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Climate Protection in Energy Intensive Industries

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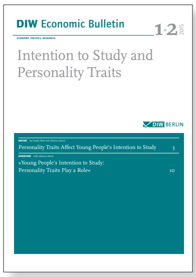

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Modernization and Innovation in the Materials Sector: Lessons from Steel and Cement

By Karsten Neuhoff, Andrzej Ancygier, Jean-Pierre Ponssard, Philippe Quirion, Nagore Sabio, Oliver Sartor, Misato Sato and Anne Schopp.

Since 2007, the European cement and steel sectors have been characterized by substantial surplus production capacity. Hence re-investment in primary production of many materials remains limited and endangers the longer-term economic viability of many plants. Opportunities for innovation and modernization could overcome these challenges. They are linked to new demands for more efficient and lower-carbon production processes, higher-value materials with less weight and carbon intensity, and new applications in construction, transport and the energy sector. Only a limited share of these opportunities has been captured so far, which can be attributed to the policies implemented to date.

For the future realization of innovation and modernization opportunities, a clear longer-term perspective is required in three policy elements. First, an effective carbon price emerging from the European Union Emissions Trading System (EU ETS) that is relevant both for producers, to facilitate switching to lower-carbon production, and also for intermediate and final consumers to create a viable long-term business case for large-scale investments in lower carbon processes, materials, and efficient use. Second, public funding for the innovation and demonstration of breakthrough technologies. Third, institutional arrangements including aspects like norms and standards as well as provisions for training of craftsmen need to be adjusted to enable the use of new production processes and materials.

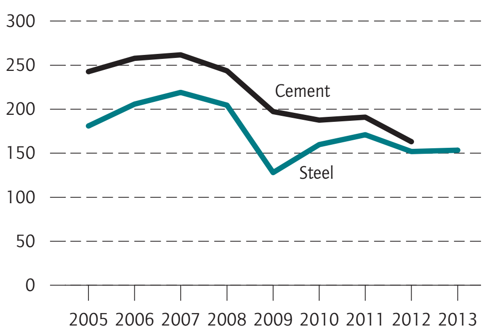
Between 2007 and 2012, carbon-intensive materials like steel and cement faced in Europe a decrease in real consumption by more than 30 percent (Figure 1). Only a proportion of pre-crisis demand is expected to be recovered in the coming years.

This decrease resulted in low margins and losses that will persist until the production capacity better matches demand, most likely through closures (Figure 2). Although all of this is not linked to climate policy, it does limit opportunities for reinvestment and thus requires attention in order to avoid putting the longer-term viability of European installations at risk. Financial challenges that result from oversupply can distract management from long-term strategies, thus requiring additional effort to engage the sectors in the development of low-carbon roadmaps.

In 2012, around 15 percent of industrial greenhouse gas emissions in Europe originated from iron and steel pro-

Figure 1

Consumption of steel and cement in Europe (EU-28)
In million tons finished products



Sources: Cement Sustainability Initiative, World Steel Association.

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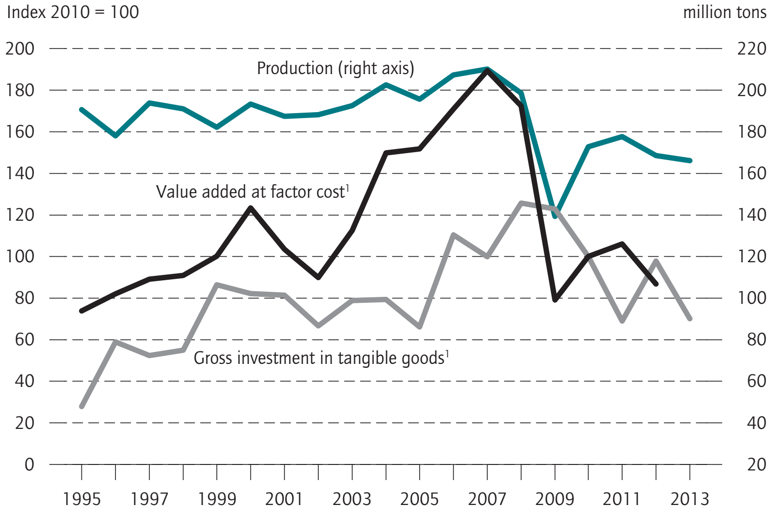
Demand for steel and cement remains below pre-crisis levels.

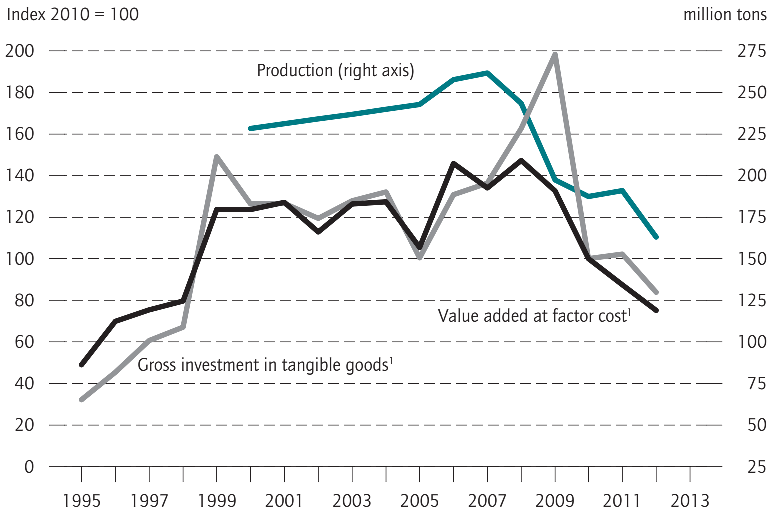
Figure 2

The European steel and cement sectors

Steel sector



Cement sector



1 Calculated using all available information on the respective statistics of the individual EU-27 countries. All values in prices of 2010.

Source: Own calculations based on Eurostat, World Steel Association and Cement Sustainability Initiative data.

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Gross investment remains well below pre-crisis levels.

duction and another 23 percent from cement production.[1] Other carbon-intensive materials include pulp and paper, plastics, and non-ferrous metals like aluminum and copper. In these sectors, most emissions are associated with primary materials production, e.g. hot-rolled steel from iron produced in blast oxygen furnaces.[2] This needs to be taken into account when assessing which policy framework can most effectively leverage mitigation opportunities. Such a policy package must be placed in the context of the 2030 emission reduction targets, as well as the deeper emission reductions following 2030 that were confirmed at the G7 meeting in June 2015.[3]

A two-year European Research Project reviewed the experience of the steel and cement sectors with a portfolio of innovation and modernization opportunities so as to assess the role of different market and policy drivers (Box). Our analysis assesses the investment framework in the iron and steel and cement sectors in particular and analyzes the extent to which a well-designed policy package could help attract investment and contribute to an economically and environmentally sustainable development of the European materials sectors.[4]

A portfolio of modernization opportunities for the steel and cement sectors

The aggregated picture within the steel and cement sectors has been blurred by the economic crisis in Europe. For this reason, it is important to uncover the individual developments beyond the aggregated sector trends. Figure 3 shows a number of different modernization and innovation options that can save resources, energy, and carbon emissions in the steel and cement sectors. These can be grouped into: (i) energy efficiency improvements resulting from a lower utilization of energy per unit of product; (ii) CO_2 efficiency improvements by reducing the carbon intensity of fuels or breakthrough technologies such as carbon capture and sequestration (CCS) or carbon capture and use (CCU); and (iii) more efficient use of materials, and the use of less carbon-intensive materials.

