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# Building blocks for a climate-neutral European industrial sector

Policies to create markets for climate-friendly materials to boost EU global competitiveness and jobs – **OCTOBER 2019**

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The Climate Friendly Materials (CFM) Platform analyses the transformation of basic material production and use to achieve carbon neutrality by 2050. Its collective aim is to aid progress toward nationally-led industrial decarbonisation policy frameworks compatible with long-term EU strategy, and to capture the potential of a just and inclusive clean energy transformation.

Convened by Climate Strategies, the CFM Platform facilitates exchange between leading analysts, policymakers, industry leaders and other relevant stakeholders. It brings together leading think tanks and university research groups in Belgium, France, Germany, Hungary, the Netherlands, Poland, Spain and Sweden to enhance Europe's analytic understanding of how individual instruments fit together into a coherent policy package.

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# Building blocks for a climate-neutral European industrial sector

*Policies to create markets for climate-friendly materials to boost EU global competitiveness and jobs*

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# Executive summary

The science is clear: global warming must be limited to 1.5 degrees Celsius to avoid catastrophic impacts. The Paris Agreement recognises the 1.5C-limit as well. The production of basic materials – cement, iron and steel, paper, aluminium, as well as chemicals and petrochemicals – is one of the main contributors to climate change, accounting for approximately 25% of global $CO_2$ emissions, and around 16% of EU GHG emissions.

The evolution of European industry toward climate neutrality is at the centre of current EU-level policy discussions. It is part of the European Green Deal proposed by incoming European Commission President Ursula von der Leyen, and appears in similar industrial strategy discussions in Member States such as Sweden, Netherlands, Spain, UK, Germany and France. Scenarios from climate scientists, governments and industry consistently show that it is possible: the clean production, efficient use and recycling of basic materials can together contribute to climate neutrality. Meanwhile, companies in the European materials sector are increasingly committed to carbon neutrality by 2050.

However, science, political commitment and even the eagerness of the industry to modernise are not enough to realise European commitments under the Paris Agreement. Nor are innovation funds or a carbon price alone able to transform the materials market with the scale and speed necessary to make a credible business case for climate-friendly options. Today, new, climate friendly production technologies are significantly more expensive than the existing processes. Incentives for efficient material choices and use are lacking. Therefore, industry and investors require and demand **an integrated, coherent and comprehensive policy framework** to support the creation of markets for climate-friendly materials and discourage greenhouse gas-intensive materials. The climate-neutral production and use of basic materials will create opportunities for innovation and investment in an industry currently haunted by uncertainties relating to global economic development and trade wars. A smart transition to climate neutrality needs to ensure the long-term competitiveness of the sector, a long-term business case for each industrial sub-sector, and the creation of local jobs, contributing to a social, clean and competitive European economy.

The Climate Friendly Materials (CFM) Platform, which brings together leading researchers and policy advisors in Spain, France, Netherlands, Belgium, Sweden, Germany, Poland and Hungary convened by the research network Climate Strategies, presents a concrete package of policy instruments that creates economic incentives for private actors to pursue transformative investments aligned with Europe's climate-neutral objectives for 2050 while keeping them in business. The underlying report offers explanation as to why such a package allows heavy industry to shift to climate-friendly materials while European industrial competitiveness in a global market is supported, through stimulation of global emission reductions and prevention of relocation of carbon-intensive production to less stringent regions.

Together these policies will:

- Create markets for the industry to pursue transformative innovation and investments towards climate neutrality production and use of materials. Thus, they accelerate the commercialisation of innovative climate-friendly technologies and create the business case for climate-neutral industrial technologies and processes

- Contribute to a just industrial transition by preventing relocation of production and jobs to other regions that may currently implement less stringent climate policies. Thus, they provide a pragmatic alternative to border carbon adjustments currently discussed at EU level.

# An urgently needed policy package to create markets for climate-neutral materials

The policy package presented by the CFM Platform combines and strengthens existing policy instruments with additional options and deepens integration across instruments. The proposed combination of policy instruments has emerged as relevant and plausible in workshops pursued with policy and industrial stakeholders across EU Member States. It needs to be complemented by policies that inform and engage actors on climate-friendly options as well as innovation funding schemes and policies that support strategic infrastructure to precede and complement pull policies creating lead and long-term markets for climate-friendly options.

The package combines the following five elements:

1. **A Climate Contribution** as part of the **EU Emissions Trading System** is a charge on carbon-intensive materials sold for final use in Europe without differentiation by production process or location. The Climate Contribution is a pragmatic alternative to the Border Carbon Tax recently proposed by incoming European Commission President von der Leyen, creating incentives for choosing and using climate-friendly materials, facilitating the funding of low-carbon production processes and aligning effective carbon pricing with carbon leakage protection. It supports a socially just implementation as it offers the possibility to directly reimburse the additional income resulting from the charge to citizens as well as raising the funds for dire support needed for the industry sector.
2. **Project-based Carbon Contracts for Difference (CCfDs)** create lead markets for innovative low-carbon production processes and materials at national and European scale. CCfDs are contracts between national governments and companies developing a low-carbon project, which reimburses the difference between the yearly average price of EU Emissions Trading System emission allowances (EUAs) and an agreed strike price per ton of emission reduction, effectively ensuring a guaranteed carbon price for the project. Companies are obliged to pay back the previously received funding in case ETS prices exceed the strike price. CCfDs protect investors against risks of low carbon prices with sufficient credibility to secure (low-cost) financing.
3. **Contracts for Difference for Renewables (CfDs)** will hedge renewable energy investors against regulatory risks such as changes in the power market design and address market failures that limit the role of private long-term contracts for mitigating electricity price risks. They therefore create stable access to competitively priced clean electricity by reducing financing costs and the overall cost of delivering renewable power to consumers by around 30%. With most climate friendly production processes based on electricity or hydrogen, competitive supply of renewable power at sufficient scale is particularly relevant for the material sector.
4. **Green Public Procurement (GPP)** allows local, regional and national authorities to use their spending power when investing in infrastructure or buildings to create lead markets for low-carbon practices and design. With efficient material use, enhanced recycling, and use of new materials at the core of any strategy towards climate neutrality, GPP allows governments at all levels to create early market opportunities and facilitate coordination across the value chain to strengthen local innovation networks.
5. **Product Carbon Requirements** effectively ban products comprising materials produced with carbon-intensive processes from being sold in Europe. Once sufficient climate-friendly alternatives are available, they will accelerate the market uptake of climate-friendly materials and processes. The requirements are not for immediate implementation. Instead, the timely development of appropriate labelling schemes may prepare the ground and demonstrate the political willingness to proceed with the future implementation of binding product carbon requirements. This may increase and prioritize industrial investments dedicated to low-carbon production processes.

The implementation of these policy instruments would be carried out across all jurisdictional levels, from the inclusion of the Climate Contribution in the EU Emissions Trading Directive to Green Public Procurement at local level supported by EU innovation funds. Together they can create lead markets as well as longer-term perspectives for climate-neutral production and use of materials and provide a framework for private sector investment and innovation across Europe. **It is crucial that these policies are urgently considered at both EU and national level if the basic materials sector is to become climate-neutral by 2050.**

# Introduction

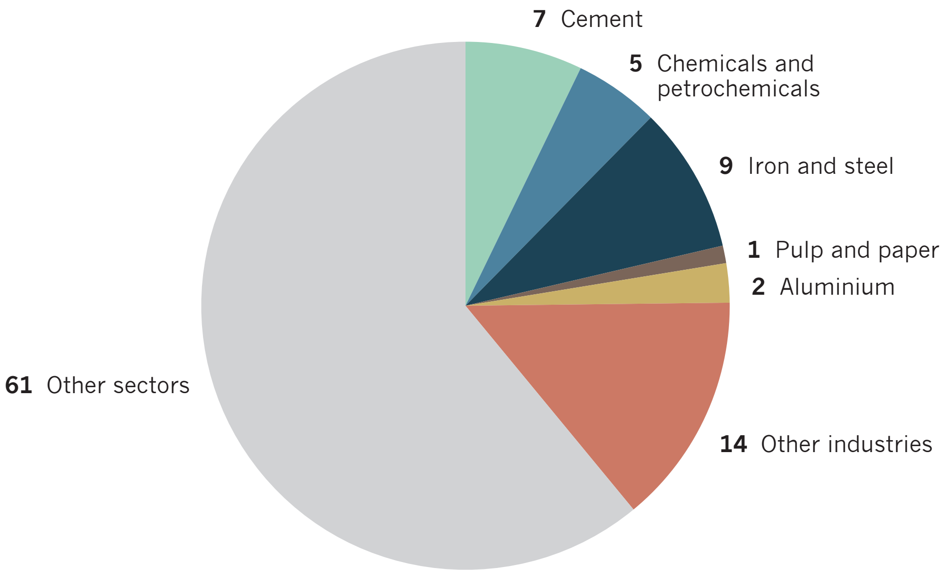
The production of basic materials - cement, iron and steel, paper and board, aluminium, as well as chemicals and petrochemicals - accounts for around 25% of global $CO_2$ emissions (Figure 1) and 16% of European GHG emissions[1]. The Paris Agreement's objective to limit the global temperature increase to 1.5 degrees Celsius can be achieved if and only if the materials sector achieves climate neutrality.

The feasibility of industry contributing to climate neutrality has been analysed in multiple studies.

- At the global level, the viability of the transition to a climate-neutral materials sector was demonstrated by the Intergovernmental Panel on Climate Change (IPCC 2018) as well as in the Beyond 2°C Scenario analysed by the International Energy Agency (IEA 2017).
- At the European level, in the long-term strategy of the European Commission different combinations of technology and behavioural options result in 95% emission reduction (EC 2018) while resource efficiency is an essential enabler (Material Economics 2018).
- At the national level, the Swedish government must, under the Swedish Climate Act, present a climate policy action plan every four years to describe how the Swedish target of zero net GHG emissions will be achieved by 2045 (Naturvårdsverket 2019). France has a national low-carbon strategy project (MTES 2018), and Germany's Federation of Industry developed 80% and 95% emission reduction scenarios (BDI 2018). In the Netherlands barriers for the decarbonisation of the chemical sector (Janipour et al. 2020) have been assessed and roadmaps for various industries exist (VNCI 2018, DNVGL 2018), like also in Spain (Economics for Energy 2017) and Poland (WiseEuropa 2019).

**FIGURE 1**

Percentage contribution of various basic materials in global $CO_2$ emissions (2014)




*Source: DIW calculations based on IEA ETP (2017)*

- At the sectoral level, all major energy intensive industries have developed and published low-carbon roadmaps, projecting greenhouse gas emission reductions of 80% to 95% compared to 1990 levels (Wyns et al. 2018a). Studies on industrial clusters (e.g. harbour areas) provide further more granular insight (Wyns et al. 2018b).
- At the company level, firms like Arcelor Mittal, HeidelbergCement and Thyssenkrupp AG have set their emission reduction targets and have outlined their strategy to achieve this objective[2].

What all the studies consistently emphasise is the need for a strong policy framework to allow for private sector innovation and investment at the required scale for a transition to climate neutrality. While the level of detailed understanding and implementation of the required policies varies across sectors and countries, many of the relevant policies for the materials industry have been discussed only as part of long lists of potential policy instruments (Neuhoff et al. 2018a, Chiappinelli et al. 2019, Wyns et al. 2019).

To further structure this discussion, it is helpful to think of three categories of policies to support actors in different decision processes to realize the portfolio of mitigation options (see Grubb et. al 2014): First, policies and programs to provide information and engage actors with resource and climate friendly options. Second, policy instruments that create markets for commercialization of and shift to climate friendly options, and third, public support for strategic investment in innovation and infrastructure.

This report presents a package of policy instruments to create markets for the commercialisation of and shift toward climate-friendly options. It is based on analysis of individual policy instruments in combination with insights that have emerged in workshops with policy makers and industrial stakeholders held by the project partners of the Climate Friendly Materials (CFM) Platform over the last year.

Together the policies create economic incentives for transforming the materials industry and boosting European competitiveness and employment while preventing potential negative distributional impacts. The proposed policy package provides incentives to support a portfolio of mitigation options to advance the decarbonisation of the material sector in line with the 2050 targets.

