IDDRI
SUSTAINABLE DEVELOPMENT & INTERNATIONAL RELATIONS

SciencesPo

Decarbonising basic materials in Europe:

How Carbon Contracts-for-Difference could help bring breakthrough technologies to market

Oliver Sartor, Chris Bataille (IDDRI)

Basic industrial materials—such as steel, cement and concrete, aluminium and certain chemical feedstocks—currently account for about 18% of EU greenhouse gas emissions. However, despite high technological potential, industrial companies still cannot commercialise and develop full-scale operations for these products. The main barrier is basic economics: there are no markets willing to pay the higher production cost of very low-carbon basic materials.

To fill this gap, a variety of policy suggestions has been put forward, including innovation funds, green public procurement, carbon price floors, consumption charges on basic materials and border carbon adjustments (BCAs). However, these options, although potentially helpful as part of a wider policy package, are not sufficiently well targeted to address one core problem, i.e. there is currently no viable business case for *commercial-scale* investments in these technologies.

This *Study* therefore explores the idea of awarding carbon contracts for difference (CCfDs) to help commercialise the first ultra-low carbon basic materials projects. It argues that this approach would be economically efficient, is compatible with EU state aid and WTO law, and is highly complementary to other policy instruments, such as those mentioned above.

KEY MESSAGES

A project-based "Carbon Contract for Difference" (CCfD) for ultra-low carbon materials could be used to ensure that projects for ultra-low carbon materials face a) a sufficiently reliable, "investible" carbon price and b) that the price is effectively high enough so deep decarbonisation technologies become commercially viable immediately, and can be commissioned during the coming 5-10 years.

This system would be somewhat similar to (although much less expensive than) "feed-in-premium/tariff" (FIP/FIT) policies for renewable energy projects to be "investible". However, it would work by guaranteeing producers of ultra-low carbon materials a fixed *carbon* price, rather than a fixed power, gas or heat price. It also only covers the difference between the current carbon price and the contracted price; if the carbon price were higher than the guaranteed price, there would be no payment.

This system would thus help to ensure that the CO_2 price faced by investors in first-of-a-kind commercial scale projects better reflects the true social cost of carbon in the economy. It would complement the EU carbon market by providing a substantially higher and more predictable (bankable) carbon price based on which large-scale long run investment decisions could be taken. A CCfD would be complementary with other key policies, including national or European innovation funds by providing a viable pathway to market for successful demonstration pilots. They could potentially be funded by a small downstream carbon charge on CO_2 intensive basic materials.

STUDY

N°06
October
2019

Decarbonising basic materials in Europe:
How Carbon Contracts-for-Difference could help bring breakthrough technologies to market

Oliver Sartor, Chris Bataille (IDDRI)

LIST OF FIGURES

1. INTRODUCTION

Decarbonising basic industrial materials is crucial to achieving the goal of climate neutrality by 2050. In Europe, for example, production of basic materials accounted for ~750 million tonnes of CO_2-equivalment in 2017, i.e. ~18% of GHG emissions.[1] Globally this number is closer to 20%. The bulk of these emissions come from just a few multi-purpose products (mainly cement and lime, steel and ferro-alloys, aluminium) and certain chemical feed-stocks (such as ammonia, methanol, ethylene and propylene).

This problem has been clearly recognised by the European Commission. In 2018, in its new Long-Term Strategic Vision to achieve carbon neutrality by 2050, the Commission's scenarios implied a need to cut their process emissions by 75% by 2050 in these sectors and energy emissions by as much 95% (vs. 2015 levels). Achieving these goals is an ambitious task. However, it also presents opportunities to modernise these sectors, to keep their production in Europe, and to make them globally competitive for the long run.

Meeting this challenge is technically possible. Europe and North America are home to a growing range of pilots of ultra-low carbon "breakthrough" production technologies for basic materials. However, despite this potential, industrial companies and entrepreneurs still cannot commercialise and develop full-scale operations for these products. The main barrier is basic economics: there are no markets willing to pay the (significantly) higher production cost of very low-carbon basic materials. In Europe, even despite recent reforms, the EU ETS carbon price, at 30€/tCO_2, is still much too low (and too risky) to allow these technologies to compete with cheaper "high carbon" alternatives. Hence, despite numerous EU and nationally funded pilots, or the existence of promising, tested, technologies, investments in *commercial scale* sites do not happen.

To fill this gap, a variety of policy suggestions have been put forward, including EU innovation funds, green public procurement, carbon price floors and border adjustments. Several of these policies could have a useful role to play in a policy package. However, these specific policies are still not sufficiently well targeted, and in some cases would take too long to implement, to address the core challenge that faces the energy intensive basic materials sector today (see discussion in Section 2).

Achieving a 75%-100% decarbonisation for basic materials and feed-stocks industries by 2050 means that, during the coming decade, companies will need to have developed the first *commercial scale* examples of available "break-through" technologies, which could then be replicated (Bataille *et al.*, 2017). However, without carbon prices at levels that are currently politically unattainable in the context of the EU ETS (e.g. 50-100€/tCO_2), there is no viable business case for these commercial scale production sites.

This *Study* therefore explores the idea, initially proposed by Richstein (2017), of awarding carbon contracts for difference (CCfDs) to help commercialise a portfolio of first-of-a-kind ultra-low carbon basic materials projects. However, it would work by guaranteeing project developers of ultra-low carbon materials production sites a fixed *carbon* price, at a level that covers the incremental capital ("capex") and operating ("opex") cost of their technology. It argues that this approach would be economically efficient, affordable, compatible with EU state aid law, and could build easily onto existing policy instruments, such as EU ETS and the EU innovation funds.

CCfDs could be a useful bridge to help kick-start the development of a decarbonised industrial sector in Europe today, without having to wait for a decade (or more), until the EU is politically and economically ready to accept much higher EU ETS carbon prices, or for an internationally negotiated set of border adjustments to be agreed and robustly implemented.

1 Iddri analysis based on UNFCCC data 2017: https://di.unfccc.int/detailed_data_by_party

2. COMPLEMENTARY POLICIES ARE NEEDED TO CREATE MARKETS FOR LOW-CARBON MATERIALS

Many of the most innovative and potentially most impactful low-carbon production processes for basic materials still cost more than the existing "high carbon" competition. This is true for alternative low-carbon cement types, steel making with hydrogen-DRI processes, end-of-pipe carbon capture and storage or re-use solutions, inert electrodes for aluminium production, etc. As long as they must compete with established higher carbon—but lower cost—options, they will struggle to charge prices that recover their full production costs and remain competitive.