Potential for energy efficiency improvements is limited

Energy costs are a significant component of the overall costs of production for carbon-intensive materials like steel and cement. Hence energy efficiency improvements have long been the focus of management and are better understood here than in other parts of industry. However, potentials for energy efficiency improve-

1 According to EEA greenhouse gas data provided in 2015. In the following, iron and steel production is more concisely referred to as the steel sector.

2 International Energy Agency (2007): Tracking Industrial Energy Efficiency and CO_2 Emissions. IEA/OECD. Paris.

3 In early June, the G7 leaders released a joint communiqué that reaffirms their previously stated goal of limiting global warming to less than 2 degrees Celsius above pre-industrial levels.

4 The authors are grateful for the support of Chris Beauman.

Box

The Climate Strategies project "Carbon Control Post 2020 in Energy Intensive Industries"

This report summarizes the insights from the research project "Carbon Control Post 2020 in Energy Intensive Industries", led by the German Institute for Economic Research (DIW Berlin) and convened by Climate Strategies (www.climatestrategies.org). Climate Strategies is a not-for-profit organization that works with an international network of experts to bridge the gap between academic research and policy and to provide unrivalled analyses for international decision-makers in the fields of climate change and energy policy.

The project is funded with support from the governments of France, Germany, the Netherlands and the United Kingdom as well as from Heidelberg Cement and Tata Steel Europe. The views expressed and information contained in the report are independent perspectives of researchers and not necessarily those of or endorsed by the funders.

Project partners of DIW Berlin were CNRS-Ecole Polytechnique, Centre International de Recherche sur l'Environnement et le Développement (CIRED), The Institute for Sustainable Development and International Relations (IDDRI) (all France), Hertie School of Governance, University Erlangen-Nürnberg (both Germany), Radboud University Nijmegen (the Netherlands), The Grantham Research Institute on Climate Change and the Environment at the London School of Economics and Political Sciences, and University College London (both United Kingdom).

A first report on the cement sector was published in February 2014, followed by a second report on the steel sector in October 2014.[1] Both reports combine a literature review, data analyses, a legal review, in-depth interviews with selected senior managers of steel companies, extensive discussions with several CEOs, and workshops with representatives of governments, the European Commission, non-governmental organisations, and industry.

1 See also Neuhoff, K., Vanderborght, B. et al. (2014): Carbon Control and Competitiveness Post 2020: The Cement Report. Climate Strategies. London, February 2014; and Neuhoff, K., Acworth, W. et al. (2014): Carbon Control and Competitiveness Post 2020: The Steel Report. Climate Strategies. London, October 2014.

ments of primary steel and cement production with existing technologies are estimated to be in the order of only 10–20 percent for European installations. They are pursued only where investment costs are covered by energy and carbon cost savings and paid back within 2–4 years.[5] Such short payback periods for cost-saving measures are common requirements for industry actors.

In energy-intensive industries, most energy efficiency savings will mainly be realized as part of large-scale refurbishment or replacement investments, but such opportunities are limited due to the combination of long investment horizons, low demand, and excess capacity in Europe, leading to a slow replacement of existing stock.

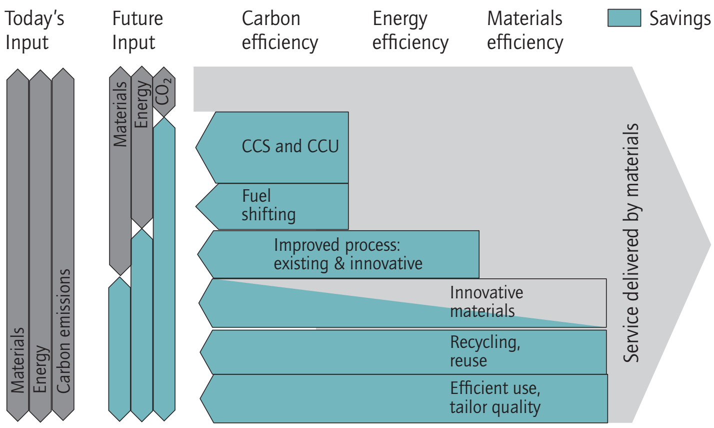
Many fuel-switching options have already been implemented

The cement sector reduced fuel-related carbon intensity— which constitutes about one third of the sector's to-

5 Neuhoff, K., Vanderborght, B., et al. (2014), l.c. and Neuhoff, K., Acworth, W., et al. (2014), l.c.

Figure 3

Multiple benefits of modernisation and innovation opportunities for materials and energy input and CO_2 emissions



Source: Own illustration.

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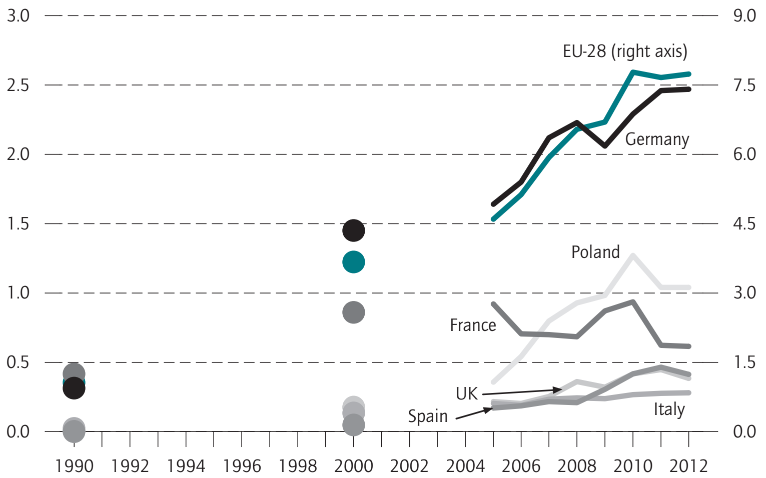
A portfolio of modernization and innovation opportunities facilitates large-scale emission reductions as well as savings of material and energy.

Figure 4

Use of alternative fossil fuels[1] in the cement industry
In million tons



1 Alternative fossil fuels are derived from waste, excluding biomass waste.

Source: Cement Sustainability Initiative, GNR Indicator 313.

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The use of alternative fuels has increased substantially.

tal emissions—by 6 percent between 2005 and 2011.[6] This was achieved by replacing 9 percent of coal with biomass residue that is considered carbon neutral according to EU ETS accounting standards. In addition, co-firing pre-treated waste products with lower carbon intensity than coal played a role in lowering the energy carbon footprint after the European Union Waste Framework Directive was implemented (see Figure 4). As regulatory constraints are removed, both of these options become commercially attractive, as the high incineration temperatures of cement kilns allow the sector to switch to waste products as fuel sources rather than incurring costs for acquiring fossil fuels.

In the steel sector, shifting away from coal to natural gas and electricity with the Direct Reduced Iron process (DRI) combined with Electric Arc Furnaces (EAFs) reduces carbon emissions of primary steel production by between 20–40 percent.[7] However, the economics of DRI depend on the combination of coal, gas, and carbon prices. The current combination of high gas prices with low coal and carbon prices makes DRI economically unattractive in Europe, but it could play a future role as part of innovative process technologies.[8]

In both of these sectors, around two-thirds of the emissions are linked to process emissions from the chemical transformation of limestone into clinker (in the case of cement), or the reduction of iron ore to raw iron (in the case of steel). Process emissions will not be reduced by fuel shifting to lower carbon fuels and energy efficiency improvements: they can only be reduced by breakthrough technologies.

Promising new process technologies not available on a commercial scale

Breakthrough technologies including CCS or CCU, are being explored to combine efficiency improvements and large-scale emission savings compatible with long-term carbon constraints.