# Technological mitigation options to advance the climate neutrality of basic materials

The transformation of the materials sector toward climate neutrality can be achieved by pursuing and combining a number of mitigation options[3]:

## 1. Share, repair and reuse

Aims at making the use of products and of the embodied materials more sustainable. For example, shared rather than individual ownership of vehicles and buildings, which together represent the largest portion of European demand for steel, cement, and aluminium, would enable a much more productive use of these currently underused assets (Materials Economics 2018). Products that last longer and are more easily repaired reduce the need for new materials.

## 2. Material efficiency

Improved product design can provide the same services with less, but better tailored, higher value materials. For example, lightweight design (for example of steel beams used for construction and of aluminium alloys used for car bodies) can reduce the need for steel and aluminium by 25% to 30% (Carruth et al. 2011). Further efficiency gains are available through the reduction of material losses during production processes and improved yield. For example, an improvement in material efficiency could reduce emissions and material costs in automobile manufacturing by 56% to 70% (Horton and Allwood 2017).

## 3. Material substitution

Substitution of materials with alternatives characterised by lower lifecycle emissions can allow for further emissions savings. For example, wood-based construction components can have much lower $CO_2$ intensity than steel and concrete (Materials Economics, 2018) and clinker substitutes are already being developed (IEA 2018). Price and environmental performance of materials will determine whether they gain or lose overall market share.

## 4. Low-carbon production processes

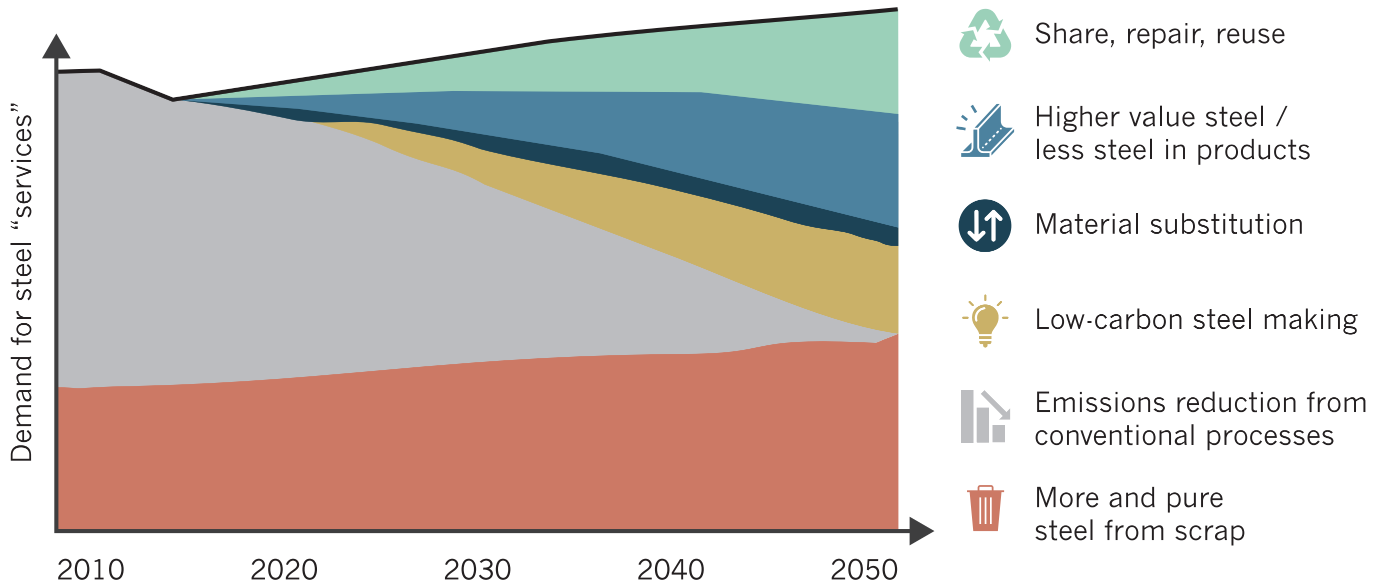
While, in the short-term, incremental efficiency improvements of conventional production processes may ensure minor emission reductions, conventional processes need to be replaced with “breakthrough” technologies (Gerres et al. 2019a). The introduction of production processes based on renewable energy (electrolysis or directly hydrogen-produced from renewable energies) or supported by carbon capture and sequestration or use can avoid or absorb most carbon emissions linked to the primary production of materials (Philibert/IEA 2017, Bataille et al. 2018).

## 5. More and purer recycling

Recycling rates still vary across applications and material types. For example, 80% to 90% of end-of-life steel is collected for recycling, while only 18% of all plastics are recovered (Material Economics 2018). Improvements depend on product design, suitable dismantling and separate collection of material to allow materials to be recycled and reused for their original applications, rather than down-cycled to lower material quality. For steel, a major concern is its contamination with copper and other elements, which reduces the quality of recycled steel. In the case of oil-based plastic products, certain types of polymers are suitable for mechanical recycling – to be used for the same function or to be re-made into the same material (mainly packaging plastics).

**FIGURE 2**

How a portfolio of mitigation options  can enable the decarbonisation of the European steel sector in line with 2050 targets




*Source: DIW's illustration (no numerical simulation)*

Figure 2 illustrates exemplary for the steel sector how the portfolio of mitigation options can align the materials sectors with the objectives of the Paris Agreement. Conventional material production will be phased out. As low-carbon production processes depend on the (limited) availability of renewable electricity or $CO_2$ storage sites, the overall volume of primary production will need to decline – and it will therefore be crucial to exploit the full potential of the mitigation options related to the use and recycling of materials. The enhanced material efficiency can also help to compensate increased production costs associated with climate friendly production processes.

# A policy package that creates markets for the climate-friendly production and use of basic materials

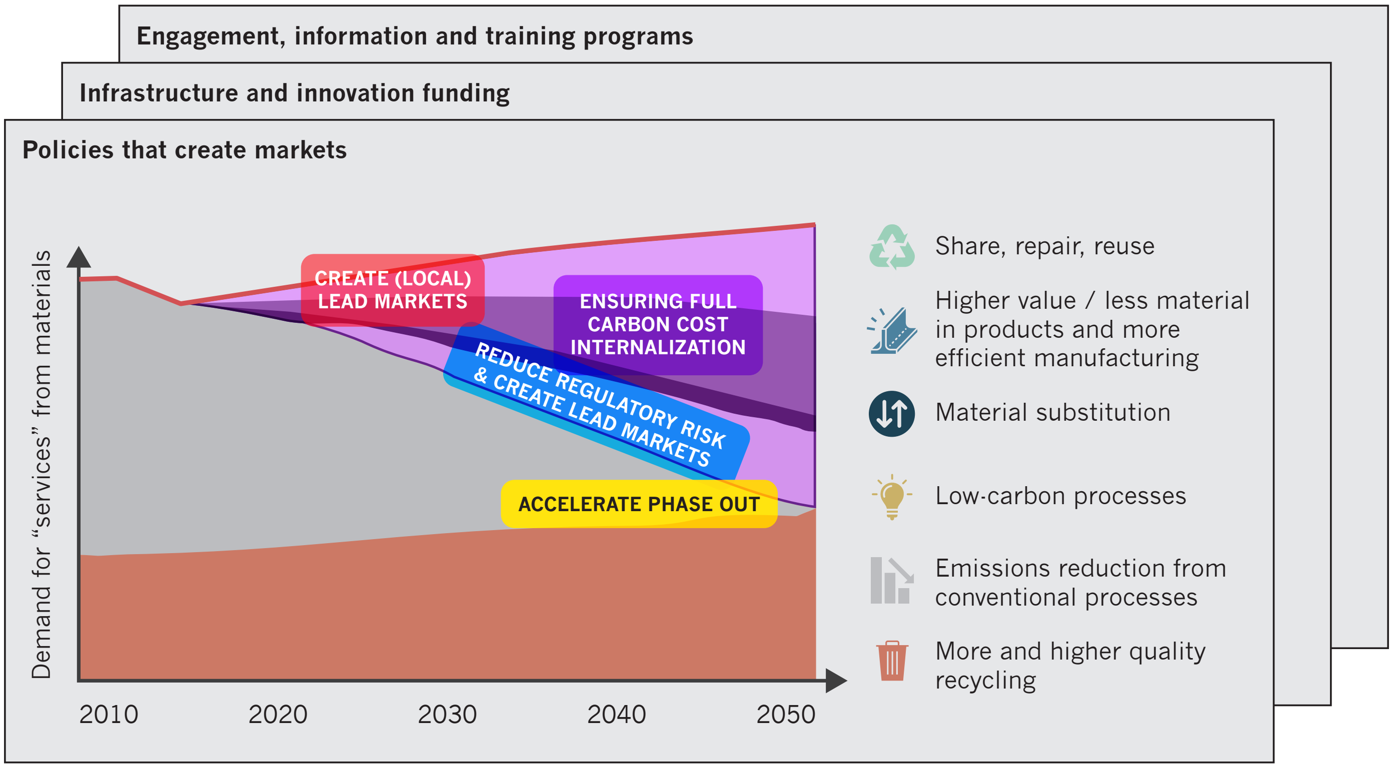
The implementation of the mitigation options reviewed above requires the interplay and coordination of various policies. The role and importance of each individual policy will change over time given that different actors need to be targeted with the appropriate policies over all transition phases.

This report focuses on the policies that may be necessary to create markets for the climate-friendly production and use of basic materials. These policies involve the following elements:

- The full internalisation of carbon cost across the value chain, currently impeded by free allowance allocation to materials producers in the EU Emissions Trading System and international tradability of materials. Raising the carbon price to improve the economic viability of low-carbon options by itself is not sufficient.
- The creation of lead markets and the reduction of regulatory risk for capital-intensive, innovative climate-friendly production processes and alternative materials. This will be necessary as the price of carbon will

## FIGURE 3

Policy needs to provide incentives to support the portfolio of mitigation options to advance the decarbonisation of the materials sector in line with 2050 targets




*Source: DIW's illustration (no numerical simulation)* increase only gradually in the EU Emissions Trading System and will be prone to regulatory uncertainty.

- The creation of lead markets for climate friendly practices and products for efficient use of materials.
- The acceleration of the phase-out of conventional options once climate-friendly options have been more widely adopted in the market.

These elements need to be complemented with additional policies which are not the focus of this report. These include policies that inform and engage actors on climate-friendly options as well as innovation funding schemes and policies that support strategic infrastructure to precede and complement pull policies creating lead and long-term markets for climate-friendly options.

## The policy package proposed by the CFM Platform contains the following five instruments for transforming the basic materials sector:

### 1. The **Climate Contribution** as part of the EU Emissions Trading System

Carbon costs have to be fully internalised along the entire value chain to improve the economic viability of all low-carbon options relative to conventional ones and thus create markets for investment in low-carbon production and use of materials. However, experience with the EU Emissions Trading System so far has shown that carbon costs are only partially internalised in material prices due to international trade with regions that do not create full incentives for carbon cost internalisation. To avoid a cost disadvantage for production in Europe that could trigger the relocation of production rather than reducing global emissions, allowances are provided for free to materials producers. Material producers anticipate that current production volumes will impact free allowance allocation in future years and therefore have an incentive to increase production levels to receive additional allowances in future years. This reduces product prices and further undermines full carbon cost internalisation.

Without full internalisation of carbon cost along the value chain, however, there is little to no incentive for basic materials producers to use and invest in less carbon-intensive production processes or to replace them with more climate-friendly alternatives. At the same time, if the carbon cost of materials, and therefore also the cost of climate-friendly production, is not payed for by the users of materials, there is little economic perspective for the large-scale use of climate-friendly production processes and alternative materials (see Wood et al. 2019).

The failure to achieve full carbon cost internalisation as well as concerns about potential windfall profits have resulted in persistent pressure from an environmental and fiscal perspective to reduce the level of free allowance allocation, including to basic material producers. This creates uncertainty about the future development of free allowance allocation as a carbon leakage protection mechanism. This in turn has motivated continuous opposition from various stakeholder groups against a strong EU Emissions Trading System.

