low-carbon investments. To ensure competition, any technology provider could submit offers, which would then be compared against pre-agreed criteria. In its report, Bruegel further elaborated:

> "Governments should adopt choice mechanisms that are dynamic and adaptable, able to digest new information and optimise support in a quick, reliable and effective manner. Transparency is critical for the success of any choice mechanism, so that industry and consumers can form the right expectations about the direction of technology. (…) The first step in constructing a technology-choice mechanism is to define a transparent set of metrics and priorities (which can later be updated, as the demands of society and climate action change). The interest of governments is to support the optimal portfolio of technologies in terms of certain metrics – such as cost, timeline, efficiency, benefits and safety. These metrics and priorities should be as technology-neutral as possible, and should be the driving force behind the technology-choice mechanism." [20]

[20] Bruegel (2015), Making low-carbon technology support smarter.

Obviously, discussions on what metrics to adopt (and at what level) would be fraught with difficulty. Nevertheless, the new long-term roadmap for 2050, updated costs modelling, and the priorities of the European Commission that enters office in 2019 would go a long way in framing the cost, timeline, efficiency and benefits metrics.

5. What role for the EU emissions trading system?

Historically, EU climate policy has developed in such a way that there has always been a bifurcation between the emissions trading sectors and those not covered by the carbon market. At the same time, most sectors are affected by multiple EU and national policies, and the suggestions above would continue to add to the policy mix. While carbon pricing could impact different sectors in different ways, expanding coverage of emissions trading can help extend the disincentive effect to sectors currently covered by non-pricing policies. Another option is of course to impose a carbon price onto the non-emissions trading sectors.

The EU emissions trading system currently covers just over 40% of EU greenhouse gas emissions in the power and industrial sectors, a share that is coming down over time. Some major sectors are currently not included in the EU's carbon market, e.g. road transport and energy use for the heating and cooling of buildings. While inclusion in the emissions trading system may not result in the uptake of low-carbon products due to various market and non-market barriers, it always brings the benefit of revenue raising, as well as bringing emissions under a single cap, thereby improving long-term credibility. Additionally, the point of compliance could be changed for certain new sectors, to the mid- or upstream level, as was done with aviation.

For virtually each of the major non-ETS sectors, an example may be found in emissions trading systems in other parts of the world. In the California ETS, road transport emissions are indirectly covered through the inclusion of transport fuels, with the distributors of these fuels being the compliance entity. Unlike in the EU ETS, where the power sector is by a wide margin the largest sector in the system, transport takes this position within California, accounting for 37% of the state's total emissions.[21]

In China, some of the regional carbon market pilots, including in Beijing and Shanghai, include the heating sector, and the national emissions trading system that is set to be expanded over time will also include heating.[22] While there are legitimate concerns about asking very small emitters (i.e. households) to comply with an ETS, focusing on distributors or only on centralised (district) heating systems could also be an option. In New Zealand, agricultural emissions from livestock have been included, at least in so far as reporting goes. Due to the (purported) absence of technological abatement options for livestock emissions, New Zealand opted not to have a compliance obligation for this sector.[23] Nevertheless, there have been some

[21] https://www.c2es.org/content/california-cap-and-trade/

[22] https://icapcarbonaction.com/en/about-emissions-trading/scope-and-coverage

[23] https://icapcarbonaction.com/en/?option=com_etsmap&task=export&format=pdf&layout=list&systems[]=48

developments in tackling livestock emissions, and even in the absence of immediate abatement options[24], there are still the benefits of cap inclusion, which may spur abatement in other sectors as well as revenue raising and internalisation of the externality.

The expansion of carbon markets is fundamentally different from other options discussed in this paper, in that it is precisely the limitations of carbon pricing in creating markets for low-carbon products that spurred the examination of other policy tools that can aid the diffusion of low-carbon innovation. That notwithstanding, carbon pricing can still play an essential role in disincentivising carbon-intensive production as soon as low-carbon alternatives are competitive in the marketplace.[25] Moreover, a stronger price signal will be beneficial to bridge the differential between low-carbon and carbon-intensive products. The suggested market-making policies and (a possibly expanded) emissions trading system therefore work in tandem in the long run.

6. Carbon leakage safeguards

The mechanisms presented above will be suitable in different ways for different sectors. Some raise issues of WTO compatibility. With a focus on creating markets within the EU, the mechanisms say little on whether demand for low-carbon products in the long run will remain stable when markets beyond the EU come into view.

Taxation (at the border) or product standards are generally identified as suitable tools to achieve a level playing field. Taxation is seen as very difficult to be implemented from a political point of view and, currently, it is hard to see a credible political scenario for the implementation of border tax adjustments. As for product standards, little has been researched and written about them in the context of low-carbon products.

From the general literature, however, we can make additional remarks on the use of product standards and technical regulation. Currently, the EU's approach is to write technical regulation and product standards in parallel with EU standards within the International Standards Organisation (ISO) and International Electrotechnical Commission frameworks. This is done to ensure compatibility to the largest extent possible but also to keep transaction costs low. Writing technical standards can be very costly.

Product standards would be a safeguard against carbon leakage, in so far as they would prevent imports of carbon-intensive products that displace lower-carbon domestic production. They would not, however, be a competitiveness safeguard given the way that some carbon leakage risk mitigation measures are conceived, as they do not have a direct impact on costs for domestic producers, nor do they affect *how* non-EU producers may comply with the standard (as may be the case with border carbon adjustments).

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[24] The absence of significant abatement options has not deterred the EU from including intra-EU aviation in the EU ETS. While more efficient engines can reduce emissions, this incentive has always been there due to fuel costs.

[25] The role of the EU ETS price signal is discussed more in depth here: The EU ETS price may continue to be low for the foreseeable future – Should we care?

Many emerging economies share the EU approach to product standards in principle, even if this does not mean that the formulation of technical standards is uncontroversial in practice. An open question is how to link performance of CO_2, re-cycling or re-use etc. in the formulation of technical standards, notably in an international trade perspective.

Notwithstanding, there is a possibility – at least theoretically – that a group of countries organised in a 'Climate Club' could agree on joint technical standards, including carbon, material or energy efficiency indicators. Such a club would almost inevitably need to include China, given the importance of Asian and world trade. It would not necessarily include the US, which has another approach to standardisation.

There is a link to Plurilateral Agreements, for example such as the Environmental Goods Agreement, which will need to be further explored. These agreements can offer opportunities as well as create new risks, depending on how the standards policy is designed in detail. Aspects stemming from the treatment of process and production methods (PPMs) will also need to be further explored.

7. Conclusion

The narrative above describes the need for additional tools that help create a market for low-carbon products. Such bottom-up, demand-side measures are necessary even as instruments such as the rejuvenated European carbon market create increasingly strong disincentives for carbon-intensive production. We have listed a number of policy tools or mechanisms that can help achieve boost low-carbon investment at different layers of governance.

8. Key messages:

- There is a need for a set of tools that incentivise investment and help create markets in low-carbon products. These bottom-up incentive policies can work in tandem with already existing top-down, disincentive policies such as the EU's carbon market.
- Both the need for and the design of the investment mechanisms are affected by an external dimension of international competition and trade. Low-carbon industrial products should gain competitiveness with more carbon-intensive alternatives, irrespective of the origin of the latter.
- The tools described would be implemented at different levels of governance. Not all would necessarily have to be fully fledged EU policies; the member states may be better placed to implement the type of policies that have significant fiscal and distributional consequences. Some, like industrial partnerships, do not require new policy at all, other than to support and coordinate.