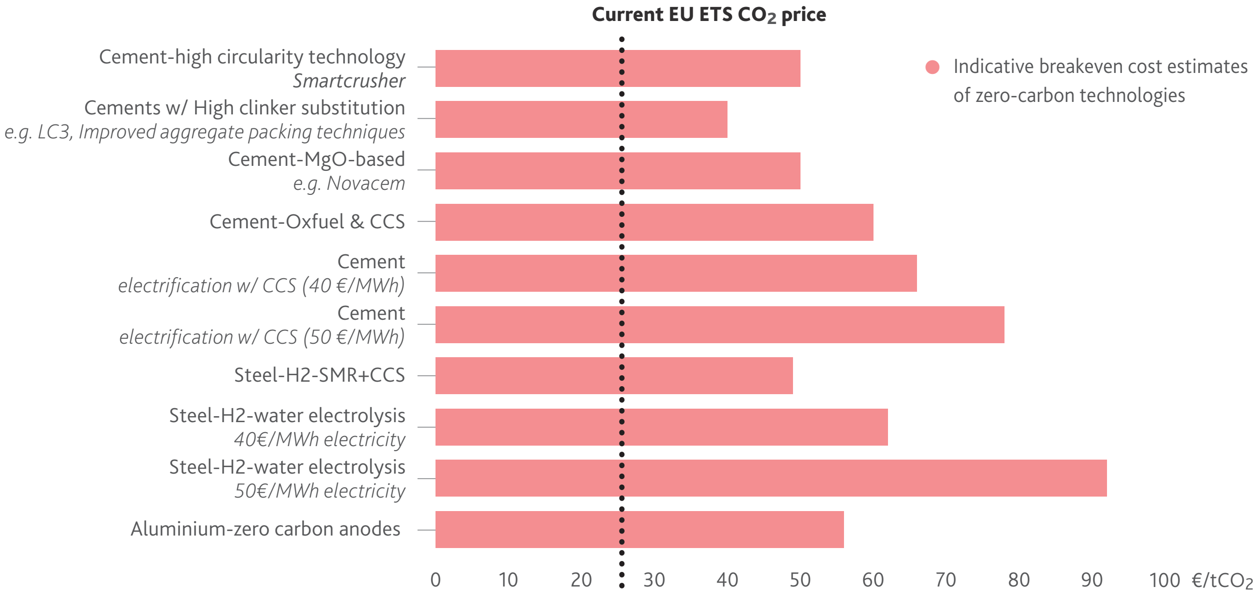
In theory, this problem was supposed to be addressed by the EU carbon price, which, it was argued, should make CO_2 intensive materials more expensive relative to lower-carbon alternatives. However, even at around 25-30€/tCO_2, the EU carbon price is still far too low to make many important breakthrough technologies economically competitive. As seen in Figure 1, prices would need to be at least 50€/tCO_2 or higher to activate some of the main carbon neutral technologies for cement, at least 60€/tCO_2 for aluminium. The price of hydrogen-based steel making would depend on a mix of carbon, hydrogen and electricity prices if the hydrogen was made with electrolysis. A study by Vogl *et al.* (2018) indicate break-even against standard steel making at 62€/tCO_2 if bulk clean electricity were available for 40€/MWh.[2] A lower (higher) electricity price would mean a lower (higher) breakeven carbon price.

Moreover, *even if* it were high enough on a levelised cost basis, the EU carbon price also comes with a second weakness—a high level of price risk for investors. During its 15-year history, the EU ETS carbon price has fluctuated between 0€/tCO_2 and ~30€/tCO_2. Industrial companies and financial lenders therefore perceive the ETS carbon price as an insufficiently reliable basis for final investment decisions.[3] This is especially true when these are investments in first of a kind commercial scale technologies and when they put at risk hundreds of millions or billions of euros. CO_2 price risk mitigation instruments are therefore needed to complement the EU ETS carbon price, in order to unlock capital.

2 Vogl, V., Åhman, M., Nilsson, L.J. (2018). Assessment of hydrogen direct reduction for fossil-free steelmaking. *Journal of Cleaner Production* 203, 736–745. doi:10.1016/j.jclepro.2018.08.279

3 Iddri analysis based on interviews with industrial and financial sector actors.

FIGURE 1. Breakeven cost estimates of very low-carbon cement, primary steel and primary aluminium technologies



NB. This graphic is simply illustrative and not intended to be an exhaustive list of technologies, nor to reflect precise breakeven cost conditions at all specific site locations.

Source: IDDRI, based on data from Vogl et al (2018), Scrivener et al (2018), Material Economics (2019), IEA, Metalbulletin, IDDRI.

3. ANALYSIS OF EXISTING COMPLEMENTARY POLICIES AND PROPOSALS

3.1. The EU ETS Innovation Fund

Under the revised EU ETS Directive (Phase 4: 2021-2030), the EU established a new Innovation Fund, seeking to help support the demonstration of innovative decarbonisation technologies. Depending on the carbon price, the Fund may have up to 8-10 billion € to invest in innovative technologies across the energy and industrial sector. Thus, these funds could help to cover part of the incremental cost of pilots for key breakthrough technologies and maybe even a part of the upfront capital cost of commercial plants later on.

However, *by itself,* this instrument is unlikely to be sufficient to incentivise large-scale commercialisation. The Innovation Fund is essentially designed to support smaller scale pilots—and across a wide range of sectors (not just basic materials). Thus it is not perfectly targeted to the basic materials sector's core problem.

For instance, it will do too little to tackle the incremental *operating cost* over the projects' true financial and operating lifetime. *Commission Regulation 2019/856 of 26 February 2019 with regard to the operation of the Innovation Fund* limits the coverage of incremental capital and operating costs of innovative projects to just 60% of the combined cost difference compared to conventional "high CO_2" projects. Moreover, such projects are eligible for grants only during the first 10 years of operation, whereas higher operating costs will generally persist for the full lifetime of the project (typically at least 20-25 years). Such terms are therefore more likely to be attractive for small-scale pilots than commercial scale production plants.

Member States should therefore see the EU Innovation Fund as a tool they can build upon with complementary instruments. They could do this, for instance, by building other national policy tools around the Innovation Fund to support low-carbon basic materials projects to evolve from pilot to commercial scale once the technologies are proven (e.g. see section 4).

3.2. An EU-wide carbon price floor and border adjustment

The current un-competitiveness of low-carbon basic materials technologies also cannot be fully addressed by an EU carbon price floor and border carbon adjustment (BCA).