For steel, the potential for such breakthrough process technologies has been explored as part of the European Ultra-Low Carbon Steelmaking (ULCOS) consortium, initiated in response to carbon constraints expected from climate policy. Outside of Europe, similar initiatives have been developed. So far, this has resulted in three small-scale demonstration projects for different technology options funded jointly by public and private sectors. However, further progress has advanced at a slower pace since 2012, primarily because the initial funding was not continued—it would have needed to be expanded in order to match increasing investment needs for a stepwise scale-up of demonstration plants towards the commercial scale.

The NER 300 program[9] uses the revenues from the sale of European Union Allowances to new entrants in the EU ETS as a means to fund innovation in CCS and renewable energy projects. This represents an additional opportunity for funding innovation in new low-carbon technologies and processes. However, the opportunities that were provided from the NER 300 fund were

6 For a detailed analysis, see: Branger, F., Quirion, P. (2015): Reaping the Carbon Rent: Abatement and Overallocation Profits in the European Cement Industry, Insights from an LMDI Decomposition Analysis. Energy Economics 47, 189–205.

7 International Energy Agency (2013): Overview of the current state and development of CO_2 capture technologies in the iron-making process. IEAGHG Report 2013/TRG.

8 According to recent research, DRI is currently being considered in the United States as well as in Japan. See: Fischedick, M. et al. (2014): Technoeconomic evaluation of innovative steel production technologies. Journal of Cleaner Production 84, 563–580; and Pinegar H.K., Moats, M.S. et al. (2011): Process Simulation and Economic Feasibility Analysis for a Hydrogen-Based Novel Suspension Ironmaking Technology. Steel Research International 82, 951–963.

9 The NER 300 program has been established by the revised Emissions Trading Directive 2009/29/EC. According to article 10(a) 8, proceeds from the sale from up to 300 million allowances should be used to finance commercial demonstration projects in the area of CCS and renewable energies. For further information on the EU NER 300 program, see http://ec.europa.eu/clima/policies/lowcarbon/ner300/documentation_en.htm.

considered too risky by many CCS project promoters, since any support for a demonstration project would have had to have been returned in the event that the technology failed.[10] Steel and cement companies struggle to bear the full risk of unknown breakthrough technologies, particularly because there are large technology spillovers that cannot be captured by the companies. This experience needs to be taken into account in the design of the new European Union innovation financing arrangements, given that the October 2014 European Council conclusions explicitly open the future Innovation Fund to also support low carbon innovation in the manufacturing and thus materials industry. Aside from the funding issue, the lack of public support for CCS in the power sector in some Member States is a concern, and points to the importance of effective early engagement strategies with the broader public.

For steel companies to fully re-engage in innovative process technologies, a long-term business case for a large-scale rollout of new technologies after the demonstration phase will also be important. As most of the process technology options involve CCS, and thus higher investment and operational costs, a clear perspective on how companies can recover high costs is necessary. This will need to be addressed in the design of the EU ETS carbon leakage protection measures post-2020.[11]

Tailored use of materials saves energy, carbon, and resources

Tailoring materials to their specific application can allow for the delivery of the same service with lower energy, carbon, and resource usages. For example, when the automotive sector had to reduce the weight of cars to meet fuel efficiency standards in the 1990s, the steel industry innovated and further tailored steel to specific industry-led demand. With high-strength steel and new forming techniques, the steel sector achieved about 25 percent savings in automobile body weight, which has been the case since 2005.[12] This reduces total emissions, as emissions from steel production are largely proportional to the weight of the steel. While such a shift from volume to value of steel will decrease the demand for primary steel production, it might provide higher margins and job opportunities in higher-value products.

Such progress has not been achieved for steel or cement use in the construction sector.[13] Significant mitigation potential exists in the construction sector through more efficient steel and cement use: for example, by using tailored shapes, supporting multiple loads with fewer structures, aligning loads to avoid bending, and avoiding over-specification of loads.[14] A clear and credible carbon price in steel and cement product prices is likely to encourage more tailored procurement of carbon-intensive materials in the construction industry. However, this will depend as much on the adaptation of building practices, standards, and information systems—and can require provision of information, e.g. with labeling approaches and reporting requirements—as on the training and certification of different actors. This will also require significant coordination across the value chain.

Innovative materials – high potential but limited incentives

Introducing innovative materials has considerable potential for emission reductions, but it is a challenging process, as evident from experiences with clinker substitutes in cement. While the main chemical basis for cement is clinker derived from limestone, some clinker may also be substituted with slag (a by-product of steel production) or fly ash (a by-product gathered from exhaust streams of coal-fired power plants) (Figure 5). However, substituting by-products for limestone was initially met with resistance from the construction industry due to alterations to the technical qualities of the concrete that was produced (such as the level of early and late strength, sulfate resistance, color, and workability). This may have delayed the adjustment of codes and standards for concrete and buildings that previously created requirements for high shares of clinker, and thus secured demand from installations of incumbent companies. This reluctance has been overcome through engagement with the construction industry—for example, by means of demonstration projects and knowledge sharing of positive experience with new materials.

The availability of clinker substitutes in Europe varies across regions. While the potential of using slag from steel production is largely exhausted, some potential for using fly ash from coal power stations in the power sector remain. The shift away from coal in the power sector

10 In other regions, such as Japan, efforts continue to progress through the COURSE50 program and exploring the synergies of low-carbon innovative options with alternative energy vectors such as hydrogen.

11 Carbon leakage protection refers to special provisions to avoid the risk of relocation of producers that bear large incremental costs from carbon pricing. For further details, see in the same issue Neuhoff, K., Acworth, W. et al. (2015): Leakage Protection for Carbon-Intensive Materials Post-2020. DIW Economic Bulletin 28+29/2015.

12 Zuidema, B.K. (2013): On the Role of Body-in-White Weight Reduction in the Attainment of the 2012–2025. US EPA/NHTSA Fuel Economy Mandate. Presentation to the Great Design in Steel Seminar. United States.

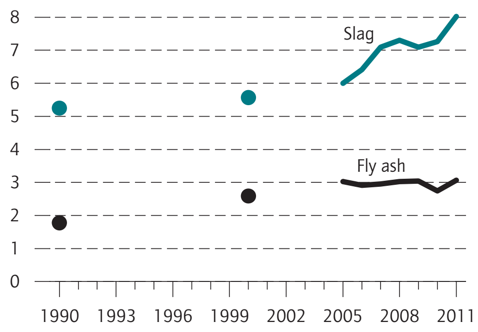
13 Giesekam, J., Barrett, J. et al. (2014): The greenhouse gas emissions and mitigation options for materials used in UK construction. Energy and Buildings (78), 210.

14 Allwood J. M. et al. (2012): Sustainable Materials: with both eyes open. Cambridge, UK: UIT Cambridge.

Figure 5

Use of selected clinker substitutes in European cement production

In percent of total cement volume



Source: Cement Sustainability Initiative, GNR Indicator 3219.

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Subsituting away from clinker reduces emissions but also changes the composition of the cement.

will, however, reduce fly ash availability. Other clinker substitutes can further decrease the clinker ratio in EU cement production (for example pozzolana).

A variety of new low-carbon cement alternatives are being investigated. Any such innovative low-carbon cements are not expected to provide the very same functions as conventional cement. Instead they might be used—and possibly preferred—according to the relative importance of soundproofing, different stability requirements, and fire protection. A further rationale for a more differentiated set of low-carbon cement types might emerge from the limited availability of resources, as few suitable materials are as accessible as limestone.