An opportunity to overcome the current stalemate in the debate on free allowance allocation has emerged with the announcement of incoming Commission President von der Leyen to consider a Border Carbon Tax, which indicates the political will to explore new perspectives. Two options are currently being discussed:

As one option, Border Carbon Adjustments (BCA) are discussed for the carbon price. Imports are charged (for example based on the weight of material in the product) and exports are potentially reimbursed (see e.g., Pirlot 2017). Combined with a shift from free allocation to the full auctioning of permits, in principle BCAs would achieve full carbon cost internalisation. The challenging international politics of a border-related approach matches the technical complexities to design a mechanism that can stand up to future WTO challenges. For BCAs to contribute to a credible low-carbon investment framework, it is imperative that they are not perceived as another ad-hoc imposed tariff level in current trade disputes, but rather as a long-term option. This requires a high level of international cooperation and is likely to imply a lengthy implementation process.

An alternative option is to include a Climate Contribution as part of the EU Emissions Trading System (sometimes also referred to as Inclusion of Consumption in the EU Emissions Trading System).

A Climate Contribution applies to domestic and imported material sold for final use in Europe. It is based on the carbon cost of the production of the material with a conventional process according to EU Emissions Trading System benchmarks. The internalization of carbon costs incentivizes the manufacturing and construction industry to use carbon intensive materials more efficiently and to shift to alternative materials with lower carbon content. Incentives for the climate-friendly production of basic materials would continue to be provided through the EU Emissions Trading System. The combination ensures full carbon cost internalisation even with continued free allowance allocation as a carbon leakage protection mechanism (see Neuhoff et al. 2016).

A Climate Contribution would be preferable to BCA for a number of reasons. First, it is uncontroversial from a trade-law perspective, as it is a consumption charge unrelated to the production process or location. Second, a Climate Contribution is only due at release for consumption, and does therefore not require reimbursements for exports as often proposed under BCA. This reduces fraud risk and thus allows for a leaner administrative implementation. Third, initial implementation at national level is possible and can allow for early exploration and implementation. Fourth, even if some of the revenues are used to fund innovation and climate action, a large share of the revenues could be reimbursed on a per capita basis in line with current practices in carbon pricing (e.g. Switzerland, Canada). The Climate Contribution therefore benefits less well-off households with inherently less consumption of carbon-intensive materials as well as households with climate-friendly purchasing choices (see Annex 1 for details).

## 2. Project-based Carbon Contracts for Difference (CCfDs)

The carbon price by itself is unlikely to create sufficient incentives. First, the level of carbon price will only be gradually increasing in the EU Emissions Trading System. Second, regulatory uncertainty constrains access to and increases the cost of capital for investment in climate-friendly production processes. Therefore, in particular for capital-intensive innovative low-carbon processes and alternative materials, carbon pricing needs to be complemented in the short term by other policies that create lead markets and hedge against regulatory risk, as well as trigger incentives in the value chain.

Project-based Carbon Contracts for Difference (CCfDs) have the potential to achieve these objectives. They are contracts signed between national governments and a low-carbon projects which pay out the difference between the yearly average price of EU Emissions Trading System emission allowances (EUAs) and an agreed strike price per ton of emission reduction, effectively ensuring a guaranteed carbon price for the project. In turn, projects are obliged to pay back the difference if carbon prices exceed the strike price. CCfDs can help creating lead markets for low-carbon processes and substitute materials, as well as dealing with the uncertainty of capital-intensive investments (Richstein 2017 and Sartor and Bataille 2019). CCfDs would only be made available for projects aligned with carbon neutrality objectives and could complement national and EU innovation funding. They ensure that incremental operating costs are covered and projects continue to operate should EU Emissions Trading System allowance prices decline. They also help to lower financing costs by stabilising revenue streams for the asset owner, so that commercialisation becomes a viable economic option (See Annex 2 for details).

## 3. Contracts for Difference for Renewables (CfDs)

Climate-friendly production processes for energy-intensive industries will also require the cost-competitive supply of large volumes of low-carbon electricity. With wind- and solar power often seen as the backbone of future energy supply, a variety of enabling elements such as planning regimes, grid access and system integration continue to require policy attention. Public policy is also important for facilitating access to and reducing the costs of project financing. One option to address this need are publicly guaranteed Contracts for Difference for Renewables (CfDs). These are contracts which remunerate renewable energy operators with the difference to an agreed strike price whenever wholesale electricity is lower than the strike price, while operators must pay back the difference when market values lie above the strike price (see May et al. 2018 and Neuhoff et al. 2018b). Publicly guaranteed CfDs are an established instrument and tendered in countries like the UK. They hedge renewable energy investors against regulatory risks like changes in the power market design and address market failures that limit the role of private long-term contracts for mitigating electricity price risks. In this way they reduce financing costs and the overall cost of delivering renewable power to consumers by around 30% (see Annex 3 for details). Other competitive support systems may also be considered.

## 4. Green Public Procurement (GPP)

Lead markets for climate-friendly practices and product design involving the use of materials are essential for many of the mitigation options. Green Public Procurement (GPP) can play a leading role in this. Climate-friendly GPP practices include significant functional carbon requirements or shadow carbon prices that increase the economic viability of efficient use of and substitution of materials in public contracts, and/or require them as part of specific technical requirements. In this way, GPP allows national and local authorities to create lead markets for climate-friendly product design, material choice, efficient manufacturing and usage patterns (see e.g., Chiappinelli and Zipperer 2017). Governments at all levels can address emissions embodied in infrastructure, buildings and carbon systems that they procure and therefore respond to local initiatives as well as national and European targets (see Annex 4 for details). In order to provide sufficient incentives in the value chain, GPP should be complemented by the inclusion of energy-intensive materials in national and European circular economy policies (see e.g., Wyns et al. 2019).

## 5. Product Carbon Requirements

Finally, in the longer term there may be a need for instruments that accelerate the phase-out of conventional options once climate-friendly options have been more widely adopted in the market. A “sunset clause” for high-carbon production processes and products could define the timeline for public and private actors and help governments and firms to focus on ensuring a timely transition toward sustainable practices, following the experiences of the coal phase-out.

For this purpose governments may consider Product Carbon Requirements to ban the sale of products comprising materials produced with carbon-intensive processes. This will however require that sufficient clean production capacity is available, probably not before the mid 2030s, and would therefore need to be combined with support measures for the phase-in of innovative low-carbon technologies. The future possibility of such product requirements would strengthen the signal that business-as-usual technologies are no longer a viable option and thus trigger climate-friendly (re-) investment in industrial capital. Gradual phase-in could potentially allow for coordinated implementation across trading partners, facilitating tracking and compliance, and limiting international trade frictions (see Annex 5 for details).

There are a number of reasons why the policy instruments fit together as a package:

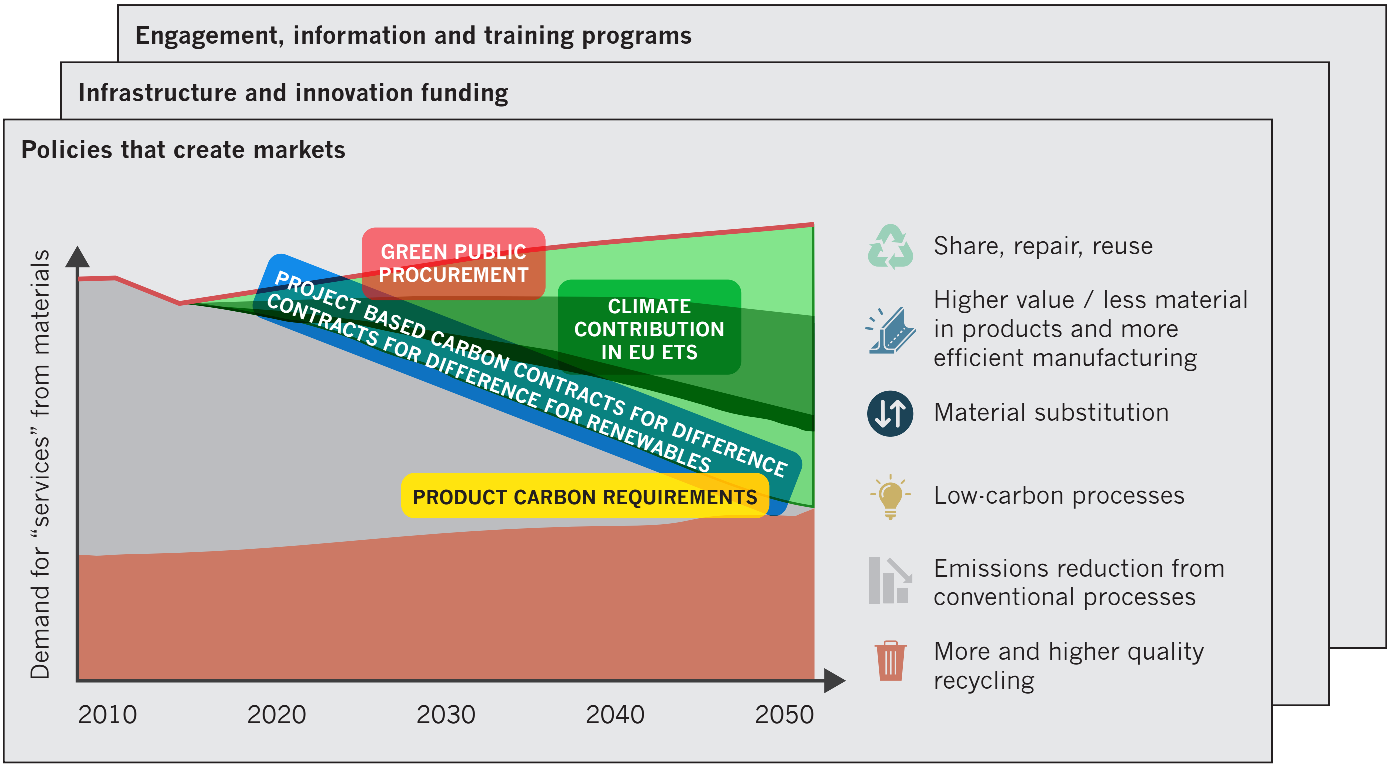
- They **complement push incentives** provided by innovation funding schemes with pull policy instruments, which are needed to provide comprehensive incentives of sufficient scale for investment in climate-friendly options.
- They **target all actors** (policy makers, public authorities, private consumers, material producers, constructors and product manufacturers) who are in the position to take actions to harness the different mitigation options through various decisions modes and at different points in time. For example, CCfDs promote breakthrough innovation and cover the blind spots of GPPs. GPPs and Product Carbon Requirements help reinforce incentives for breakthrough technologies at broader scale as innovations are proven. Climate Contributions strengthen the carbon price signal along the value chain while enhancing confidence in carbon leakage protection measures. In this way they support the roll-out of innovative options created by CCfDs and GPPs for the entire sector.
- Instruments in the package **provide financial hedging and regulatory commitment**. By stabilising the revenue streams of climate-friendly production processes and new materials, CCfDs and CfDs for renewables reduce financing costs and the need for innovation funding. They also address regulatory risk and anticipate long-term carbon price expectations. Finally, some instruments in the package can create resources for other instruments in the package. For example, the Climate Contribution can fund the incremental cost of GPPs and CCfDs in the short term.

The policy package just described has the potential to create the business case for transforming the basic materials sector. The question remains of how to translate long-term decarbonisation objectives into tangible implementation and what the implications are for short-term action. Public and private governance frameworks will be essential toward reaching these aims. In particular the following elements are likely to play a key role:

- The **EU 2030 governance structure** i.e. the National Energy and Climate Plans (NECPs) will help outline the pathways, set timelines for the development of national plans, and review these plans against mid- and long-term policy objectives.
- **EU and national climate action laws** will ensure the effective monitoring of progress against policy objectives, create lead indicators to ensure transparency for the public on policy achievements, and allocate responsibility for policy implementation and management, for example with relevant line ministries.
- An **EU circular economy strategy** and supporting policy focusing on energy-intensive materials will be important to create comprehensive incentives for high-quality recycling and resource efficiency.
- **Sustainable Finance frameworks** will be important for creating transparency along the entire financial value chain regarding the alignment of company strategies and actions with long-term targets and to internalise climate risks in financing choices.