Firstly, an EU ETS-based *carbon price floor* at a sufficiently high level to drive these technologies will not simply not be politically acceptable in the near future for the EU28. For example, only a handful of more progressive Member States support a recent French proposal for an EU-level agreement on a price floor of 30€/tCO_2. However, our analysis shows that a much higher price level—i.e. of at least 50-60€/tCO_2—would be needed to start to commercialise some of the cheaper industrial breakthrough technologies. EU Member States thus need to think about alternative solutions for the next decade or so, until an EU ETS price floor at much higher levels can be politically accepted.

Secondly, a border carbon adjustment would also be insufficient to tackle the problem of low and unstable carbon prices. A BCA may indeed be desirable as a long-run solution to equalise international carbon prices for industry. If it can be agreed and implemented, a BCA would would allow for free allocations to be phased out and for the EU carbon price to be to internalised into the value chain. Thus, ultimately consumers would bear the CO_2 cost of (decarbonising) these products (as indeed they ultimately will have to)

However, a BCA would only charge the prevailing EU carbon price attached to *imported* products. Thus, it would not address the fact that the EU carbon price is still too low—and too uncertain over the long run—to support much needed low-CO_2 material production technologies.

Finally, both an EU carbon price floor at a price > 50-60€ and border carbon adjustment are also likely to take a long time before they can be implemented. For instance, a border carbon adjustment raises a number of important challenges in relation to trade and climate diplomacy, international trade law, and the technical capacity to implement the measures properly around the world. For instance, it would require intensive cooperation with trading partners in the relevant goods to accurately trace CO_2 intensity of processes behind each product. It is thus very difficult to see how the EU will be able to implement a meaningful and effectively implemented BCA without significant international diplomacy and technical cooperation with major trading partners.

In the long run, a high CO_2 price floor and BCA are desirable and may be possible for the EU. However, creative alternative solutions are needed in the interim to start decarbonising the relevant industries without depending on these instruments' success.

3.3. Consumption-based charges on basic materials

Because of international trade competition, EU ETS carbon price signals cannot be fully internalised and passed along the value chain from the producer of basic materials (and ultimately paid by the final consumer). However, unless this can be done, it will be difficult to see how basic materials companies could ever be willing to completely switch to rolling out decarbonised technologies. After all, if the consumer does not ultimately pay for the cost, they would need to rely on subsidies from governments indefinitely, which is also not a viable proposition. Currently, the only option on the table for reinstating the carbon price along the value chain for basic materials is border carbon adjustments combined with full auctioning of EU ETS allowances. As explained above, however, this solution might be very complicated from a WTO trade law/trade diplomacy perspective.

Neuhoff *et al.* (2016) have thus proposed to implement a tweak on border adjustments based on a consumption-based charge[4]. For example, once a tonne of steel leaves the factory gate, it would incur a weight-based CO_2 price charge (e.g. 1.8tCO_2/t-steel x prevailing EU ETS price). This consumption charge would then have to either be paid or passed on to the purchaser by each actor in the value chain until it is ultimately paid by the final consumer. Importers would also have to pass on the consumption charge, so trade distortions would be removed. The revenues from the consumption charge could be collected from the national treasury and then used to fund policies to scale up low-carbon basic materials technologies.

While border carbon adjustments could achieve the same goal of carbon price internalisation in final product prices, the inclusion of consumption idea may have some advantages. Firstly, because the system technically applies onto the "consumption" of basic materials, it is likely to be on stronger legal ground with the WTO. Second, if the charge would be weight-based, it would avoid the technical complexity of tracking true CO_2 intensity behind each tonne of steel, aluminium, etc. Thirdly, unlike a BCA, a consumption charge could build on existing IT infrastructure for tracking VAT and, since it would be weight based, could potentially be implemented in a more reduced manner at national level for willing EU Member States in a shorter time frame. BCAs on the other hand would require the full political weight of the EU (and perhaps others) behind them to happen.

However, for our purpose of making low carbon investments economically competitive, consumption charge-based approaches would nevertheless suffer from the same shortcoming as border adjustments: in the short-to-medium term, the CO_2 prices created by the ETS for materials producers would still be too low and two unstable to justify low-carbon investments economically. Thus, neither a border adjustment not a consumption charge would be sufficient by themselves to kick-start these first investments. Moreover, implementing a consumption charge that reflects the full carbon price and is fully integrated into the EU ETS would create other technical complexities that would take time to resolve.[5]

A small–scale, national carbon charge might therefore be best conceived as a complement to other investment support measures (see section on CCfDs below): they could raise funds from consumers of these products to pay for supports to low-carbon technology projects. But they would not be a substitute.

3.4. Public procurement of low-carbon materials

Some authors have also explored the possible role that public procurement could play to help create markets for low-carbon basic materials (Chiappinelli and Zipperer, 2017). Public procurement of materials like cement and concrete, steel and non-ferrous metals often constitute a significant share of national markets of these products. It is possible to implement public procurement practices that include either: a) significant technical carbon requirements for products used, or b) shadow carbon prices in order to increase the economic viability of low-carbon materials in the awarding of public contracts. This in turn could allow national and local authorities to create lead markets for climate-friendly materials and product design.

However, green public procurement cannot be the sole means of creating lead markets for the commercialisation of climate neutral basic materials. One limitation is that public purchase markets in EU Member States will often be fragmented across smaller local and sub-national governments. Many of these sub-national governments may also be too small in scale to justify large-scale investment by companies. This may make it complicated to generate sufficient scale and visibility to support large-scale investments sites in a specific location.

Secondly, sub-national governments typically face numerous competing constraints when engaging in public purchasing decisions, while also frequently suffer from limited resources. This may lead national or sub-national governments to favour the most administratively simple, most technologically proven and most economically "low-cost" short-term solutions. Consequently, public procurement processes might be too limited in their ambition.

To combat these two problems, a nationally centralised coordination of green public procurement would be needed. However, such coordination would require substantial time and resources to develop at scale. It is likely that "testing" of requirements in certain cities or regions would be undertaken first. Therefore, a singular focus on public procurement may take a long time to have the intended market signalling effect to investors in breakthrough technologies.

In reality, implementing meaningful green public procurement criteria for many sub-national governments would probably have to *follow* the creation of commercial scale plant for zero carbon materials, rather than being its justification. It could thus be a way to expand markets once these technologies exist, rather than to drive their inception.

4 Neuhoff, K. *et al.* (2016). Inclusion of Consumption of carbon intensive materials in emissions trading – An option for carbon pricing post-2020, Climate Strategies, London. https://climatestrategies.org/wp-content/uploads/2016/10/CS-Inclusion-of-Consumption-Report.pdf

5 Two such questions would be whether and how to differentiate between secondary and primary materials, and how to manage free allocations under the ETS, which would arguably need to shift to an output-based allocation if the charge was to reflect the full CO_2 price.