Low-carbon cement options include "new" cements based on "old" ideas, such as calcium sulfoaluminate cement, clinker mineralization, as well as other new products. Cement sector executives argue that developing and demonstrating such new products will take 10 to 15 years. Perhaps the most important barrier for product innovation is the absence of market demand for products with lower embedded carbon, especially as long as carbon prices are low and not reflected in cement prices. Even with carbon prices included in cement costs, it will take time, and the process of encouraging users to make the shift to new cement types will be gradual: the use of cement and concrete for infrastructure with a very long lifetime, particularly foundations and buildings, makes proven durability of the cement a necessity.

Focus extending from quantity to also quality of recycled materials

A ton of scrap steel collected and recycled saves about 75 percent of emissions compared to a ton of newly produced steel.[15] A maturing economy increasingly replaces rather than adds buildings and cars, and thus the volume of recovered scrap in Europe already equals 64 percent of European steel consumption.[16] This rate will increase further as the economy continues to mature, thus gradually reducing the demand for primary steel production.

While almost 100 percent of steel from the automotive sector and structural components in construction is later recycled, there is still potential for improvement of recycling rates for reinforcement steel in construction, packaging, and appliances. Action is required not only at the recovery stage, but also during the primary steel production and design stages in order to facilitate better separation and recovery of different materials down the value chain, thus enhancing the recyclability of the collected scrap.

While mature OECD economies collect larger volumes of scrap than do emerging economies, they also retain a large capacity for primary steel production. Hence about 20 percent of European Union scrap is exported, and replaces primary steel production in emerging economies. Thus using more of this collected scrap in Europe instead of exporting it would decrease carbon emissions in Europe in the short run, but lead to an equivalent emission increase outside of Europe. Globally and over time, however, improving steel recovery and increasing recycling volumes are likely to form part of the solution to curb steel emissions, together with other strategies such as extending the life of steel products, diverting scrap to other uses before recycling, and reusing metal components without melting them and converting them into new products.

While steel recycling creates material of similar quality, recycling of other materials only allows for lower-quality products (paper, glass) or very low-quality products (some plastics, concrete). Some materials also create economic and environmental costs when treated at the end of their lifetime. This is reflected in total life cycle assessments of materials. It remains debated how the lifetime emissions concept should best be reflected in carbon, resource efficiency, or other environmental policies, so as to provide the appropriate incentives for material choice to producers and consumers.

15 Average CO_2 emissions in the EU: 1888 kg CO_2/ton for integrated steelmaking and 455 kg CO_2/ton for secondary steel route. EUROFER (2013): A Steel Roadmap for a Low Carbon Europe 2050. EUROFER.

16 Genet, M. (2012): EAF and/or BOF. Which route is best for Europe? Presented at the 8th Steel Markets Europe Conference. Brussels. May 2012.

Implications for future policy design

The realization of the various opportunities for innovation and modernization depends on a suitable policy framework.

CO_2 price signal for producers needs to be strengthened

Capital-intensive investments in the steel sector require long-term decision and investment periods. Viable returns over more than a decade must also be ensured. Hence early clarity on longer-term perspectives, especially for large scale-investment projects and the development of new low-carbon technologies and materials, is essential.

Technological opportunities are inherently uncertain and hence it is impossible for the industry to commit to, and for the governments to prescribe, a precise emission trajectory for any one individual sector. This points to the value of coverage of emissions across a number of sectors: It provides a credible commitment to an overall emission reduction trajectory, while offering the flexibility to respond to technology developments at the sector level.

Long-term carbon constraints will only obtain credibility and enhance the investment framework if today's carbon prices are consistent with the long-term expectations. As such, the decline of the EU ETS carbon price from 30 €/t in 2008 to 5–10 €/t in recent years significantly reduced the credibility of the EU ETS and virtually eliminated the incentives created through the scheme. This has been broadly recognized and is the motivation for the Market Stability Reserve that will be in effect from 2019 onwards.

CO_2 price signal needs to be preserved for intermediate and final consumers

To avoid risks of carbon leakage, installations in the cement and steel sectors receive allowances for free, based on historic activity levels and emission benchmarks.[17] This use of ex-ante free allocation as a leakage protection mechanism has resulted, in the steel and cement sector, in a low and uncertain carbon price pass through to intermediate and final consumers.

However, the business case for low-carbon process technologies and materials requires that the carbon price be reflected in the price of carbon-intensive materials. Thus the CO_2 costs are taken into account in consumer choices among materials, more efficient uses, and substitutes. In many instances it will not be the final consumers, but rather the intermediate consumers like the automotive or construction industries that will make the decisive choices—but they will do so in light of the total costs ultimately borne by final consumers.

The full reflection of carbon costs in the price of carbon-intensive materials is also important for allowing the producers of alternative low-carbon production processes to account for incremental production costs in the price of their product, and thus allow them to foresee longer-term perspectives for cost recovery and economic viability of new production processes.

An effective carbon price in the value chain is necessary to provide a credible perspective for the large-scale use of innovative materials and production processes. This is a necessary condition for companies to allocate resources and dedicate management and research capacity. This points to the importance of exploring new approaches to carbon leakage protection that preserve the carbon price signal for intermediate and final consumers.

Breakthrough technologies require financial support

Product and process innovation has very different features with respect to the scale of investment required and the timeframe over which new technologies are commercially applicable. For successful product innovation, the close link to consumers is essential. Short timeframes from development to market implementation and clear product differentiation for the consumer allow for largely private sector-funded innovation. This has been evident in the improvement of steel qualities achieved over the last decade through the close cooperation between steel producers and the automotive sector.

However, if markets are fragmented, timescales are longer, risks are larger, and the relevance of technology spillovers is higher, there is a case for public funding to complement private investments. Innovation in low-carbon steel processes that also include CCS[18] is unlikely to be consumer-led, especially if the innovation does not improve the properties of the resulting steel. In addition, timeframes and investment volumes for demonstration are large, pointing to a more prominent role for public policy to guide and support the innovation process compared to classical product innovation. At the demonstration stage, there is a need for a sustained public funding of process innovation to transform ideas into industrial

17 For further details, see in the same issue Neuhoff, K., Acworth, W., et al. (2015), l.c.

18 Bassi, S., Boyd, R. et al. (2015): Bridging the Gap: improving the economic and policy framework for carbon capture and storage in the European Union. Grantham Institute for Climate Change and the Environment and the Centre for Climate Change Economics and Policy Brief June 2015.

reality. Technological progress should become the key criterion in determining the continuation of funding.

Once breakthrough technology options reach a commercial scale, investment in initial plants will still involve significant risks that extend beyond the plant exploiting the new technology to the entire firm. In the case of the steel sector, this is due to the central role of the blast furnace in integrated steelmaking. Firms are reluctant to bear such risks, in particular if low-risk alternatives exist in continuing the use of established technologies Therefore risk-sharing arrangements may be required. These should involve the public sector both with regard to the risks and the benefits. Future financing arrangements might consider the use of quasi-equity instruments, sharing both potential losses and profits from operations of initial commercial-scale facilities.

The adoption of new building practices and materials requires significant upfront investment to demonstrate the viability of new practices and the long-term viability of new materials. The extent to which initial investors will be able to capture the future benefits of the product must be explored in more detail, and if this leaves insufficient incentives, the existence and implementation of additional public support must be structured.

Institutional adjustments and additional regulatory instruments to facilitate implementation of sector roadmaps

Much of the emission reduction in the cement sector up until now was linked to adjustments to regulation for co-firing of waste, new permits to allow co-firing of biomass residue and adjustments to codes and standards for concrete and construction. Investment in innovative techniques and products depends on the confidence that such adjustment will be pursued in a timely manner. Hence an early analysis is necessary to assess whether and which precise adjustments are needed for the exploration and diffusion of further modernization options.