## FIGURE 4

How the suggested policy package can create markets for the decarbonisation of the materials sector in line with 2050 targets




*Source: DIW's illustration (no numerical simulation)*

# Conclusion

The decarbonisation of the European basic materials sector in line with 2050 targets requires a mix of policy solutions on both the demand and supply side to address various market and non-market barriers and horizons of deployment. This calls for an integrated and comprehensive policy package to match this diversified action.

The policy mix may build on improving existing policy instruments, whether these are revised current norms and standards, or additions that are integrated with existing measures. A combination of five instruments has emerged as relevant and plausible in analysis and workshops with policy and industrial stakeholders held by the partners of the CFM Platform.

A Climate Contribution as part of the EU Emissions Trading System ensures full carbon cost internalisation and creates market opportunities for low-carbon options, while enhancing the credibility of current carbon leakage protection mechanisms. Project-based Carbon Contracts for Difference create lead markets for innovative low-carbon production processes and materials and hedge against regulatory risk. Contracts for Difference for Renewables address regulatory risk and reduce financing costs for renewables, to enable a shift to electricity- and hydrogen-based low-carbon technologies.

Green Public Procurement creates local lead markets for efficiency in material use. Product Carbon Requirements will eventualy allow governments to ban the sale of products comprising materials produced with carbon-intensive processes. Firms that anticipate the possibility of a future product carbon requirement will increase their prioritisation of and investment in low-carbon production processes to maintain their 'license to operate'.

Together these instruments can create lead markets as well as longer-term perspectives for the climate-neutral production and use of materials. They will help seize the transformative potential of the materials industry and make significant strides toward meeting Paris Agreement objectives. A renewed and modernised European materials industry will support a dynamic, forward-looking European economy as well as the livelihoods of European citizens.

# Annex 1: Climate Contribution for carbon-intensive materials in the EU Emissions Trading System

*Based on work by Manuel Haussner, Roland Ismer and Karsten Neuhoff*

A strong and clear regulatory framework is necessary for manufacturers and users of basic materials to switch to climate-friendly options. For the following three reasons, the EU Emissions Trading System can take up an important steering function in this process.

First, the European market is large enough to be relevant for globally active companies. Second, nowadays, the European Union has more credibility in many areas when it comes to effective climate protection laws than individual Member States, as shown by the Eco-design Directive or the European Renewable Energy Directive. This is important for long-term corporate decisions on innovation and investment. The credible announcement that carbon-intensive options have no long-term perspective further enhances companies' dedication to climate-friendly approaches. Third, uniform regulations prevent competitive distortion within the EU.

Experience with the EU-ETS since its implementation in 2005 has shown that the carbon cost is only partially internalized in material prices (Ritz and Neuhoff 2019). This is due to international trade or tradability of materials with regions with lower carbon prices. Concerns that basic materials manufacturers will shift their production to foreign locations due to additional carbon costs in Europe (carbon leakage risk) also motivated governments to allocate allowances for free as carbon leakage protection mechanism, further undermining full carbon cost internalisation[4]. Without internalisation of carbon costs in the material price, there is little to no incentive for manufacturing industry and construction sector to use less carbon-intensive materials or to replace them with innovative and climate-friendly materials. At the same time, if carbon costs - and therefore also the cost of low-carbon production processes - are not internalised in material prices, there is no business case for large-scale use of and thus incentives for innovation in climate-friendly production processes.

To tackle this problem, the EU-ETS should be supplemented by a Climate Contribution on the use of carbon-intensive basic materials (previously also referred to as Inclusion of Consumption in the EU Emissions Trading System, Neuhoff et al. 2016). This refers to a charge paid by the consumers of industrial products, based on the benchmark level of carbon intensity of the basic materials contained in the products.

A combination of two reforms would make it possible to implement a Climate Contribution. First, the allocation of free emission certificates to industrial companies should be based on benchmarks multiplied with the current production volume ("output-based allocation") instead of benchmarks multiplied with more historic production volumes in combination with activity level requirements. This would mean that companies would only have to purchase emission certificates for emissions exceeding the emission benchmark level. Companies that emit less than the benchmark would benefit from selling excess certificates – but only for emission savings for realized material production. Thus, at the level of the benchmark, there is no internalization of carbon cost in material prices (so called "pass-through" is fully muted).

Second, the Climate Contribution would be charged for the use of basic materials. It would be equivalent to the value of the certificates per ton of basic materials that are allocated for free as part of the EU-ETS. For example, if two certificates (at 30 euros each) were allocated per ton of steel (efficiency benchmark), and one ton of steel is processed to produce one car, the Climate Contribution for the car would amount to 60 euros. Unlike under current EU-ETS regulation, the Climate Contribution would be added to the price of the end product, providing an incentive for the downstream industry to use carbon-intensive basic materials more efficiently or replace them with climate-friendly alternatives. As is the case with other consumption charges, the Climate Contribution would be applied to imported basic materials and products, while exports would be excluded. This would secure a level playing field with the rest of the world, both for material producers and manufacturing industry. Designing the Climate Contribution as a consumption charge would also ensure compliance with World Trade Organisation rules and reduce administrative complexity.

Part of the revenues of the Climate Contribution could finance climate protection measures, while most of the available funds would be used to reimburse all citizens on a simple per capita basis. The Climate Contribution would have a progressive component, since poorer households that consume fewer basic materials on average would pay a lower contribution than wealthier households but would receive the same amount of reimbursement.

Supplementing the EU-ETS with a Climate Contribution ensures full carbon cost internalization for and restore the intended steering effect towards more climate-friendly investments along the entire value chain (see Pollitt et al. 2019). It does however not create incentives for climate friendly production processes outside of Europe. The philosophy of the Paris Climate Agreement suggests that such incentives should emerge from national policies in other countries and might be backed with for example international financial cooperation.

At the same time, the Climate Contribution, as a complement to benchmark and output based free allowance allocation, aligns full carbon cost internalisation with effective carbon leakage protection and can put an end to the persistent debates on the level of free allowance allocation. Thus it contributes to a long-term stable policy framework that is necessary for investment in climate-friendly production processes and practices. This mechanism can and should be included in the EU Emissions Trading Directive within the upcoming review processes to strengthen its climate protection effectiveness (Ismer and Haussner 2016).

# Annex 2:
# Project-based Carbon Contracts for Difference

*Based on work by Jörn Richstein*

## Introduction and what to learn from renewable policy

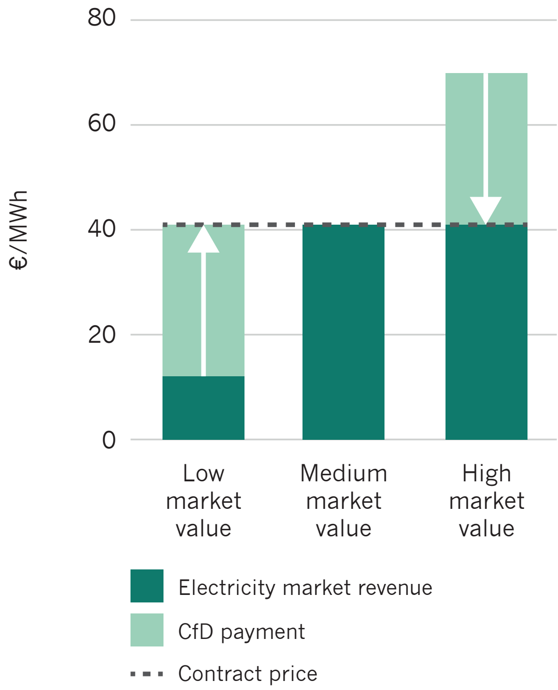
Due to the moderate price level of the EU Emissions Trading System and the uncertain price development, incentives for significant investments in innovative climate-friendly options are currently insufficient. Experiences from policies for wind- and solar energy can provide important lessons in this context.

While renewable technologies already have become competitive in terms of production costs, they are still affected by uncertainty of revenues. An efficient solution to address this financing challenge has been provided by publicly guaranteed Contracts for Difference for Renewables (see Annex 3), which have been implemented in the UK since 2014 and in France since 2017. These contracts guarantee a stable power price to producers by filling up missing revenue from power markets in case of low prices but also entail an obligation to pay back money when power market prices exceed the agreed contract price (also referred to as the "strike price"). Due to the more stable revenues, financing costs are lowered, reducing the overall cost of delivering wind and solar energy by around 30%, as several analyses have shown (see Aurora Energy Research 2018, Hering 2019 and May and Neuhoff 2017). Additional advantages of such contracts are that they enable competition between small and large actors and, as compared to privately organised Power Purchasing Agreements (PPAs), avoid the downgrading of counter-parties due to uncovered liabilities in terms of long-term contracts on their books.

Learning from best practices in renewable policy, national governments could offer investors in innovative climate-friendly technologies and practices, project specific long-term Carbon Contracts for Difference (CCfDs) for emission reductions on the EU emissions allowance price.

**FIGURE 5**

Example of CfD in the electricity market




*Source: DIW illustration*

These contracts should be financed by the consumers of materials via levying a Climate Contribution (see Annex 1) that also addresses carbon leakage concerns and restores carbon prices throughout the value chain.

CCfDs would guarantee investors a fixed price for each ton of emissions reductions below today's emission benchmark of the current best available technology at a price level that reflects expected $CO_2$ price developments during a contract duration extending up to 20 years of, for example, 50 Euro/ tonCO2. The innovativeness in reaching deep emissions reductions of these projects could be ensured by granting the carbon contracts only to those projects that are compatible with the net climate neutrality objective, as for example assessed for the provision of innovation support e.g. through the EU Emissions Trading System Innovation Fund or national equivalents. Thus, CCfDs could for example be automatically awarded to projects winning in tenders for the EU Innovation fund, or national innovation funds, which would have the benefits of having a single innovativeness assessment and allowing coordination between the two instruments. Alternatively, or at a later stage, CCfDs could be tendered competitively either on a sector basis, or even fostering competition between different materials.

If investors in climate-friendly production use the contract, they can lock in carbon benefits at a fixed price. They are, however, not required to sign such a contract if they expect that the carbon price developments during the contract duration would exceed the contract price and if they would not require the revenue stability from emissions reductions.

The key benefits of CCfDs as a policy instrument for supporting innovative projects are 1) increased stability of revenues, lowering the financing cost for low-carbon investment projects, and resulting in a reduced need for innovation funding (Richstein 2017), 2) potential for recuperation of costs for governments as the carbon price rises, 3) full incentives for investment and operation, as revenues are linked to delivered emission reductions with integration in the EU Emissions Trading System and its monitoring requirements, 4) clear signaling of governments' commitment to long-term policy goals (Chiappinelli and Neuhoff 2017) and 5) confidence that clean production technologies can be operated rather than stand still should carbon prices not reach sufficient levels.

## How do carbon contracts work and lower financing costs?

The CCfD pays out the difference between the yearly average auction price of emissions allowances (EUAs) and the contract price, thus effectively ensuring a guaranteed carbon price for the project[5]. In exchange for this insurance, investors are liable for payment if the carbon price exceeds the contract's strike price.

Emissions reductions are calculated by subtracting the verified emissions of an installation from the emissions that would have been expected with a conventional technology calculated by multiplying production volumes with the EU Emissions Trading System benchmark of emissions of the best available technology per ton of material production at the time of investment.