4. CARBON CONTRACTS FOR DIFFERENCE (CCfDs) FOR FIRST-OF-A-KIND CARBON-NEUTRAL BASIC MATERIALS PROJECTS IN EUROPE

One potentially more attractive policy option, suggested by Richstein (2017), could be for the government to award "carbon contracts for difference" (CCfDs) to investors in first-of-a-kind commercial-scale projects. These would be projects that produce climate-neutral or ultra-low-carbon basic materials.

This system would be very similar to the way existing "feed-in-premium/tariff" (FIP/FIT) policies in France support producers of renewable energy projects to be "investible". However, it would work by guaranteeing producers of ultra low-carbon materials a fixed *carbon* price, rather than a fixed power, gas or heat price, as in the case of renewables.

A CCfD for ultra low-carbon materials could be used to ensure that first-of-a-kind projects face:

- A stable, investible, carbon price;
- An effective carbon price high enough that essential technologies are economically viable;
- A viable pathway from technology pilot to commercial-scale plant during the next 5-10 years.

They would thus help to ensure that the first such commercial example projects could get up and running in the next decade without needing to wait potentially into the 2030s or 2040s until a range of economic conditions are united to justify investment (e.g. high EU ETS carbon prices, border adjustments, etc.).

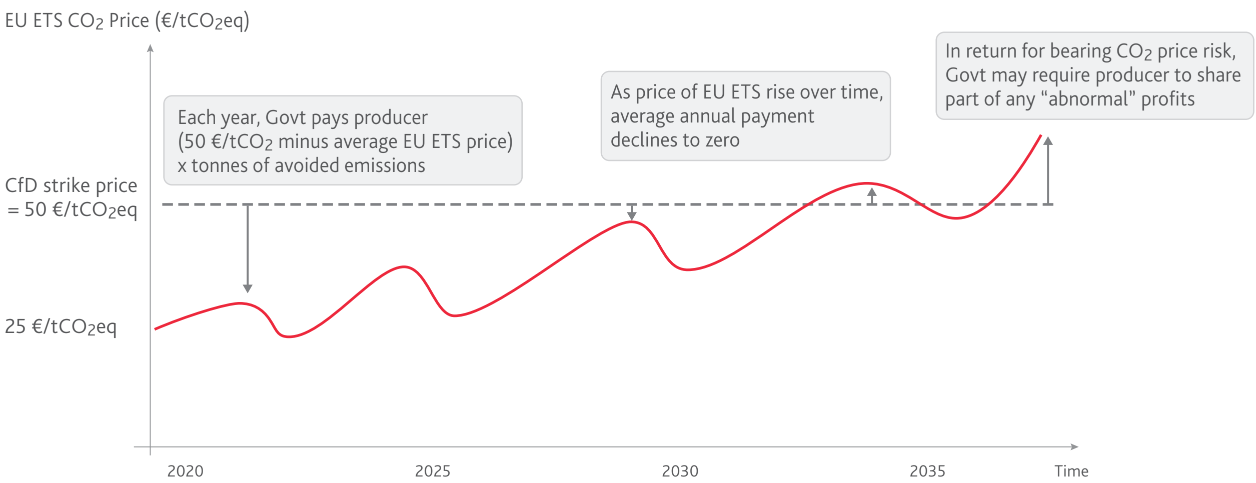
The CCfD would work by setting an effective guaranteed or "strike price" for CO_2 for the project, e.g. at 50€/tCO_2. If, at the end of the year, the average annual EU ETS price was 40€/tCO_2, the project investor would be guaranteed that for each tonne of avoided CO_2 from his project, the national government would provide the difference (i.e. +10€/tCO_2). If the average annual ETS price was at or slightly above 50€/tCO_2, the producer would receive no payment in that year.

If the average annual ETS price was significantly above the strike price of 50€/tCO_2 avoided, then the government would have a choice on how to design the sharing of profits. One option would be to require no payment from the investor back to the government. However, another option would be that, in return for taking on all of the downside risk in relation to CO_2 prices for the project, the Treasury might require the investors to share a portion of any abnormal profits.[6]

This system would thus help to ensure that the CO_2 price faced by investors in commercial scale zero-carbon materials projects better reflects the true social cost of carbon in the economy. It would complement the EU ETS by providing a sufficiently high and predictable carbon price based on which competitive, commercial scale long-term investment decisions could be taken. It would also complement EU or national innovation funds by providing a viable investment case to go from demonstrator to commercial scale immediately, after a breakthrough technology was proven to work.

6 This could be written into the contract terms in various ways. One option would be that if EU ETS prices rose to more that X% above the agreed strike price during any given year, then the project investor would be required to share Y% of the related excess profits per unit sold. For instance, if the strike price were 50€/tCO_2, for every euro the average EU ETS price is above 70€/tCO_2 during the year, the investor has to pay back 50 cents. This way (abnormal) returns would be shared with the government for taking on the downside risk.

FIGURE 2. Example of how a CCfD could work to support commercial-scale investments in first-of-a-kind decarbonised basic materials production



Source: O. Sartor, IDDRI.

4.1. CCfDs could be allocated through a technology neutral, competitive tendering process

Similar to the competitive tendering process for RES projects, the government would announce calls for tender for projects that produce innovative ultra low-carbon basic materials. The tenders would be open to all material types for a predefined scope of basic material uses. These would be usages that currently have a high carbon footprint embedded in the materials (e.g. construction, public works, automotive manufacturing materials).[7]

Winning projects would be awarded CCfDs based on the following criteria:

a) Capacity to replace significant volumes of high-carbon primary[8] materials for the relevant usage;

b) Consistency with national long-term decarbonisation strategy (e.g. the SNBC[9]);

c) Economic justification (i.e. does the project face an incremental cost compared to alternatives?);

d) Cost per unit of CO_2 reduced;

e) Social, environmental or economic co-benefits.

The winning projects would enter into a carbon contract for difference with the government for a period of, say, 20 years. These CCfDs would guarantee that the project would face a given effective CO_2 carbon price during this period. The strike price of the CCfD could be set to reflect only the incremental capital and operating cost of new, low-CO_2 technologies. However, it must also be set a level that protects the Treasury from excessive CO_2 price risk.

This raises a question of asymmetry of information about the true cost of technologies. However, the tender would only be for commercial-scale projects that have already produced successful pilot projects (often in collaboration with large pan-European consortia and public authorities). Thus, experience would already exist with the technologies and key information—given a plausible range of costs—would often be in the public domain.

Secondly, asymmetry of information may be a relatively small problem because the total cost of the mechanism would be much smaller than that of, say, renewable energy tenders (see estimates in Figure 3). Thus, errors would be much less costly for the government than was the case in the case of feed-in-tariffs in Europe in 2008-11.