Regulation can help support the diffusion of economically viable options that are currently not being exploited due to inertia and other priorities in decision-making processes. This has been the prominent motivation for codes on thermal efficiency in buildings. Standards and regulation thus helped to facilitate the innovation and deployment of lower-carbon technologies. At the same time, regulation of the thermal performance of buildings limits the operational energy use in buildings, and could be complemented by labelling or standards to limit the volume of carbon embedded in the materials of the building. Or, to give another example, given the conservatism of the building and construction sector with respect to new low-carbon cements, there may be a role for public procurement for specific applications to gradually build up industry experience and provide demand for new cement types.

Potentially, norms and standards could be even more ambitious and prescribe activities that might not be economically viable to encourage innovation and cost reductions, as has been the case with fuel efficiency standards in the automotive industry. In the materials sector, this could involve requiring a certain thermal performance of a primary production process (irrespective of the origin of the materials).

A vision for low-carbon materials

The European production of materials must be highly energy efficient and innovative in a future that is shaped by ambitious climate and energy policy goals. It will therefore be important to develop a positive perspective towards carbon and energy improvements in materials production so as to attract investment and talent, increase efficiency, and remain among the technology leaders.

The 2030 framework for European climate and energy policies and sector-specific roadmaps for 2050 offer this sort of positive perspective, given that regulators develop the roadmap into a fitting policy framework. Materials are at the core of the low-carbon transition, and progress requires a dynamic industry that attracts young talent and delivers with less materials and increased value added. That way, the materials sector can not only contribute to environmental sustainability, but also to economic sustainability.

While there are significant opportunities to transition to low-carbon cement and steel sectors, there are also serious challenges and risks. It will therefore require both effective policy and forward-thinking, innovative companies to translate any such roadmaps into tangible investments and innovation.

Markets create economic opportunities and are therefore an important way of generating efficiencies if combined with carbon pricing for dealing with an externality. The analysis of steel and cement points to the importance of an effective carbon price signal both to producers and consumers in realizing the different modernization and innovation potentials (Table).

However, the problems within the European Union's steel and cement sectors and of climate change in general are both structural and long-term.

Innovation and structural change involve the economics of transformation and the design of new production processes in which industry structure and the capacity for strategic investment are crucial. The capital intensity of materials production and the relatively homogenous nature of products impede the ability of the industry to advance new production processes on its own. This implies an unavoidable role for strategic investment led by public sector agents if the industry is to adapt to the demands of the future and a necessary input from manufacturing and process-engineering expertise, while still supplying indispensable materials as well as creating employment and value.

Finally, at the consumer end, questions of consumer choice in materials and resource efficiency emerge: for example, habits, routines, and shortsightedness introduce structural inefficiencies and may blunt the impact of market-based instruments. Hence dedicated policies to adjust regulation and facilitate coordination are required to create an enabling environment.

European climate policy involving a predictable long-term strategy embedded in the broader policy framework can thus provide a focal point for the modernization of the European carbon-intensive materials industry. The European Union covers a territory large enough to host and finance demonstration projects. Climate policy has a well-defined objective to provide clear guidance and visibility and it is based at its core on a shared climate policy objective that facilitates cooperation across the European Union member states and beyond.

Table

A policy package for low-carbon materials

		CO_2 price to producers	CO_2 price to consumers	Innovation funding	Other regulation
Energy efficiency	Best available technology	X			
	Operational practices	X			
Carbon efficiency	Fuel shifting	X			
	Innovative process	X	X	X	
Materials efficiency	Building practices		X	X	X
	Innovative materials		X	X	X
	Recycling				X

Source: Own illustration.

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Carbon prices both to producers and consumers are an important part of the policy package.

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Keywords: Energy Intensive Industries, Materials, Steel, Cement, Mitigation, EU ETS

Prof. Karsten Neuhoff, Ph.D., Head of the Climate Policy Department at DIW Berlin

SIX QUESTIONS TO KARSTEN NEUHOFF

»Combining dynamic allocation and Inclusion of Consumption into the EU ETS would be beneficial«

1. Professor Neuhoff, the EU Emissions Trading System, or the EU ETS, has been in existence for ten years now. Has the scheme stood the test of time so far? First, the EU ETS has demonstrated that Europe can act collectively and it takes climate protection seriously. Second, it has established a long-term framework for emissions reductions. Third, the price signal has helped companies consider more efficient low-carbon options. However, since 2012, the carbon price has plummeted. Now this is addressed at the European level through the market stability reserve.

2. What are the weaknesses in the system? When the EU ETS was introduced, there was the expectation that within a few years a global carbon price would emerge. However, now countries choose which policy measures they want to use to achieve their climate protection goals. As a result, we have to cope with different carbon prices in different regions. This, in turn, means that there are incentives for manufacturers of carbon-intensive materials to relocate production if they have to bear the carbon costs in full. In order to avoid this, carbon leakage protection measures have been implemented. Producers are allocated carbon emissions allowances for free to absorb the additional costs.

3. To what extent has there been a geographical shift in the production of carbon-intensive goods, or carbon leakage? We examined this in detail specifically in the cement and steel sectors and were unable to detect any signs of carbon leakage. However, we do have carbon leakage protection measures. The cement and steel industries have been allocated more carbon emissions allowances in recent years than the level of production actually requires.

4. Is this not somewhat unfair toward the industries producing lower levels of CO_2? Carbon leakage protection measures are needed for highly carbon-intensive materials. For the majority of the manufacturing industry, carbon and energy costs make up a marginal share of total costs, thus carbon leakage protection is not necessary.

5. How can we ensure that the carbon-intensive industries still have an incentive to reduce their CO_2 emissions? The first step in this direction was taken in 2013. Since then, the allocation of free allowances has been based on a benchmark. This means that, as a company, I have incentives to improve my production efficiency in order to retain or be able to sell as many allowances as possible or, conversely, so that I do not have to buy as many allowances. By using free allocation as a carbon leakage protection measure, however, the incentives for intermediate and end customers are lost, the price of a ton of steel or cement will not go up. I therefore have no incentive to use these materials more effectively, no chance of competing with alternative low carbon materials, and no confidence that the additional costs of innovative processes such as carbon capture and sequestration will be covered. Here, the carbon leakage protection measures employed so far have had a negative impact.

6. How should this system be further developed in the future? We analyzed this question for those sectors producing carbon-intensive materials and determined four possible ways of structuring carbon leakage protection after 2020. One option is to continue with ex-ante free allocation while making minor refinements. A second option would be to make this system more dynamic and better aligned with production volumes. A third option would be to carry out border carbon adjustments (BCAs). A fourth option could be to combine dynamic free allocation with the Inclusion of Consumption in emissions trading. The advantage of the last two options is that the carbon price signal is maintained, not only for producers but also for intermediate and end customers, thus enabling us to enjoy the full effect of emissions trading in terms of reaching maximum greenhouse gas reduction potential. BCAs are, however, politically challenging. The Inclusion of Consumption in the emissions trading system has advantages here but is more work in terms of administration than other options. However, this additional effort seems warranted to create incentives for innovation and modernization and is consequently an important basis for further developing the industry and achieving climate goals.

Interview by Erich Wittenberg

Leakage Protection for Carbon-Intensive Materials Post-2020

By Karsten Neuhoff, William Acworth, Roland Ismer, Oliver Sartor and Lars Zetterberg

Climate protection is a global challenge that all countries have a common but differentiated responsibility to address. However, not all governments are willing to commit to targets of equal stringency, and individual countries may put different emphases on carbon pricing in their policy mix. Carbon prices may thus continue to differ over longer time horizons. Therefore, measures to protect production of carbon-intensive materials from carbon leakage might be required not only as short-term transition instruments, but also for longer periods.