### Numerical example with free allocation

*(Without free allocation linked to production and without international trade, in equilibrium the product price would increase by the carbon cost, having an equivalent effect)*

- Benchmark: 1 $t_{CO2}/t_{Product}$
- Innovative project: 0.1 $t_{CO2}/t_{Product}$
- Project signs CCfD at 50 €/$t_{CO2}$

**Low price example:** Revenue per ton production of product at spot ETS price of 20 €/$t_{CO2}$ :

- Allocation: 20 €/$t_{CO2}$ * (1 $t_{CO2}/t_{Product}$ free allocation – 0.1 $t_{CO2}/t_{Product}$ emissions from process)
  = 18 €/t
- CCfD: (50-20) €/$t_{CO2}$ * 0.9 $t_{CO2}/t_{Product}$
  = 27 €/$t_{Product}$
- Total: 45 €/$t_{Product}$

**High price example:** Revenue per ton production of product at spot ETS price of 70 €/$t_{CO2}$ :

- Allocation: 70 €/$t_{CO2}$ * 0.9 $t_{CO2}$/tProduct
- CCfD: (50-70) €/$t_{CO2}$ * 0.9 $t_{CO2}/t_{Product}$
  = -18 €/$t_{Product}$

## Financing example and effect on the required carbon price level

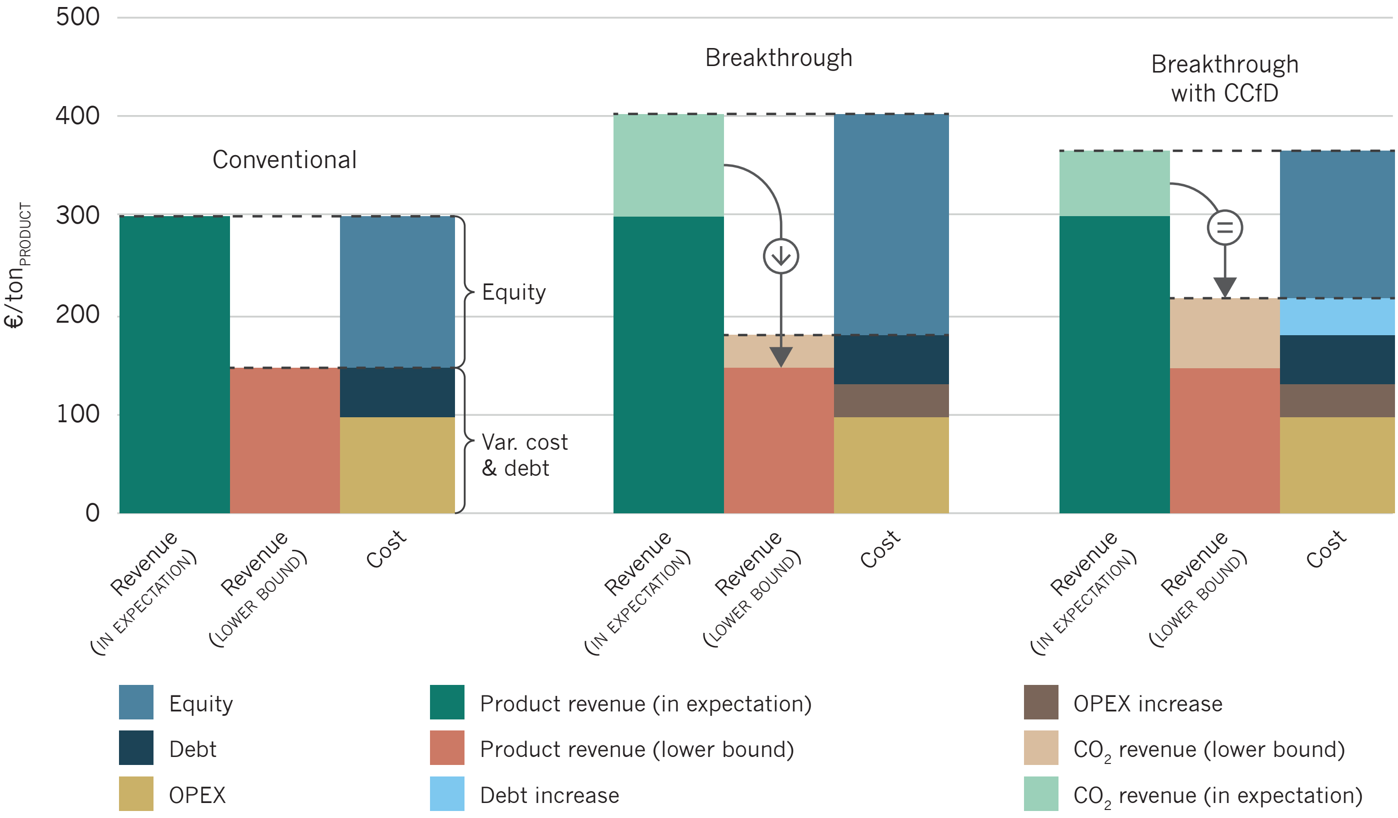
One major advantage of CCfDs is the reduction of financing costs, which results in lower levels of required $CO_2$ prices to realise the investments in clean technologies. An illustrative example is described in the following and depicted in Figure 6 where three investment choices are compared for an (abstract): i) conventional technology, ii) clean breakthrough technology financed without CCfD and iii) the same clean breakthrough technology financed with a CCfD. In line with expectations by several producers, the investment is structured as project finance[6]: a new company is set up to realise the investment. The project receives its capital from shareholders in the form of equity and from creditors in the form of debt. Debt is significantly cheaper than equity (the interest rate is lower than the required rate of return for equity). Creditors like banks or bond markets, require high levels of confidence that debt is paid back. Hence debt has priority in being served from revenues and is usually dimensioned such that it can be served in almost all instances even of worst-case scenarios, such as falling product or emissions prices.

For the purpose of the comparison, we define the benchmark case for product prices as one where a new investment in the conventional technology is just profitable at expected price levels and can serve its debt payments as well as pay for its variable costs in the worst-case price scenario.

The conventional technology has emissions of 1 $tonCO_2$ /$ton_{Product}$, operational costs of 100 Euro/$ton_{Product}$ and at a 40% debt rate capital costs of 200 Euro/$ton_{Product}$ of which around 50 Euro/$ton_{Product}$ are for debt payments, and 150 Euro/$ton_{Product}$ for equity over a period of 20 years. In this case, the debt can be served, even if the revenue halves (variable cost and debt equal the lower bound of revenue). Equity is thus needed to cover the uncertain part of revenue.

**FIGURE 6**

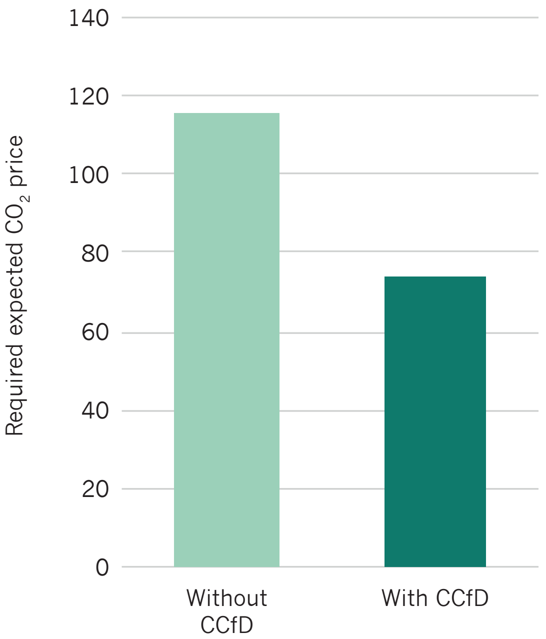
Effect of CCfD on financing structure and total cost of production




*Source: author's calculations*

## FIGURE 7

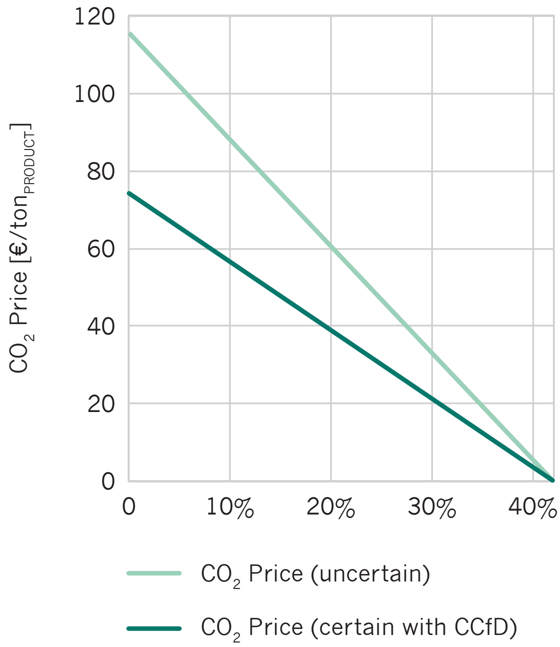
Effect of CCfD on CO2 abatement cost.




*Source: author's calculations*

## FIGURE 8

Effect of CCfD on CO2 abatement cost.




*Source: author's calculations*

For the breakthrough technology, we assume 30% higher variable costs and 30% higher overnight investment costs than the dirty technology, and that it is being allocated free allowances per ton of material produced based on the same benchmark level as the conventional technology, which it will sell at the carbon price level[7]. The breakthrough technology achieves emissions reductions of 90%.

In the following, we determine the required expected $CO_2$ price levels the breakthrough technology needs with and without a CCfD. The CCfD reduces the expected $CO_2$ price that is required for the technology to break-even because it allows for the use of more debt to pay for the investment and thus reduces the overall financing cost as compared to the case without a CCfD. The amount of debt is determined by utilising the same product price (and revenue) scenarios as for the conventional technology, but with the additional assumption that the project without a CCfD can experience a 2/3 drop of $CO_2$ price levels and needs to be able to serve the debt in this case, while the CCfD stabilises the revenue from selling its free allocation of emissions certificates and thus allows for a higher share of debt to be served.

In the case of the breakthrough technology without a CCfD the uncertainty of $CO_2$ prices in addition to the usual revenue uncertainty needs to be covered by additional expensive equity. In contrast, in case of a CCfD, there is no additional uncertainty due to $CO_2$ prices, and the secure revenue from the CCfD can be used to raise additional debt. Thus, in the example, the same level of equity as for the conventional technology is sufficient to secure the investment.

As compared to the breakthrough case without the CCfD, the latter reduces the amount of equity needed to finance the project and thus also lowers the required $CO_2$ price level needed in expectation to realise the project (from around 115 Euro/ton$_{CO2}$ to around 75 Euro/ton$_{CO2}$, a reduction of around 35%. Depending on the share of operational cost to capital cost, this reduction could be smaller for material production technologies that are more OPEX intensive).

## Closing the funding gap

CCfDs can be combined with innovation funding, for example from the European Innovation Fund. Given a fixed carbon contract price, this can reduce the necessary public co-funding as assessed for example in tenders for innovation support. In our illustration, a CCfD with a contract price of, for example, 50 Euro/tonCO2, would reduce the necessary public co-funding from around 24% to around 14% of the investment cost. In this calculation, volume and technology risks are not considered. These risks are also further mitigated by a combination of up-front innovation funding and a CCfD (Richstein 2017). It needs to be stated, however, that this is an illustrative example case, and additional analysis is needed for concrete industries.

Overall necessary funding volumes for CCfDs in the materials sector would be small as compared to renewable policy expenditures even at current prices, and fall further if the CO2 price rises, as Sartor and Bataille (2019) show for the example of France.

# Annex 3: Contracts for Difference for Renewables

*Based on work by Nils May*

## Privately-secured PPAs for new investments increase costs

Decarbonising industries requires large amounts of electricity from renewable energies. Especially when energy-intensive industries invest into electrification of processes or use hydrogen, e.g. using electrolysis in steel-making, electricity becomes an even larger input factor and must be available at low costs.

Private long-term electricity contracts (Corporate Power Purchase Agreements, PPAs) between project developers and off-takers (utility companies or industry itself) increase the costs of new investments for two reasons. Firstly, the risk of default on the part of the electricity off-taker makes it more difficult to finance the projects for the project developer, so that the cost of capital rises, which increases the costs of capital-intensive renewable energies[8]. Secondly, the financing costs for electricity off-takers increase, as long-term electricity contracts are rated as liabilities by rating agencies and thus affect off-takers' creditworthiness[9].