However, the government could nonetheless protect itself from companies benefitting from asymmetric information through competitive tendering and, in particular, smart tendering process design. For example, it could require expert third party independent verification of incremental cost estimates of the project. It could also start out by setting the strike price it was willing to pay at a relatively conservative level. For instance, it may offer to pay only 50€/tCO_2, while requiring that emissions need to be reduced by a minimum of -50% compared to a benchmark. Then, based on information revealed through the tender, it could then re-evaluate whether this strike price was too high or too low for the given level of ambition. Later on, as more information becomes public about technology costs and competition for tenders develops, the strike price could be determined endogenously by the competitive tendering system.

The contract would also need to specify a volume of production of materials, which would be linked to the proposed project size. This would in turn need to be translated into a relevant number of tonnes of CO_2 that would be "avoided" by the new technology. Thus, in its tender documentation, candidate producers would be required to identify:

a) The relevant product category or product market;

b) The relevant product emissions benchmark per tonne for this product market (this could be done using the existing EU ETS product benchmarks);

c) The rate of substitution in use between its product and the relevant benchmark product (in most cases, this would be one, e.g. one tonne of low-carbon steel for one tonne of BF-BOF steel).

The government would require independent verification of this information a part of the tender. Note that in response to question b), the EU ETS already establishes best available technology benchmarks based on maximum energy efficiency performance of existing "high-carbon" production processes for materials like cement clinker, steel, aluminium and numerous basic chemicals. Thus, a new set of benchmarks would not be required.

The volume of the CCfD would be linked to project size, i.e. the production capacity of the relevant production unit or site. However, the payment received at the end of each year would be based on actual production data. Thus, the site would only be paid for what it produces. Under the EU ETS, companies in the basic materials sectors are required to report this information already, in relation to their verified emissions reporting obligations and to manage their free allocation of allowances. Thus, this would not require a new reporting system.

At year-end, the counterparties would settle any annual obligations under the CCfD. This settlement would be based on the average daily CO_2 price observed during the previous year, the verified production volume of the low-carbon material, and the above-mentioned CO_2 benchmark factor per tonne. A third party independent verification of the production level and production process used would be required to receive payment—this could be combined with the EU ETS reporting system to save administrative effort.

7 Different usages could perhaps be progressively targeted by the tendering process over time, depending on the level of technological readiness of different solutions.

8 As they represent an important part of the circular economy and are often much lower in their CO_2 intensity, secondary (recycled) materials should not be targeted for replacement. On the contrary, highly efficient and innovative circular economy projects could also be eligible in principle, provided they compete on the same criteria as primary materials production projects.

9 MTES (2018). Stratégie Nationale Bas-Carbone

CCfDs would be allocated only to proven, pilot-tested technologies. Thus, basic technology risk should be reduced significantly. However, some risks around the cost, timing, acceptability, etc., of the project would remain from the fact that the projects were first-of-a-kind at commercial scale. There would thus be a residual risk that projects were not delivered on time or to scale.

This project delivery risk could also be handled simply: since the CCfD would be a production-based measure, if the project did not produce, it would receive no payments. If it did produce, it would receive the payments for the exact amount of materials produced. Project delivery risk would thus require no additional financial risks for the government.

The only significant problem for the government would be in the case that a producer wished to significantly delay the relevant contract period of the CCfD, since this could affect the government's decarbonisation strategy. In such cases, project default or renegotiation clauses could be added to annul a CCfD in the event of serious project delays or incapacity to deliver. (Such clauses already exist in many renewable energy auction designs and could be adapted as necessary.)

In general, however, one would expect companies to have a strong incentive to deliver on these projects, since they would have invested significant amounts of their own balance sheet in their success.

4.2. Pilot projects winning EU (or national) innovation funds could have priority consideration for CCfDs to scale up after successful demonstration

The national government could allow winners of innovation grants under the EU ETS or other national innovation funds to become automatically eligible for individual consideration for CCfDs. Once their technology is proven to work, the projects could be given priority consideration for a CCFD that would allow them to scale up a commercial scale plant or production unit. Provided that their technologies were proven to meet the relevant criteria (see above), these projects would expect to be awarded CCfDs to scale up.

This would help to minimise administrative burden and leverage public funds most effectively. Most importantly, it would help to provide a clear perspective for successful technological pilot projects—they would see that they could quickly jump from pilot scale to commercial scale because the government would be there offering them a CCfD if their technology works.

Combining a system like CCfDs with EU and national innovation-funded pilots could thus provide much needed continuity between demonstrator and commercial scale project. It would thus help to overcome the "valley of death" financing problem that has prevented many industrial decarbonisation pilot projects in the past from becoming commercially viable.

4.3. CCfDs would be economically efficient per tonne of CO_2 reduced

From a purely economic perspective, a CCfD would be an economically highly cost-efficient means of reducing CO_2 in France. This can be seen if one compares the expected CO_2 abatement costs to the shadow price of carbon that EU governments and institutions now use to guide fiscal policy decisions. In the wake of the French government adopting the climate neutrality objective in 2017, the French *Plan Climat* sets a trajectory for the carbon component of fiscal policy to be at 86€/tCO_2[10] by 2022 and rise to beyond 100€/tCO_2 by 2030. The European Bank for Reconstruction and Development uses a shadow carbon price of 40-80€/tCO_2 in 2020 and 50-100€/tCO_2 by 2030.[11] Meanwhile, the European Commission's Long-Term Strategy for a Climate Neutral Economy found that shadow carbon prices in the order of 250-350€/tCO_2 would be appropriate by 2050.[12]

In comparison, the strike price of a CCfD for basic materials could even be set at an initially modest value of, say, 50-60€/tCO_2, while still helping to incentivise key climate neutral technologies in the cement or aluminium sector (cf. Figure 1). Over time, this strike price could gradually be lifted slightly to encompass zero-carbon steel making. Depending on the success of the mechanism with these materials, and the availability of key technologies, it could eventually also be expanded to basic chemicals (e.g. ammonia, methanol, ethylene, propylene).

Such a mechanism would thus would help to extend the true cost of carbon across the economy, by closing the gap between the EU ETS carbon price and the price faced by investors in energy intensive basic materials sector.