Leakage protection measures therefore need to preserve carbon price incentives for emission mitigation across the value chain. If ex-ante or dynamic free allocation of emission allowances is used as a leakage protection measure, only the primary producers face the full carbon price signal for efficiency improvements. Accordingly, shifts to lower-carbon fuels and the carbon price signal for intermediate and final consumers are muted. Thus a large share of mitigation opportunities cannot be realized. Combining dynamic allocation of allowances with a consumption charge (Inclusion of Consumption into the The European Union Emissions Trading System, EU ETS) or combining full auctioning with Border Carbon Adjustment could reinstate the carbon price signal along the value chain and create incentives for breakthrough technologies, the use of higher-value products with lower weight and carbon intensity, alternative lower-carbon materials and more tailored use of materials. Border Carbon Adjustment is, however, politically contentious as it has often been discussed as an instrument to discriminate against foreign producers. Hence it is important to further explore design details to implement the combination of dynamic allocation with Inclusion of Consumption in the EU ETS.

The European Union Emissions Trading System (EU ETS) is the main instrument for European climate policy. Entities in the regulated sectors are required to surrender allowances to cover their emissions. The allowance price gives incentives for innovation and mitigation. In the absence of a global carbon price, the additional costs of acquiring these allowances could create incentives to relocate production and result in carbon leakage. Hence sectors considered to be at risk of carbon leakage currently receive allowances for free.

The European Parliament has asked – as part of its decision on the implementation of the EU ETS Market Stability Reserve on July 8th 2015 – the European Commission to make a proposal for the design of the mechanism for carbon leakage protection for the period after 2020. It is now being discussed whether to refine the existing criteria so as to reduce the length of the overall carbon leakage list,[1] whether to apply differentiated treatment to sectors covered by the list, or more broadly, whether to change the approach to carbon leakage protection within the EU ETS.

This report evaluates leakage protection mechanisms for carbon-intensive materials. We find that a dedicated analysis of carbon-intensive materials is necessary because many of the mitigation choices reside not only with producers, but also with intermediate and final consumers, i.e. throughout the whole value chain.[2] Carbon-intensive materials are also particularly suitable for efficient leakage protection measures due to the existence

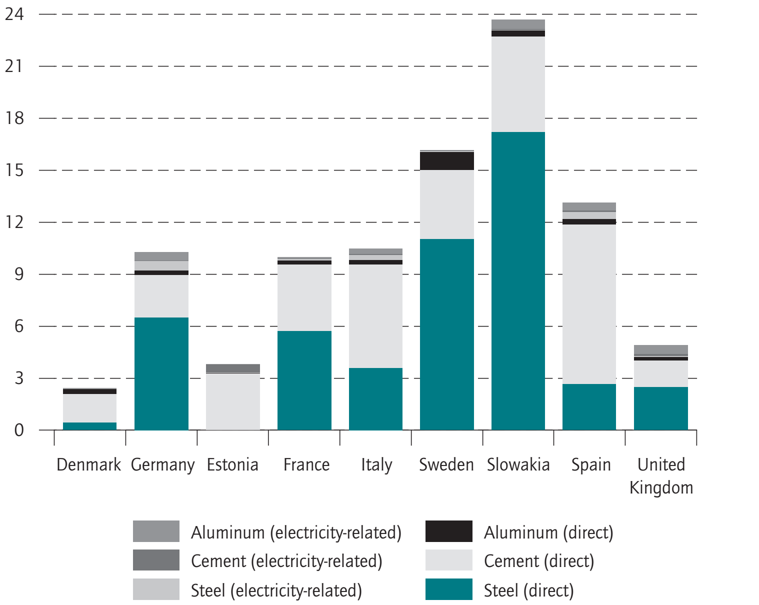
1 The existing EU ETS Directive has defined a set of criteria to identify sectors that are part of a carbon leakage list and for which different mechanisms can be applied to avoid the risk of carbon leakage. See Zaklan, A., Bauer, B. (2015): Europe's Mechanism for Countering the Risk of Carbon Leakage. DIW Roundup 72.

2 Compare also: Neuhoff, K., Ancygier, A. et al. (2015): Modernization and Innovation in the Materials Sector: Lessons from Steel and Cement. DIW Economic Bulletin 28+29/2015; Neuhoff, K., Vanderborght, B. et al. (2014): Carbon Control and Competitiveness Post 2020: The Cement Report. Climate Strategies. London, February 2014; and Neuhoff, K., Acworth, W. et al. (2014): Carbon Control and Competitiveness Post 2020: The Steel Report. Climate Strategies. London, October 2014.

Figure 1

CO_2 emissions related to the production of selected carbon-intensive materials in 2007[1]

Share of national CO_2 emissions in percent



1 The five European countries with largest population and two countries with smallest or largest emission shares of selected materials.

Source: Pauliuk, S., Owen, A. et al. (2015): Consumption-based extension of EU ETS for emissions intensive materials. Unpublished Manuscript.

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Steel, cement and aluminum production are responsible for at least 10 percent of CO_2 emissions in many countries.

of clearly defined product benchmarks. Detailed analysis is also warranted because of the large share of emissions attributed to materials production.

We find four different options for carbon leakage protection including: (i) continuation of ex-ante free allocation, based on historic production levels with activity thresholds; (ii) dynamic or "output-based" free allocation, based on current or recent production levels; (iii) full auctioning of allowances combined with Border Carbon Adjustments (BCAs); and (iv) dynamic free allocation combined with a consumption charge for energy-intensive materials, referred to as Inclusion of Consumption in the EU ETS.

Selected carbon-intensive materials warrant focus

A major share of European industrial emissions is linked to the production of carbon-intensive materials. As an example, the production of iron and steel and cement together accounted for 38 percent of industrial greenhouse gas emissions in the EU-28 countries in 2012.[3] Iron and steel, cement, and aluminium together account for at least 10 percent of total emissions in many European countries (Figure 1). Within these sectors, the majority of emissions are linked to the production of the primary material, for example iron (85 percent of steel-related emissions) or clinker (90 percent of cement-related emissions). Further refinement to different types of steel or cement is capital- and labor-intensive and increases the value added, but is linked to only a relatively small share of total emissions. However, more efficient and innovative use of the primary (CO_2-intensive) part of the product at these later stages of the value chain offers large abatement potentials. Therefore it is important to ensure that leakage protection measures retain the full incentive of the carbon price for mitigation potential linked to the production as well as intermediate and final consumption choices of carbon-intensive materials.

The production cost for carbon-intensive materials would increase more than other products if in the absence of leakage concerns all allowances were to be auctioned. However, carbon-intensive materials are internationally traded, and in many instances exhibit little product differentiation. Therefore, carbon leakage risk is of greater concern compared to other sectors. As such, more tailored leakage protection measures are warranted for carbon-intensive materials than, for example, in manufacturing, where cost increases in the case of full auctioning of allowances only add little to total production costs.[4]

Moreover, clarity on long-term climate policy is more important in the materials sector, as production of carbon-intensive commodities is capital-intensive. Accordingly, investment decisions in innovation and modernization of the respective installations are based on longer time horizons than in case of consumer-oriented manufacturing.