Current off-takers for PPAs are (1) utility companies that take over the electricity price risk but cannot always pass it on, since electricity contracts with households cover a maximum of two years and with industrial customers a maximum of three to five years; (2) Energy-intensive industries (e.g. basic industries, which account for approx. 2/3 of industrial electricity demand in Germany), which are switching to new, electricity- and hydrogen-based production processes and, thus, consume even larger quantities of electricity than today. If purchasing these through long-term contracts for 10-20 years, they add tremendous electricity price exposure ("What if electricity prices drop and competitors are not locked into long-term contracts?") to their balance sheets. This effectively limits their capability of signing such contracts. The crucial difference with existing contracts for fossil fuels and emission allowances is that the renewable energy contracts necessarily need to be very long-term to enable project developers to finance their projects with (very) high shares of debt.

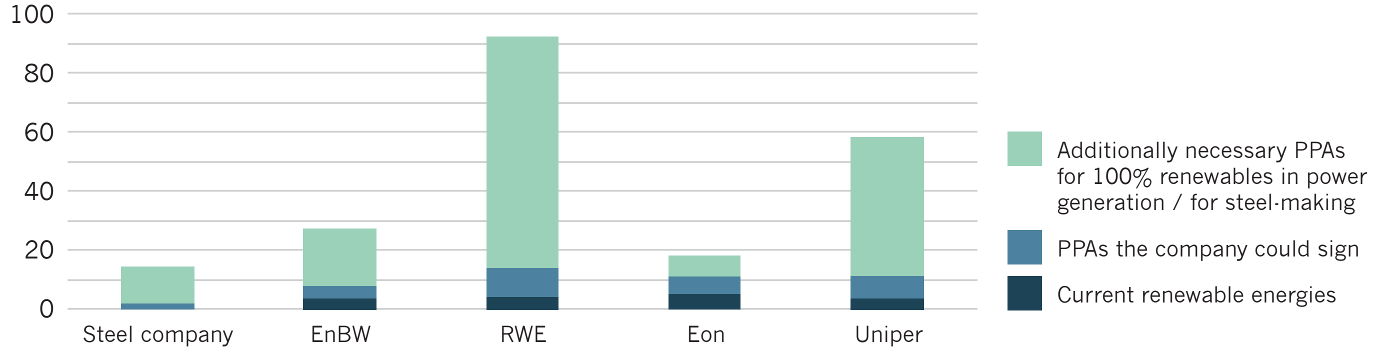
According to calculations by DIW Berlin, privately secured long-term electricity contracts mean additional costs of approx. 29% compared to secure remuneration mechanisms. For the year 2030, this corresponds to around 3 billion euros per year (May and Neuhoff 2017). Other studies arrive at similar results[10]. Either electricity consumers or the government will end up covering this additional cost, or the respective investments into renewables are not made, such that industry cannot decarbonise. Thus, it is in the public interest to limit the risks that create these costs through dedicated public policies.

## The potential of privately-secured PPAs is too limited to base the renewable energy expansion on them

Energy-intensive companies and utilities are limited purchasers of PPAs. For a large German steel company as well as for EnBW, RWE, Eon and Uniper, singing the necessary privately secured PPAs to switch to 100% renewable energies would by far exceed their financial strength (see Figure 9). An estimate of the potential by Aurora Energy Research also shows that an extension based exclusively on private PPAs is not nearly sufficient to achieve the renewable energy expansion targets of 2030, but only adds around a tenth of emissions savings of the public auctioning scheme (Aurora Energy Research 2019).

FIGURE 9

Private-secured PPAs exceed the financial strength of energy utilities and industry




*Source: May and Neuhoff (2019). Author's calculations are based on the assumptions (i) additional RE demand is covered equally by onshore wind power, offshore wind power and large solar power plants (ii) Half of long-term contracts are classified as long-term liabilities by rating agencies (iii) Companies only sign so many PPAs that their debt-equity ratio rises by 0.5 to avoid too large a negative effect on their creditworthiness (iv) Electricity demand in steel production by electrolysis according to Vogl et al. (2018). Uniper's existing renewable energy share has been estimated.*

## Public hedging can make cost-effective expansion possible

The uncertainties for long-term electricity contracts are determined by regulatory decisions on (i) CO2 prices, (ii) renewables expansion, (iii) grid expansion and (iv) electricity market design. Publicly guaranteed long-term contracts (which may take the form of Contracts for Difference, CfDs, or other) between renewable energy project developers and the government can protect investments against these regulatory uncertainties. This reduces financing costs for new plants and electricity prices, which also enables the use of renewables-based electricity for the decarbonisation of industrial processes.

Long-term contracts secured by the government also protect consumers against fluctuations in electricity prices. Potentially, larger electricity customers such as industrial companies can also purchase 100% renewables-based electricity by registering their demand in the auctions.

If designed as CfDs, these contracts would remunerate renewable energy operators with an agreed strike price whenever the wholesale electricity price is lower than the strike price, while operators must pay back the difference when electricity prices lie above the strike price (May et al. 2017 and May et al. 2018).

The design of such long-term contracts as CfDs was analysed and already implemented in Great Britain and France (see NERA 2013 and Neuhoff et al. 2018). They are easy to implement in Germany and most other EU member states: existing premium schemes can be further developed into contracts for difference with few changes. The advantage over existing premium schemes are that possible windfall profits in times of high electricity prices are prevented. When such speculative additional profits do not need to be incorporated into bids in auctions, project developers can obtain high shares of low-cost debt. The desired incentives for system-friendly investment decisions (location, design) and system-oriented operation can be ensured.

## Conclusion: Favourable framework conditions for long-term electricity contracts must be implemented

In the case of privately secured PPAs, investments in new renewable energies come at considerable additional cost. One solution is to switch to competitive, stable and predictable public auctions for renewable energies for long-term contracts, which may take different forms (Contracts for Difference (CfDs), or other). Publicly backed PPAs enable low-cost renewable energy investments, strengthens competition between projects, ensures low electricity production costs and stable electricity prices for electricity consumers, offers the possibility of integrating corporate demand into tenders, and thus actively promotes corporate climate action (see also May et al. 2017 and May et al. 2018).

Green Public Procurement (GPP) describes procurement processes that take into account the

# Annex 4: Green Public Procurement

*Based on work by Olga Chiappinelli*

environmental quality of bids and/or bidders in the award of public contracts.

As there is a soft regulatory framework at the EU level on GPP (set by the Directives 2014/24/EU and 2014/25/EU), both the extent and specific mode of implementation of GPP is a decision of single national or local government or single contracting authorities[11].

For example, the environmental quality of a bid or a bidder can be included in tender evaluation as part of the **award criteria** to determine the Most Economically Advantageous Tender (MEAT), i.e. the best offer based on both price and quality offered. One option is that specific environmental quality dimensions (e.g., material use, energy efficiency) are given an explicit weight relative to the price offered and the bid with the highest weighted average ("score") wins the tender. Another option is that the environmental impact of the bid and/or the bidder is quantified, monetised (e.g., using shadow prices for environmental externalities), and used to discount the price offered. The lowest discounted bid wins the tender.

Otherwise, environmental considerations can be specified as **technical requirements** i.e., certain (minimum) environmental standards or technical specifications that bids and/or bidders must comply with (e.g., type of fuel for vehicles, type of lighting (e.g., LED) in buildings, minimum percentages of cement clinker replacement or maximum carbon intensity for materials in construction, minimum percentage for electricity from RES sources); or **functional requirements**, which only specify the level of environmental quality that the bid needs to meet (e.g., 30% emission reduction relative to a baseline), but allow for flexibility on how to implement the level (e.g. improved product design, more efficient manufacturing, use of low-carbon materials etc.)

## Impact and potential of GPP

A major share of public sector emissions is linked to procurement of infrastructure, transport systems and buildings[12]. Given the large purchasing power of public authorities[13] in particular in these sectors, GPP can play a central role for decarbonisation: by imposing significant functional carbon requirements or including a shadow carbon price that increase the economic viability of low-carbon materials, and/or require them as part of specific technical requirements, and considering Life Cycle Cost emissions, GPP can create lead markets for climate-friendly product design, material choice, manufacturing and usage patterns which carbon pricing alone may struggle to create in the short term. This is particularly valuable in the context of materials where carbon costs from the EU Emissions Trading System are not fully internalized in material prices due to the combination of international trade and conditional free allowance allocation. Furthermore, like other "demand-side" innovation policies (e.g., regulation and standards), certain forms of GPPs (e.g. minimum technical or functional requirements) can provide incentives for innovation with limited impact on public finances, which in times of fiscal consolidation can be an advantage relative to other schemes (e.g. tax credits). Last, it allows increasing the visibility of lower-carbon options, which could enable a multiplier behavioural effect in the economy.

At the same time, GPP also have some limitations in creating lead markets for climate-friendly materials. Hence, GPP should be seen as a complement of CCfDs. One limitation is that governments will tend to implement GPP requirements with climate as just one criteria among many. They will therefore tend to focus on the most administratively simple and "cost-effective" short-term requirements, and thus are more likely to favour marginal CO2 reduction technologies over genuine breakthrough technologies. Second, public purchase markets in EU Member States will often be fragmented across smaller local and sub-national governments. This may make it complicated to generate sufficient scale and permanence and a thus sufficiently strong business case for first of a kind large-scale, long-lived ultra-low-$CO_2$ technology investments sites in a specific location.

## Optimal design criteria for maximum effectiveness:

There is a track record of successful implementation of GPP in Netherlands[14], Sweden[15] and UK[16] where purchasers have achieved substantial emission reduction relative to standard procurement, in particular for the procurement of infrastructure (see Kadefors et al. 2019 and Neuhoff and Chiappinelli 2019), the following measures could be adopted to maximise the potential of GPP.

First, to achieve full potential of carbon emission reduction and speed-up transformation, functional reduction requirements (or award criteria), to stimulate innovative technical solutions, should be combined with specific requirements (e.g., on carbon caps in materials) to influence directly materials producers and spread technologies and practices already tested (e.g., low-temperature asphalt, LED lighting). In addition, strategies based on combinations of testing in small and shorter pilot projects and wider dissemination in large projects or cities with high visibility and thus potential market impact are often preferable. A central authority may need to play a role in helping to coordinate purchases and supporting information flow across fragmented sub-national governments during initial roll-out phase.

Second, it is crucial that the contracting authority has long-term perspective, and that requirements are raised over time to reflect tightening standards and GHG neutrality targets implications for the relevant sectors. These will also need to be communicated clearly and in a timely manner so that industry can adjust ahead of time. A declining CO2 performance standard with a long-term perspective may be needed, for instance.

Third, collaborative and long-term contracting allows for continuous learning and can give strong incentives for mitigation and innovation. Breaking the silo thinking between different tasks and areas of expertise through integration of or at least more collaboration within the supply chain allows to detect and realise greater carbon reduction potential.

## Barriers to implementation

Despite this potential, GPP has been so far little implemented (see e.g., CEPS 2011, UN 2017, Chiappinelli and Zipperer 2017). There are two main barriers for more extensive implementation related to incentive structure and capacity constraints.

First, GPP typically implies that purchasing costs for the contracting authorities will be higher. While (in the case of infrastructure), best experiences so far have demonstrated that substantial emission reduction (up to 50%) can be achieved without an increase in cost by reducing material use and optimisation in logistics and construction, using GPP to create demand for low-carbon material production processes or alternative materials would likely imply an incremental cost.[17] Especially at the local level (i.e., regions and cities), where budget constraints are tighter and commitment to climate policy lower, this substantially hinders the willingness to uptake GPP.

Second, climate effective GPP can be very complex, time-consuming and effort-intensive to implement. Especially at the local level, procurement teams are often small and officials lack both technical expertise (e.g., on including carbon requirements/criteria and assessing offers against them and on ex-post compliance, information and resources (e.g., softwares and databases) and legal expertise (e.g., compliance with competition and procurement law) for the implementation of GPP[18]. Since the main objective of public purchasers is that procurement processes are fast, efficient, require minimum capacity and procurement related expenses, and are legally certain, the use of GPP is strongly hindered.

## Policy options for overcoming the barriers

Two main categories of regulatory and policy options would help overcoming the above-mentioned barriers, and support a broader implementation of GPP especially at the local level where the barriers are stronger (see Chiappinelli and Zipperer 2017 and Casler and Wuennenberg 2017).