4.4. Total fiscal commitments would be a small fraction of the cost of renewable energy supports

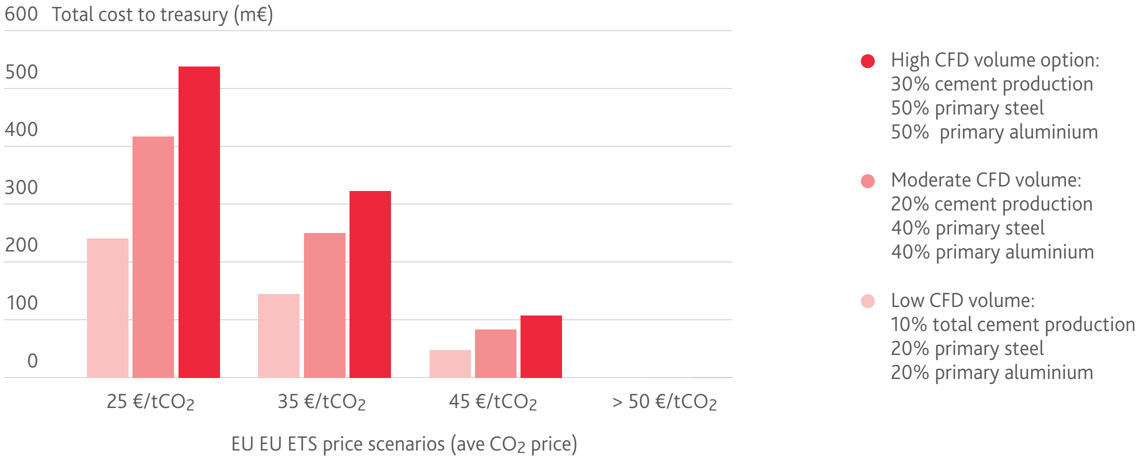
In terms of total direct burden public resources, a CCFD for low-carbon materials would be very small compared to funds spent on the energy and climate transition in other sectors. There are three reasons for this. First, the relevant basic materials markets are much smaller than the domestic energy market in most countries. Second, the CCfD would be available only to first-of-a-kind commercial projects. Thus, the government would not need to subsidise the whole sector, but only a minority percentage of production in the national market. Thirdly, the Treasury would not pay the full strike price of the CCfD. Rather, it would pay (or receive) only the difference between the strike price and the actual observed EU ETS price. Thus, as the EU carbon price steadily rises over time, the net annual cost to the Treasury would fall and eventually become

10 MTES (2017). Plan Climat

11 https://www.ebrd.com/news/2019/what-is-shadow-carbon-pricing.html

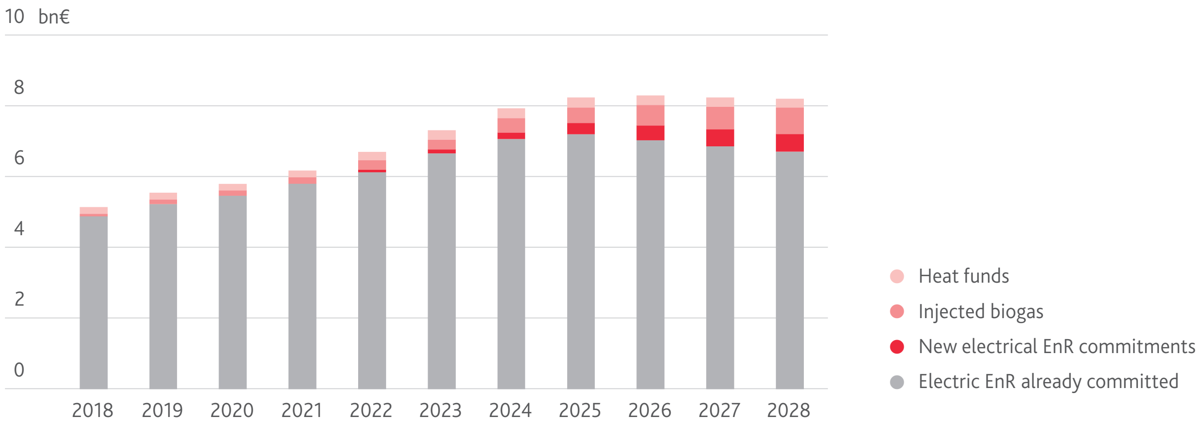
12 European Commission (2018)

FIGURE 3. Total cost scenario estimates of a CCFD for cement, steel and aluminium in France



Source: IDDRI.

FIGURE 4. Financial commitments by the French state to support RES (2018-2028)



Source: French MTES, « PPE 2018-23, 2024-2028 : Synthèse » (2019)
https://www.ecologique-solidaire.gouv.fr/sites/default/files/Synth%C3%A8se%20finale%20Projet%20de%20PPE.pdf

zero. In cases, where CO_2 prices rise very high, the Treasury could potentially also require some of the profits to be paid back to the state (cf. Figure 3).

An example of the potential scale of the cost risk to a national Treasury is explored in Figure 3, based on the example of France. It calculates the possible maximum annual exposure from CCfD obligations under different EU ETS carbon price and CFD volume scenarios. It assumes an average strike price of 50€/tCO_2 and that the mechanism begins by covering only cement, steel and aluminium production (it is assumed that basic chemicals would be covered only later, if the system was successful). This specific scenario assumes the government would not share any profits in the case of EU ETS prices above 50€/tCO_2.

The first scenario shown in Figure 3 assumes that the French Government in total writes CCfDs for a volume of production equivalent to 10% of total annual national cement production, and 20% of both primary steel and primary aluminium production.[13] The second scenario assumes that the government contracts for a volume of production equivalent to 20% of cement, and 40% of primary steel and aluminium. The third and potentially the most expensive scenario increases these numbers to 30%, 50% and 50% respectively. (Larger market volumes are assumed for primary steel and aluminium than cement, since these markets are smaller and the average plant size is larger.)

These results show that, even for relatively low range of carbon price scenarios during the next 20 years, i.e. between

13 Note that the total production of primary steel and aluminium is done by just two plant in each sector, respectively. Thus, such as scenario would imply something like a partial retrofit of these plant—something which may or may not be economical depending on the technology chosen.

35-45€, the total cost for a country the size of France would be quite small, ranging from 321 million €/yr in the highest volume scenario to just 42 million €/yr in the low volume scenario. In the central "moderate volumes" scenario, the cost ranges from 400 to 251 to 84 million € for the 25, 35 and 45€/t scenarios respectively.

To put this in perspective, these numbers would represent only a very small fraction of the total expenditure of that many national governments spend to support zero-carbon solutions in other sectors. As shown in Figure 4, the French government currently spends 5.5 billion € per year on renewable energy solutions and is aiming to increase this to over 8 billion € by 2025. Since the basic materials sector represents roughly 14% of national GHG emissions, it could thus be considered fiscally proportional and justifiable to allocate in the order of 100-500 million €/yr to develop viable zero-carbon innovations, as in other sectors.[14]

4.5. CCfDs can be implemented consistently with EU state aid and WTO principles

From a legal perspective, CCfDs could be considered a form of subsidy in two ways. Firstly, if, during the life of the CCFD, the government pays out more to the investor than it receives back in payments, then it constitutes a form of net payment to the private investor. Secondly, because a CCFD is, by design, *a transfer of risk* from the project developers to the national government, this is technically a state aid under the legal definition. EU state principles and guidelines would therefore apply.