Leakage protection needs to be designed with a long-term perspective in mind

Climate protection is a global challenge that all countries have a common but differentiated responsibility to address. However, not all governments are willing to commit to targets of equal stringency. Moreover, countries may have different views on which policy mix is the most appropriate. Some countries may put a stronger emphasis on carbon prices whereas other countries may

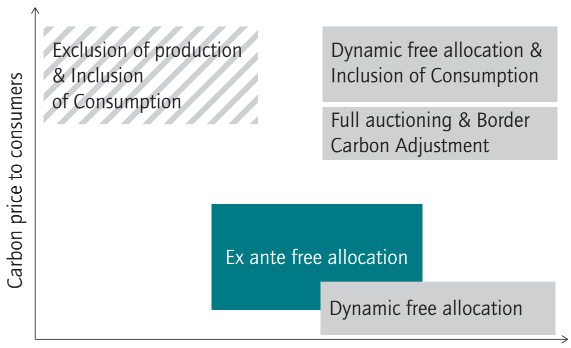
3 According to EEA greenhouse gas data provided in 2015.

4 Sato, M., Neuhoff, K., Graichen, V., Schumacher, K., Matthes, F.C. (2015): Sectors under Scrutiny - Evaluation of Indicators to Assess the Risk of Carbon Leakage in the UK and Germany, Environmental and Resource Economics 60, 99–124.

Figure 2

Carbon price incentives with different mechanisms to address leakage concerns[1]

For steel, cement and aluminum



1 Based on analysis in the project Carbon Control Post 2020 in Energy Intensive Industries.

Source: Own illustration.

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Carbon leakge protection with free allocation mutes the carbon price signal in materials sectors.

make more use of other regulatory instruments. Carbon prices may thus continue to differ between countries or regions over longer time horizons.

Measures to avoid carbon leakage have therefore been put in place to complement carbon pricing in the production of carbon-intensive materials, and they most likely will continue to be in place for the foreseeable future. All existing emission trading mechanisms covering industrial emitters offer some free allowance allocation and all carbon tax schemes have implemented special provisions for materials production.

Previously, such protection measures were considered of temporary nature and therefore primarily focused on securing leakage protection. However, if leakage protection measures might be required for the foreseeable future, there is now a need to ensure that leakage protection does not undermine incentives for innovation and modernization throughout the value chain.

In a hypothetical world with a common carbon price and no carbon leakage concerns, all allowances could be auctioned. Producers would then face the full carbon cost and would pass these costs onto consumers. Yet in a world with differentiated carbon pricing and free allowance allocation as leakage protection, producers can be expected to limit the extent to which carbon prices are passed to product prices in order to protect market shares from international competitors. Thus, a priori there are persuasive reasons to expect that leakage protection based on free allocation alone will blunt the carbon price signal.

The extent to which the carbon price is able to perform its role effectively in the presence of leakage protection measures can be broadly characterized by the extent to which the measure ensures that both producers and consumers face the full carbon price signal (Figure 2). The carbon price signal for producers creates incentives for efficiency improvements, fuel switching, and shifting to alternative lower-carbon production processes. A carbon price signal to consumers creates incentives for more tailored and more efficient use of the material and market opportunities for innovative lower-carbon products. Many of the choices will not be made by final consumers, but rather by intermediate consumers selecting, for example, materials for building components or cars.

Leakage protection with free allocation limits incentives for innovation and modernization

Until 2012, free allocation to industrial emitters was largely linked to historic emission volumes. As the baseline for emissions used for future allocation was not kept fixed, this undermined incentives to reduce CO_2 emissions. Hence since 2013, the free allocation to materials producers is based on product benchmarks of CO_2 emissions, reflecting the average emission performance of the top 10 percent of the most efficient installations in the EU.[5] The benchmark is multiplied with historic production volumes to determine the free allocation volume. In case of new investments and substantial capacity changes of installations, the allocation is based on installed production capacity. Thus emission volumes will not directly impact future allowance allocation. Materials producers thus face a carbon price signal for efficiency improvements and for a shift to lower-carbon fuels.

However, a fixed ex-ante allocation on its own will not create leakage protection against relocation of production.[6] Hence for leakage protection, the allocation has to be linked to the activity level of an installation. Such activity level requirements, however, lead to undesired threshold effects. For example, during Phase II of the

5 European Commission (2011): Decision determining transitional Union-wide rules for harmonised free allocation of emission allowances. April 27, 2011.

6 Concerns about leakage linked to relocation of investment choices can be addressed with ex-ante free allocation, using specific allocation rules for new installations, substantial capacity changes of installations, and partial or full cessation of business. Cp. Neuhoff, K. Matthes, F.C. (2008): The role of auctions for emissions trading. Climate Strategies Report.

EU ETS, it was required in most countries that installations remain operational for continued free allocation. As cement demand had dramatically declined in Europe, this resulted in large-scale surplus allocation to cement companies, with benefits of well over one billion Euros from 2009 to 2012. These profits went directly into the overall corporate budget of companies and did not support efficiency or emission reduction projects.[7] The perceived ineffectiveness of the mechanism together with extensive complaints about these windfall profits reduced the credibility of the EU ETS with companies in the materials sector, and thus undermined the incentives it can create.

Since 2013, allocation rules require, for example, a 50 percent utilization of the historic activity level to receive full free allocation for the next year. These activity thresholds created incentives for companies to spread production over several installations to maintain the full issuance of free allowances, and have led to production inefficiency resulting in approximately 5.2 million tons of excess CO_2 emissions in 2012.[8] Thus benchmark-based allocation based on historic production volumes or capacity will deliver much of, but not the full carbon price for producers.

The bigger concern remains, however, the level at which carbon costs are passed to material prices if ex-ante free allocation is used as leakage protection mechanism. A producer of a homogeneous material, globally traded with low transport cost, cannot pass carbon cost to the product price without losing market share. In contrast, a producer of a difficult-to-trade commodity—for example, electric power—which is not traded much beyond Europe's borders, can pass all carbon costs to the product price. In practice, most materials fall in between these two extremes, and thus producers will partially pass through carbon prices so as to trade off a higher product price with the risk of losing market share. It is also possible that, while carbon prices may be passed through at low levels, at higher pass-through rates windfall profits would trigger public attention, which could lead to the removal of free allocation – as occurred with the power sector in Phase 1 of the EU ETS. Thus, there may be strategic reasons why companies will be unable or unwilling to fully pass-through carbon prices to consumers under ex-ante free allocation.

The concern that ex-ante free allocation eliminates incentives for intermediate and final consumers to realize mitigation opportunities has resulted in political pressure to reduce the level of the free allocation. A cross sectoral correction factor reduces allocation for all sectors—for example, for sectors on the carbon leakage list, decreasing to 91 percent of the benchmark in 2015, and to around 82 percent in 2020.[9] For post-2020, differentiating the level of allocation among sectors on the carbon leakage list is under discussion.

Limited carbon price pass-through also poses a challenge for breakthrough production processes that incur incremental costs, for example Carbon Capture and Sequestration (CCS) or Use (CCU). Primarily they require a carbon price signal for producers to incentivize such investments. But exposure of the carbon price to consumers is also necessary to create a credible business case for paying for the investment. Otherwise, investments in these technologies depend on selling unused freely allocated allowances to emitters in other sectors, de facto expecting a cross-sector subsidy from sectors that can pass carbon costs to consumers towards materials sectors that continue to not internalize the carbon cost. This is not necessarily a stable regulatory arrangement, and thus is unlikely to be a sufficient justification for undertaking investments in new production processes with long payback periods.