First, there is need of a clear political mandate and dedicated national and EU funding (e.g., competition for EU (co-)funding for Green cities pilots) to cover the incremental cost of GPP. Second, initiatives should be taken to improve the administrative capacity of procurement teams, especially at the local level. These could include the following: i) training programs for public officials to gain expertise on and commitment to GPP, ii) establishment of a nationally centralised professional consultancy service on the technical and legal implementation of GPP, to be used by contracting authorities until sufficient capacities are reached internally, iii) development of guidelines and standardised tools for the implementation of GPP (e.g. LCC calculation software and methods, as well as monitoring and reporting practices), and local-, national- and international-level platforms to share and promote best-practices, iv) Supporting cooperation and coordination between authorities and countries (like e.g. GPP2020 initiative[19]), and joint public procurement initiatives for smaller contracting authorities, to allow creating the necessary scale for suppliers to invest for low-carbon solutions, as well as pooling resources and capacities.

# Annex 5: Product Carbon Requirements

*Based on work by Timo Gerres, Manuel Haussner and Alice Pirlot*

Innovation support, effective carbon pricing, and consumer engagement play an essential part in the decarbonisation of the materials sector, but it is unclear whether they are sufficient to build a global commodity market for low-carbon basic materials. Currently, the market can be characterized as follows: (i) producers tend to focus on innovation that improve competitiveness and material characteristics instead of research that enhances the emission intensity of production processes and (ii) consumers have little choice about materials used in products manufactured abroad or embodied in infrastructure.

This raises the question whether carbon pricing mechanisms on their own will suffice to phase out the production of materials with carbon intensive processes, or whether future governments will have to deploy additional policy tools. For example, in recent years the discussion of coal phase out triggered national governments to define phase out plans for coal power stations to supplement the incentives from the EU ETS. For basic materials a similar policy, purely based on emission limits for producers of materials, is currently little discussed – perhaps because these sectors are thought to be “dealt with” by the EU Emissions Trading Scheme. However, as the complex challenge of decarbonising energy-intensive basic materials industries is increasingly coming into focus, it may be time to revisit this assumption.

Against this background, Gerres et al. (2019b) explore a possible policy design for the phase in of an EU-wide climate-friendly product requirement for carbon-intensive materials. The analysis combines a review of the experience from various product standards and technical regulations and their implementation with a discussion of how such a policy could be implemented in line with WTO law.

An EU labelling standard for basic materials linked to their emission-intensity could be a first possible (voluntary) step. Such a standard would set criteria for traditional carbon-intensive materials like steel, cement, plastics, and aluminium in order to evaluate whether they have been produced without significant direct and indirect carbon emissions (near climate neutral). Materials complying with the standard, and products exclusively containing such materials could obtain a corresponding label. A variety of actors would benefit from such a labelling scheme. It would allow businesses to provide evidence of the climate impact of their materials to final consumers and demonstrate the viability of their business model to financial investors in a carbon-constrained economy. An example of how voluntary schemes can establish new best practices within global value chains is e.g. the ISO-14000 family of standards, which is used for certifying the environmental management of businesses and organizations.

In a second step and after a predefined period of time, the voluntary standard could be complemented by mandatory Product Carbon Requirements. The sale of basic materials or products containing significant volumes of carbon-intensive basic materials like steel, cement or aluminium, would only be permitted within the EU territory if the basic materials or the embodied basic materials are certified to be at or near climate neutrality. One option would be to allow companies to use the previously described voluntary standards in order to demonstrate the climate neutrality of their basic materials.

A Product Carbon Requirement would differ from traditional standards and requirements that are not linked to the embodied emissions of products. Instead, these traditional standards and requirements either address emissions from the use of products, e.g. emission efficiency standards for certain road vehicles (ex: Regulation (EC) No 715/2007). Or they limit the emissions released during the production process, e.g. limits on conventional pollutants like SOx/NOx for new and existing industrial installations and $CO_2$ emission limits for the participation of coal power stations in capacity mechanisms (Regulation (EU) No. 2019/943, Article 22 Section 4).

Product Carbon Requirements allow for a stringent implementation of environmental policies that are aligned with the global emissions reduction objectives. By contrast to climate-related standards or technical requirements that only apply to domestic producers and are hence vulnerable to carbon leakage and competitiveness concerns, Product Carbon Requirements are much less vulnerable to carbon leakage.

Product Carbon Requirements would complement rather than substitute other energy and climate policies. Such requirements can only become mandatory for material use once sufficient production capacity for climate friendly materials exist, for example for hydrogen-based steel making, ultra-low carbon cement binders, etc. This is not likely to be feasible before the mid-2030s at the earliest, given current technological readiness levels. Thus, a first step for adequate incentives is to ensure innovation pilots and investments in the first commercial scale operations for climate-friendly processes and materials. To this end, instruments like innovation funding, a climate contribution added to the EU ETS to ensure full carbon price internalization and project based carbon contracts for difference for commercial scale pilot projects will be important steps. Furthermore, Green Public Procurement, infrastructure roll-out, information (labelling) and capacity building would need to be deployed.

The anticipation of a future Product Carbon Requirement would enhance the effectiveness of these other policy instruments. It can do this by creating an unambiguous vision or target for the sector's $CO_2$ performance within the coming 10-20 years. By doing so, a Product Carbon Requirement would significantly reinforce incentives for businesses to reposition their strategies towards full replacement of carbon intensive production processes with clean alternatives during the coming 10-20 years. Without an anticipated Product Carbon Requirement, the risk is that past failures of EU innovation policy in these sectors would be repeated, whereby companies invest half-heartedly in pilot projects without a strong impetus to take the relevant technologies to commercialisation (Neuhoff et al. 2014). Additionally, uncertain carbon price developments create an additional option value for postponing new investments while waiting for more clarity, and thus further increase the carbon price required to overcome the inertia. A credible announcement of a Product Carbon Requirement can trigger a shift to climate friendly basic products at an earlier point in time or at lower carbon prices. Companies would need to adapt their production processes to ensure that their products can be sold on the markets.  It may even result in the prioritisation of investments in climate friendly production processes by those companies that aim to guarantee that their business model is compatible with the anticipated policy development.

# References


Aurora Energy Research (2018), "Erneuerbaren-Markt ohne Subventionen bringt neue Risiken", Tagesspiegel Background Standpunkt

Aurora Energy Research (2019). "Can PPAs take the Energiewende to the next level?", June 12th 2019. Online available at https://www.auroraer.com/wp-content/uploads/2019/06/Aurora-Energy-Research-German-PPA-market.pdf

Baron, R. (2016), "The Role of Public Procurement in Low-carbon Innovation", Background paper for the 33rd Round Table on Sustainable Development, 12–13 April 2016, OECD Headquarters, Paris

Bataille, C., Åhman, M., Fischedick, M., Lechtenböhmer, S., Neuhoff, K., Nilsson L.J., Solano-Rodriquez, B., Denis-Ryan, A., Steibert, S., Waisman, H., Sartor, O., and Rahbar, S. (2018), "A review of technology and policy deep decarbonization pathway options for making energy intensive industry production consistent with the Paris Agreement", Journal of Cleaner Production, 187, pp. 960-973

BDI, Federation of German Industry (2018), "Climate Paths for Germany". Online available at https://english.bdi.eu/media/presse/presse/downloads/20180308_Climate_Paths_for_Germany_ExecutiveSummary_FINAL.pdf

Carruth, M.A., Allwood, J.M. and Moynihan, M.C. (2011), "The technical potential for reducing metal requirements through lightweight product design", Resources Conservation Recycling, 57, pp. 48–60

Casler, L. and Wuennenberg, L. (2017), "Leveraging the power of the public purse: using public procurement of low-carbon innovation for sustainable infrastructure. Recommendations to the European Commission and EU Member States", I24c, December 2017

CEPS and College of Europe (2011), "Uptake of Green Public Procurement in the EU 27", Study commissioned by the European Commission, DG Environment

Chiappinelli, O. and Zipperer, V. (2017), "Using Public Procurement as a Decarbonisation Policy: A Look at Germany", DIW Economic Bulletin No. 49/2017, pp. 523-532

Chiappinelli, O., Bartek-Lesi, M., Błocka, M., Chaves Ávila, J.P., Felsmann B., Gerres T., Linares, P., Neuhoff, N., Śniegocki A, Szajkó, G. and Wetmańska Z., (2019) "Inclusive Transformation of the European Materials Sector", Report for the EUKI 2018 Project "Climate Friendly Materials Platform: supporting transition in Central and Southern Europe"

Chiappinelli, O. and Neuhoff, K. (2017), "Time-Consistent Carbon Pricing", DIW Discussion Paper 1710

DNVGL 2018, "Carbon Emission Reduction Roadmap for Refineries", implemented for the Dutch Petroleum Industry Association (VNPI). Online available at https://www.dnvgl.com/cases/carbon-emission-reduction-roadmap-for-refineries-135592

EC, European Commission (2018), "A Clean Planet for all - A European strategic long-term vision for a prosperous, modern, competitive and climate neutral economy", COM (2018) 773, 28/11/2018. Online available at https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52018DC0773

Economics for Energy (2017), "Escenarios para el sector energético en España 2030-2050". Online available at https://eforenergy.org/docpublicaciones/informes/informe_2017.pdf

EEA, European Environment Agency (2012), "End-user GHG emissions from energy: reallocation of emissions from energy industries to end users, 2005–2010" (No. 18/2012).

*EEA, European Environment Agency (2016). National emissions reported to the UNFCCC and to the EU Greenhouse Gas Monitoring Mechanism [WWW Document]. URL [https://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-6](https://www.eea.europa.eu/data-and-maps/data/national-emissions-reported-to-the-unfccc-and-to-the-eu-greenhouse-gas-monitoring-mechanism-6)*

*Gerres, T., Chaves Ávila, J.A., Linares Llamas, P. and Gómez San Román, T. (2019a), "A review of cross-sector decarbonisation potentials in the European energy intensive industry", Journal of Cleaner Production, 210, pp. 585 – 601*

*Gerres T., Haussner, M., Neuhoff, K. and Pirlot, A. (2019b), "Can governments ban materials with large carbon footprint? Legal and administrative assessment of Product Carbon Requirements*

*Groenenberg, H. and de Coninck, H. (2008), "Effective EU and member state policies for stimulating CCS", International Journal of Greenhouse Gas Control, 2(4), pp. 653 – 664*

*Grubb, M., Hourcade, J.C. and K. Neuhoff (2014), "Planetary Economics: Energy, climate change and the three domains of sustainable development", Routledge*

*Helm, D. and Hepburn, C. (2005), "Carbon contracts and energy policy: an outline proposal", Working Paper, University of Oxford*

*Hering, G. (2019), "Corporate PPAs vs. CfDs aus Sicht eines Projektierers", Presentation Strommarkttreffen, 19.01.2019*

*Horton, P.M. and Allwood, J.M. (2017), "Yield improvement opportunities for manufacturing automotive sheet metal components", Journal of Materials Processing Technology, 249, pp. 78-88.*

*International Energy Agency (2017), "Energy Technology Perspectives 2017 (ETP 2017)", retrievable online at [www.iea.org/etp2017](www.iea.org/etp2017)*

*International Energy Agency (2018), "Technology Roadmap, Low-Carbon Transition in the Cement Industry"*

*IPCC, Intergovernmental Panel on Climate Change (2018), "Global warming of 1.5 °C. An IPCC Special Report on the impacts of global warming of 1.5 °C above pre-industrial levels and related global greenhouse gas emission pathways, in the context of strengthening the global response to the threat of climate change, sustainable development, and efforts to eradicate poverty", Masson-Delmotte, V., P. Zhai, H.-O. Pörtner, D. Roberts, J. Skea, P.R. Shukla, A. Pirani, W. Moufouma-Okia, C. Péan, R. Pidcock, S. Connors, J.B.R. Matthews, Y. Chen, X. Zhou, M.I. Gomis, E. Lonnoy, T. Maycock, M. Tignor, & T. Waterfield (eds.)*

*Ismer, R. and Haußner, M. (2016), "Inclusion of Consumption into the EU ETS: The Legal Basis under European Union Law," Review of European, Comparative & International Environmental Law, 25 (1), pp. 69–80*