Nevertheless, not all subsidies are considered illegal either under WTO or under EU state aid law. Furthermore, a CCfD, if designed using the principles proposed in this paper, would almost certainly be deemed EU and WTO state aid-compatible. There are several reasons for this.

In the EU, subsidies may be allowed on the basis of Article 107(3)(c) of the Treaty, which states that the Commission may consider to be compatible with the internal market: "state aid to facilitate the development of certain economic activities within the European Union", where such aid does not "adversely affect trading conditions to an extent contrary to the common interest". This exception is currently used, for example, to allow state aid to support a range of investments in the field of environmental protection, renewable energy and carbon capture and storage.[15]

Under the current Guidelines for these items, subsidies can be granted to cover up to 100% of the net cost-benefit difference between environmentally friendly and counterfactual investments in cleaner technologies. Moreover, this aid can apply to both investment *and* operating costs.[16] Importantly, both exceptions are based on the requirement of aid being granted based on a *competitive bidding process*. Hence, CCfDs would need to be allocated this way to be legal (see discussion above).

Another key test for whether nationally administered CCfDs would be legal would be whether their net benefit in addressing environmental externalities outweighs any risk of distortions to internal market or international trade. There is a very strong case that this would be true, if the instrument is designed more or less as described above. For instance, emissions from basic materials sectors are a major hurdle to achieving the EU's climate goal of carbon neutrality and account for a significant share of French, EU and global GHG emissions. Moreover, CCfDs would be designed with the very targeted and explicit aim to address a very specific market barrier of early phase commercialisation, as described above. This, plus the fact that they would only cover the incremental cost of low carbon technologies compared to conventional production, means that no significant trade distortion would be created: there would be no net revenue or profitability advantage in the internal to being low-carbon per se.

Finally, and perhaps most importantly, the mechanism for CCfDs described above would only be *designed to support first-of-a-kind commercial scale projects*. This would be done to overcome the well-known economic phenomenon of pilot projects struggling to attract finance and create a business case to scale up—the so-called "valley of death" financing problem. The aid would therefore be *proportional* to addressing the specific market barrier in question. Furthermore, since they would only be given to first-of-a-kind commercial "examples" of a technology, this means that CCfDs would be an extension of EU R&D&Innovation policy. In general, both WTO and EU state aid law have considered R&D and related innovation policy to be non-trade distorting *de facto*.

There is therefore a strong a priori case that CCfDs for low-carbon basic materials should be and would be considered compatible with EU state aid law.

However, to avoid uncertainty and risks, it would be desirable for this to be clarified explicitly during the next revision of EU State aid guidelines for environmental aid (to be revised in 2022). Specifically, one possible complexity is that the current Guidelines state that they do not apply to the "design and manufacture of environmentally friendly products, machines or means of transport". This exclusion is explained in footnote 10, which explains that, "*environmental aid is generally less distortive and more effective if it is granted to the consumer/user of environmentally friendly products instead of the producer/manufacturer*

14 These numbers would also not significantly increase the total funds engaged over the next 20 years. For instance, the PPE of 2019 notes that the government has committed to spend 120 billion € over the coming 20 years on the energy transition, averaging 6.25 billion €/yr.

15 Cf. Communication from the Commission — Guidelines on State aid for environmental protection and energy 2014-2020, *OJ C 200, 28.6.2014*

16 Cf. Communication from the Commission — Guidelines on State aid for environmental protection and energy 2014-2020, *OJ C 200, 28.6.2014,* Section 3.2.5.3 makes explicit reference to operating costs as one of the relevant factors that can lead to higher costs compared to the counterfactual investment in a more polluting technology.

of the environmentally friendly product. In addition, the use of environmental labels and claims on products can be another means to allow consumers/users to make informed purchasing decisions, and to increase demand for environmental friendly products….In this light, the Commission does not include specific rules concerning aid for the design and manufacture of environmentally friendly products in the scope of these Guidelines."

At first glance, this current language may appear to complicate the interpretation of inclusion of CCfDs for manufactured basic materials like cement or steel under EU environmental state aid exemptions. However, it should be evident from the foregoing discussion in this Study that labelling and information to consumers would be not be an effective instrument by itself to make up for the fundamental lack of economic competitiveness faced by low-carbon basic materials. It is also evident from the above that there are good reasons to consider them state-aid compatible and that the current guidelines (with the exception of CCS) were simply not designed with the relevant sectors and problems in mind. Hence, the 2022 revision of these Guidelines, or indeed a clarifying note from the Commission, could help to resolve this ambiguity.

5. CCfDs NEED TO BE PART OF A *POLICY PACKAGE* TO DECARBONISE BASIC MATERIALS

CCfDs for decarbonised materials projects have the potential to fill a crucially important gap in the current policy framework to decarbonise energy intensive industries in Europe (and potentially in other countries).

However, it must be stressed that CCfDs are not a panacea to decarbonise basic materials industries. Other policies will be needed to help ensure that they can be as effective and cost-efficient as possible. Other policies will also be needed to tackle parts of the decarbonisation problem that CCfDs do not fully address. Three issues are important to mention in this regard.

Firstly, even with CCfDs, the very first commercial scale projects for some technologies will encounter a higher degree of risk aversion from industrial or financial sector investors. This is unavoidable, because they are first of-a-kind projects. At least for some technologies, industrial or financial sector companies could demand relatively high strike prices in CCfDs to cover themselves against this uncertainty. This would be undesirable, because it would effectively be adding risk/cost to the public sector, while potentially providing windfall higher profits to the private sector.

In practice, this problem could be mitigated in two ways. One option is that the public sector (e.g. national or EU investment banks) could co-invest upfront capital in the project—thus making it take on some of the equity risk to reassure financial investors, but also giving rights to the public sector to a share of the profits in return. In this case, CCfDs might therefore be part of a package deal, whereby upfront equity funds are provided by public investment banks (to manage the capital cost), while CCfDs would be given to help cover incremental operating costs.

Another option is that the public sector could help to motivate the private sector to take on a greater appetite for these project risks through *technology sunset clauses*. For instance, by signalling that a given sector would have to meet increasingly strict CO_2 performance standards over the coming 10-15 years, the relevant sectors could be motivated to take on more equity risk on some of these projects. This could be done, for instance, through changes to public procurement standards that ratchet down over time; and *via* political signals that operating licences for plant in these sectors will no longer be granted unless certain CO_2 performance standards are met. Under these kinds of circumstances, first of-a-kind commercial scale investments for low CO_2 technologies would then become more strategically relevant for these businesses and risk appetite would be evaluated differently. (This would be similar for instance to the way major auto companies are taking on investments to develop electric vehicles—sometimes are no or limited short-term profit—because car pollution standards are tightening in Europe.)

Secondly, in the long run, CCfDs will not be the optimal instrument to roll out 100% of the market's production capacity. For this, a mechanism will be needed to not only ensure higher carbon prices (ideally in the EU ETS), but also to ensure that the consumer of basic materials ultimately pays the cost of decarbonised basic materials production. In the long run, a border carbon adjustment and full auctioning of CO_2 allowances in the EU ETS could in principle achieve this aim. In the shorter term, however, a nationally based carbon consumption charge on consumers of basic materials, as discussed in section 3, may be more feasible. This could then be superseded either into an EU-based consumption charge or a border adjustment system. Either way, some such mechanism will be needed, so that the implicit subsidies from CCfDs could ultimately be removed.

Finally, some sectors face specific barriers to decarbonisation that would also require addressing with targeted measures. For instance, the cement sector cannot currently sell certain low carbon cement alternatives as cement under certain EU cement standards. Etc. These issues would need addressing in parallel.

REFERENCES

M. Axelson, I. Robson, G. Khandekar, T. Wyns (2018). Breaking Through Industrial Low-CO2 Technologies on the Horizon, IES-VUB, Brussels. https://www.ies.be/node/4695

Bataille, C., M.Ahman, K.Neuhoff, L.Nilsson, M.Fischedick, S.Lechtenböhmer, B.Solano, A. Denis-Ryan, S.Steiber, O.Sartor, S.Rahbar, H.Waisman (2017). *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 · March 2018 https://www.iddri.org/en/publications-and-events/scientific-publication/review-technology-and-policy-deep-decarbonization

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"

European Commission (2019). *Commission Regulation 2019/856 of 26 February 2019 with regard to the operation of the Innovation Fund* https://ec.europa.eu/clima/policies/innovation-fund_en

European Commission (2014). *Communication from the Commission — Guidelines on State aid for environmental protection and energy 2014-2020,* OJ C 200, 28.6.2014 https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52014XC0628%2801%29

European Commission (2018). *In-depth analysis in support of the Commission Communication COM(2018) 773, A Clean Planet for all A European long-term strategic vision for a prosperous, modern, competitive and climate neutral economy*. European Commission, Brussels. https://ec.europa.eu/knowledge4policy/publication/depth-analysis-support-com2018-773-clean-planet-all-european-strategic-long-term-vision_en

IEA (2018). *IEA Technology Roadmaps: Low-Carbon Transition in the Cement Industry*, IEA/OECD Paris https://webstore.iea.org/technology-roadmap-low-carbon-transition-in-the-cement-industry

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

Material Economics (2018). *The Circular Economy a Powerful Force for Climate Mitigation,* Material Economics, Stockholm.

Material Economics (2019). *Transformative innovation for a prosperous and low-carbon industry*, Material Economics, Stockholm.

Metalbulletin (2018). Elysis could revolutionize aluminium smelting technology https://www.alcoa.com/global/en/what-we-do/elysis/pdf/Alcoa-Elysis-Metal-Bulletin.pdf

MTES (2017). Plan Climat: https://www.ecologique-solidaire.gouv.fr/sites/default/files/2017.07.06%20-%20Plan%20Climat_0.pdf

MTES (2018). Projet de Stratégie Nationale Bas-Carbone : La transition écologique et solidaire vers la neutralité carbone, https://www.ecologique-solidaire.gouv.fr/strategie-nationale-bas-carbone-snbc

Neuhoff, K. *et al.* (2016). Inclusion of Consumption of carbon intensive materials in emissions trading – An option for carbon pricing post-2020, Climate Strategies, London. https://climatestrategies.org/wp-content/uploads/2016/10/CS-Inclusion-of-Consumption-Report.pdf

Neuhoff, K, O. Chiappinelli, C. Bataille, M. Haußner, R. Ismer, E. Joltreau, I. Jürgens, C. Piantieri, J. Richstein, O. Sartor, P. Singhal, J. Stede, (2018). *Filling gaps in the policy package to decarbonise production and use of materials*. Climate Strategies, London. https://climatestrategies.org/wp-content/uploads/2018/06/CS-DIW_report-designed-2.pdf

Quinet (2019). Rapport de la Commission Quinet : La Valeur de l'Action pour le Climat » , France Strategie, Paris. https://www.strategie.gouv.fr/sites/strategie.gouv.fr/files/atoms/files/fs-2019-rapport-la-valeur-de-laction-pour-le-climat_0.pdf

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

Scrivener, K.L., John, V.M., Gartner, E.M. (2018). Eco-efficient cements : Potential economically viable solutions for a low-CO2 cement-based materials industry . Cement and Concrete Research. UN Environment, doi:10.1145/2370216.2370232

Wyns, T., G. Khandekar, M. Axelson, O. Sartor, K. Neuhoff (2019). *Industrial Towards an Industrial strategy for a Climate Neutral Europe*, IES-VUB, IDDRI, DIW Berlin, E3G, Brussels 2019. https://www.ies.be/node/5074

WTO (1998, accessed: 2019). Explaining General Agreements, Series 2 : General Agreement on Tariffs and Trade, WTO, Geneva https://www.wto.org/english/res_e/booksp_e/agrmntseries2_gatt_e.pdf

WTO (1996, accessed: 2019). Agreement on Subsidies and Countervailing measures, WTO, Geneva

https://www.wto.org/english/docs_e/legal_e/24-scm.pdf

WTO.org (accessed: 2019). https://www.wto.org/english/thewto_e/whatis_e/tif_e/agrm8_e.htm

Decarbonising basic materials in Europe:
How Carbon Contracts-for-Difference could help bring breakthrough technologies to market

Oliver Sartor, Chris Bataille (IDDRI)

Citation: Sartor, O., Bataille, C. (2019). Decarbonising basic materials in Europe: How Carbon Contracts-for-Difference could help bring breakthrough technologies to market. IDDRI, *Study* N°06/19.

ISSN: 2258-7535

This article has received financial support from The French government in the framework of the programme "Investissements d'avenir", managed by ANR (the French National Research Agency) under the reference ANR-10-LABX-01.

CONTACT
oliver.sartor@iddri.org
chris.bataille@iddri.org

Institut du développement durable et des relations internationales 41, rue du Four - 75006 Paris – France

www.iddri.org
@IDDRI_ThinkTank