*Janipour, Z., de Nooij, R., Scholten, P., Huijbregts, M.A.J. and de Coninck", H., (2020), "What are sources of carbon lock-in in energy-intensive industry? A case study into Dutch chemicals production", Energy Research & Social Science, 60, pp. 101320*

*Kadefors, A., Uppenbgerg, S., Alkan Olsson, J., Balian, D., Lingegard, S. (2019), "Procurement Requirements for Carbon Reduction in Infrastructure Construction Projects– An International Case Study", Project report June 2019Materials Economics (2018), "The Circular Economy: a Powerful Force for Climate Mitigation"*

*May, N. and Neuhoff, K. (2017), "Financing Power: Impacts of Energy Policies in Changing Regulatory Environments," DIW Discussion Paper No. 1684*

*May, N., Jürgens, I. and Neuhoff, K. (2017), "Renewable Energy Policy: Risk Hedging Is Taking Center Stage", DIW Economic Bulletin No. 39/40*

*May, N., Neuhoff, K., and Richstein, J., (2018),"Affordable electricity supply via contracts for difference for renewable energy", DIW Economic Bulletin No. 28*

*May, N. and Neuhoff K. (2019)."Private langfristige Stromabnahmeverträge (PPAs) für erneuerbare Energien: kein Ersatz für öffentliche Ausschreibungen", DIW Aktuell 22, DIW Berlin. Online available at [https://www.diw.de/de/diw_01.c.677987.de/publikationen/diw_aktuell/2019_22/.html](https://www.diw.de/de/diw_01.c.677987.de/publikationen/diw_aktuell/2019_22/.html)*

*MTES, Ministère de la Transition écologique et solidaire (2018), "Stratégie Nationale Bas-Carbone (SNBC)". Online available at https://www.ecologique-solidaire.gouv.fr/strategie-nationale-bas-carbone-snbc*

*Naturvårdsverket, 2019. Underlag till regeringens, klimatpolitiska handlingsplan - Redovisning av Naturvårdsverkets regeringsuppdrag. Naturvårdsverket Report 6879 by The Swedish Environmental Protection Agency, March 2019. Online available (in Swedish) at https://www.naturvardsverket.se/Miljoarbete-i-samhallet/Miljoarbete-i-Sverige/Regeringsuppdrag/Redovisade-2019/Underlag-till-regeringens-klimatpolitiska-handlingsplan/*

*NERA (2013), "Hurdle rates change UK London", commissioned by the UK's Department of Energy and Climate Change*

*Neuhoff, K., Ismer, R., Acworth, W., Ancygier, A., Fischer, C., Haussner, M., Kangas, H.L., Kim, Y.G., Munnings, C., Owen, A., Pauliuk, S., Sartor, O., Sato, M., Stede, J., Sterner, T., Tervooren, M., Tusveld, R., Wood, R., Xiliang, Z., Zetterberg, L. and Zipperer, V. (2016), "Inclusion of Consumption of Carbon Intensive Materials in Emission Trading: An Option for Carbon Pricing Post-2020", Climate Strategies Report*

*Neuhoff, K. and Chiappinelli, O. (2017), "Policies to stimulate climate friendly innovation in the materials sector", Workshop summary from the Climate Friendly Materials Platform Roundtable held at DIW Berlin on October 20th 2017. Online available at https://www.diw.de/de/diw_01.c.603623.de/veranstaltungen/workshop_on_policies_to_stimulate_climate_friendly_innovation_in_the_materials_sector.html*

*Neuhoff, K., Chiappinelli, O., Bataille, C., Haußner, M., Ismer, R., Joltreau, E., Jürgens, I., Piantieri, C., Richstein, J., Sartor, O., Singhal, P. and Stede, J. (2018a), "Filling gaps in the policy package to decarbonise production and use of materials", Climate Strategies Report*

*Neuhoff, K., May, N. and Richstein, J. (2018b), "Renewable Energy Policy in the Age of Falling Technology Costs", DIW Discussion Paper No. 1746*

*Neuhoff, K. and Chiappinelli, O. (2019), "Policy Design for Greening Construction Supply Chains" Main insights from the Climate Friendly Materials Roundtable held at the Swedish EPA, Stockholm, on 24th May 2019. Online available at https://www.mistracarbonexit.com/news/2019/9/28/insights-from-the-roundtable-policy-design-for-greening-construction-supply-chains*

*Philibert, C. (2017), "Renewable Energy for Industry: from Green Energy to Green Materials and Fuels" [WWW Document]. URL https://www.iea.org/publications/*

*Pirlot, A. (2017), "Environmental Border Tax Adjustments and International Trade Law. Fostering Environmental Protection", New Horizons in Environmental and Energy Law series, Edward Elgar Publishing, https://www.elgaronline.com/view/9781786435507/9781786435507.xml*

*Pollitt, H., Neuhoff, K. and Lin, X. (2019), "The Impact of Implementing a Consumption Charge on Carbon-Intensive Materials in Europe", Climate Policy, forthcoming*

*Richstein, J. (2017), "Project-Based Carbon Contracts: A Way to Finance Innovative Low-Carbon Investments", DIW Discussion Paper No. 1714*

*Ritz, R. and Neuhoff, K. (2019), "Carbon price pass-through in Industry", University of Cambridge Discussion Paper*

*Rootzén, J. and Johnsson, F. (2017), "Managing the costs of CO2 abatement in the cement industry", Climate Policy, 17 (6), pp. 781-800*

*Sartor, O. and Bataille, C. (2019), "Creating a business case for carbon-neutral basic materials: How Carbon Contracts-for-Difference could help kick-start commercial-scale projects", IDDRI Study no. ST06-19, IDDRI, Paris*

*UN Environment (2017), "Global review of sustainable procurement"*

*VNCI, Dutch Chemical Industry (2018). "Chemistry for Climate. Acting on the need for speed. Roadmap for the Dutch Chemical towards 2050". Online available at https://www.vnci.nl/Content/Files/file/Downloads/VNCI_Routekaart-2050.pdf*

*Vogl, V., Åhman, M. and Nilsson, L.J. (2018), "Assessment of hydrogen direct reduction for fossil-free steelmaking", Journal of Cleaner Production, 203, pp. 736-745*

*von Stechow, C., Watson, J., and Praetorius, B. (2011), "Policy incentives for carbon capture and storage technologies in Europe: A qualitative multi-criteria analysis", Global Environmental Change, 21(2), pp. 346 – 357. Special Issue on The Politics and Policy of Carbon Capture and Storage*

*WiseEuropa (2019), "A new chapter: Shifting Poland towards net-zero economy", edited by Maciej Bukowski. Online available at: http://wise-europa.eu/en/2019/03/21/a-new-chapter-wiseeuropa-report-on-shifting-poland-to-net-zero-economy/*

*World Green Building Council (2018), " Global Status Report - Towards a zero-emission, efficient and resilient buildings and construction sector"*

*Wood, R., Neuhoff, K., Moran, D., Simas, M., Grubb, M., and Stadler, K. (2019), "The Structure, Drivers and Policy Implications of the European Carbon Footprint", Climate Policy, forthcoming*

*Wyns, T., Khandekar, G. and Robson, I. (2018a), "Industrial Value chain: A bridge towards a carbon neutral Europe", IES. Online available at https://www.ies.be/node/4758*

*Wyns, T., Khandekar, G., Axelson, M. and Robson, I. (2018b), "Towards a Flemish Industrial Low-carbon Framework", IES. Online available at https://www.ies.be/node/4894*

*Wyns, T., Khandekar, G., Axelson, M., Sartor, O. and Neuhoff, K. (2019), "Industrial Transformation 2050 - Towards an Industrial Strategy for a Climate Neutral Europe", IES. Online available at https://www.ies.be/node/5074*

# Endnotes

1 DIW calculations based on EEA (2012) and EEA (2016).

2 ArcelorMittal published a Climate Action Report in May 2019; HeidelbergCement and Thyssenkrupp AG are included in the list of "Companies taking action" by the Science Based Targets Initiative.

3 This section is based on Neuhoff et al. (2018a) "Filling gaps in the policy package to decarbonize production and use of materials".

4 One-time free allocation of certificates would not negatively affect the carbon price transfer. The effect arises since 1) the future allocation of certificates is tied to the current production level and 2) new plants also receive free certificates, making investment more attractive, boosting supply in the market, and causing it to fall based on the equilibrium price.

5 Earlier literature suggested giving projects carbon price guarantees (Groenenberg and de Coninck, 2008; von Stechow et al. 2011), or even carbon contracts (Helm and Hepburn 2008), however, not in the context of an implementation within an Emissions Trading system.

6 Also in other modes of financing, increased risks lead to higher required returns on investment.

7 The calculation is the same if there is no free allocation, but there is a 100% pass-through of emissions costs to the product price by the price-setting conventional technology.

8 An example of the default risk is California's utility PG&E, which has gone bankrupt, and more than $30 billion in privately secured PPAs are now obsolete.

9 As described by the rating agency Standard&Poor's (available online) and occurred in the UK (available online).

10 According to Aurora Energy, the additional costs in the respective example calculations amount to approx. 28% (available online), according to Enertrag to 25% (available online) and according to Energy Brainpool to 34 percent (available online, PPAS II).

11 There are a few sector specific EU legislations e.g., requiring certain energy efficiency standards of office IT equipment or road transport vehicles.

12 Buildings and construction contribute close to 40% of global GHG emissions (WGBC 2018).

13 Public procurement accounts for around 15% of GDP in the EU (this number excludes procurement by state-owned enterprises https://ec.europa.eu/growth/single-market/public-procurement_en).

14 The Dutch Infrastructure Authority, Rijkswaterstaat (RWS), adopts a LCC-based shadow carbon price GPP approach for the procurement of low-carbon infrastructure. The system achieved a 24% to 50% estimated emission reduction compared to business-as-usual infrastructure design (see e.g., Baron 2016 and Chiappinelli and Zipperer 2017).

15 The Swedish Transport Administration (STA) uses functional carbon requirements that mandate minimum emission reduction from planning and construction relative to a baseline. The system triggered implementation of measures that reduced emissions up to 50% without increasing cost (mostly related with optimization of material use and logistics). National emission reduction targets are raised over time and reflected in the baseline.

16 The best experience in the UK is currently provided by Anglian Water (AW), the largest water and wastewater company, that has established an alliance with key suppliers in the value chain such that partners are remunerated only if both cost and emission-reduction targets are reached. The collaborative approach allowed to exploit higher mitigation potential through a longer-term and more holistic approach to projects, and achieved 50% emission reduction with no increased cost.

17 *However, current research shows that, for the case of infrastructure, such incremental cost is likely to be very contained and therefore could be compensated by savings from optimization at the design and construction stage (see Rootzén & Johnsson 2017). Furthermore, public procurement remains overly focused on the purchasing price and not on the overall costs that the contracting authority has to incur over the entire lifetime of the purchased good, service of infrastructure. By basing the award decision on a more comprehensive cost concept, like total cost of ownership (TCO) or life cycle cost (LCC), a green product would not only imply lower life cycle emissions, but possibly also lower overall cost, because potentially higher initial purchasing costs (e.g., because of more expensive low-carbon materials) would be compensated by lower operating cost (e.g., because of higher energy efficiency), maintenance cost (i.e., because of longer lasting materials) and disposal costs (e.g., because of eased deconstruction and reuse of materials.*

18 *GPP can also increase the complexity of the process for bidders (e.g., extra effort and cost to check compliance of bids with environmental criteria, e.g. via label or certificate). This can deter the participation and competition in tenders, which in turn can increase the purchasing price or lead to follow up problems, as the services and products to be procured are needed on time and setting a new procurement process is costly.*

19 *GPP2020 was a project which aimed to establish green procurement practices st the EU level. It involved a consortium of eight Europan countries, among which Germany and Netherlands, implementing more then 100 GPP tenders, directly reducing $CO_2$ emissions, conducting training and networking activities on GPP and extending support structures such as helpdesks in the partner countries. GPP tenders organized as part of GPP2020 led to an overall saving of 922,932 tons of $CO_2$ eq calculated on life cycle and based on comparison relative to "standard" tenders. More details including on calculation methodologies can be found at http://www.gpp2020.eu/home/.*

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