Dynamic allocation further reduces incentives for intermediate and final consumers

To avoid distortions of ex-ante free allocation discussed above, it has been proposed to apply the benchmark-based allocation using current production volumes (of the same year) or recent production volumes (of the previous year) instead of historic production volumes. This is referred to as dynamic or output-based allocation, which can be designed and implemented in numerous ways. What is common to all design options is that allocation is more closely aligned with allowance requirements, thus avoiding perceived unfairness of surplus allocation. Dynamic allocation also ensures that for the majority of installations, free allowance allocation is below emission volumes, thus ensuring that emitters face real costs, and not only opportunity costs, for marginal emissions to strengthen the incentive for implementing mitigation actions.[10]

7 Neuhoff, K., Vanderborght, B. et al. (2014) l.c.

8 Branger, F., Ponssard, J.P. et al. (2014): EU ETS Free allocations and activity level thresholds in the cement sector: the devil lies in the detail. London School of Economics Working Paper.

9 The cross sectoral reduction factor is calculated so that total allocation to industrial emitters does not exceed the pre-defined industrial share of the overall emissions cap. European Commission (2013): Commission Decision of 5 September 2013 concerning national implementation measures for the transitional free allocation of greenhouse gas emission allowances in accordance with Article 11(3) of Directive 2003/87/EC of the European Parliament and of the Council.

10 Firms typically allocated revenue from selling surplus allowances to general corporate budget, and may therefore not consider the opportunity cost of using allowances that could otherwise be sold in decisions on mitigation efforts. They only fully consider benefits of mitigation efforts at the level of a business unit, if allowances have to be acquired.

Dynamic free allocation, however, further limits the carbon price pass-through compared to allocation based on ex-ante free allocation. Producers only bear costs for their emissions above the benchmark. This is because for any additional ton of material produced, an additional allocation of allowances according to the benchmark will be received. Thus only allowances corresponding to emissions above the benchmark need to be acquired. Only costs for purchasing allowances above the benchmark will be passed through to materials prices, to the extent that international competition allows.

However, as dynamic allocation limits the carbon price pass-through, it also further reduces incentives for mitigation options from carbon prices for intermediate and final consumers and the long-term business case for innovative process technologies like CCS. As such, dynamic allocation can only be expected to leverage production efficiency mitigation opportunities, which are limited for carbon-intensive materials such as steel and cement.[11]

Border Carbon Adjustments politically challenging

To restore incentives for producers and consumers lost with free allocation as leakage protection, be it based on historic or current production levels, full auctioning of allowances could be combined with BCAs. Under BCAs, imports and exports are adjusted for the carbon price differential between trading countries. Thus the full carbon price signal remains intact and creates incentives for innovation in new production processes, products and services, and supports the substitution towards lower carbon alternatives.[12]

This idea is already widely applied in schemes of value-added taxes (VAT) within Europe. Furthermore, BCAs are being discussed and starting to be implemented in regional cap-and-trade schemes such as one in California, where risk of inter-state leakage is high. Specifically, the California cap-and-trade scheme includes BCAs for electricity imports, and the state is considering applying similar measures to carbon-intensive materials such as cement.[13]

The compatibility of BCAs with World Trade Organization (WTO) rules could, in principle, be ensured through careful implementation.[14] Specifically, there must be no differentiation between like products by foreign and domestic producers without due justification. This requirement is met when charges levied at the border for imports or reimbursed for exports do not exceed the carbon costs of producing with the best available technology.[15] Also, from a WTO perspective, BCAs can only be applied to the extent that installations pay for their allowances—for example, in auctions.

The politics of BCAs are more challenging. Developing countries have experienced a long history of border provisions in trade with agricultural and other goods, with adverse impact on their economic development. This situation was not simplified by various proposals to use border measures as a stick to enforce participation in climate policy.[16] Therefore, the clear anchoring in the general rules of the WTO is important to prevent such abuse. This can involve international cooperation that clearly limits the scale and scope of BCAs on carbon prices and creates trust and shared understanding about the objectives and constraints of BCAs.

Indeed, rather than creating barriers between countries, BCAs should ideally focus on correcting for carbon price differentials, not unlike VAT adjustments at the borders between many European countries. In this way, BCAs could allow countries to implement carbon pricing schemes with higher carbon prices so as to increase their decarbonization effort, which would ultimately be beneficial for all countries.

Combining Inclusion of Consumption with dynamic allocation for an effective carbon price along the value chain

Dynamic allocation only creates carbon price signals for producers. Hence it is of interest to reinstate a carbon price signal for intermediate and final consumers. A consumption charge could achieve this objective.

Consumption charges are already levied on products like alcohol, tobacco or fuels. They do not differentiate between product processes or the location of the covered products, and are not considered a trade-related meas-

11 Neuhoff, K., Ancygier, A. et al. (2015), l.c.

12 For simulation results in the case of cement, see Demailly, D. and Quirion, P. (2006): Leakage from climate policies and border tax adjustment: Lessons from a geographic model of the cement industry. CIRED Working Paper, HAL 0009337.

13 Munnings, C., Acworth, W., et al. (2015): Pricing Emissions from Carbon Consumption. Unpublished Manuscript.

14 See Zhang, Z. X. (1998): Greenhouse Gas Emissions Trading and the World Trading System. Journal of World Trade 32 (5), 219–239.

15 For a description of the implementation at the level of best available technology and a discussion of WTO compatibility, see: Ismer, R. and Neuhoff, K. (2007): Border Tax Adjustments: A feasible way to support stringent emissions trading. European Journal of Law and Economics (24), 137–164.

16 Some proposals aim to compensate for average carbon intensities, or to differentiate based on the climate policy implemented by the trade partner. This would, however, discriminate against some foreign producers. Also, if carbon prices continue to differ across regions, the leakage risk might not necessarily follow the lines of signatures of the international environmental agreement, but rather would be linked to carbon price differentials.

Box

Inclusion of Consumption into EU ETS: not a substitute for upstream coverage of a sector

If a consumption charge on a material would replace the coverage of materials production under the EU ETS, then this would only create a carbon price to consumers that incentivizes more tailored use of carbon-intensive materials and the use of lower-carbon materials. However, no incentives for efficiency improvement of production, fuel switching, or breakthrough process technologies would exist. Therefore a consumption charge is no substitute for coverage of a sector under the EU ETS.

Charges to consumers could in theory create incentives for the production process as well, if the emissions from the production of the specific material contained in each product were to be traced along the value chain as the basis for the charge (instead of using an emission benchmark for a generic material). This tracing of product-specific emissions would, however, multiply administrative complexity both within countries and for imports; would be difficult to monitor; and would constitute a trade-related measure, as it is specific to the production process, unlike a consumption charge.

ure. Consumption charges could also be levied on carbon-intensive materials.

Consumption charges are based on upstream recording of the production of the material. The sale of the carbon-intensive material is then traced along the supply chain. A charge based on the weight of the carbon-intensive materials contained in a product, multiplied with a benchmark emission rate for the material and the carbon price from the EU ETS (e.g., average of the last quarter), is then levied on the final product. The money would be raised for national trust funds to support climate action. Consumption in this context not only relates to demand by households, but also to the use of the material as an input for other industries in the production of cars or the construction of buildings.

Where a product is exported outside the region covered by the carbon pricing system, the liability for the consumption charge is acquitted. For imported carbon-intensive commodities or products in Standard International Trade Classification (SITC)—categories with significant shares of carbon-intensive commodities—the importing firm acquires a liability for the carbon-intensive commodities contained in the imported goods, and can again pass this on to consumers.

Consumption charges would be levied on selected carbon-intensive materials. Materials that are close competitors and see significant price increases with a consumption charge, like clinker, steel, and aluminium should be jointly covered so as to avoid distortions to product choices. The charge would apply both to carbon costs related to direct and indirect emissions.[17]

Administrative and compliance costs are likely to be higher than for other approaches. However, they can be limited by following long-established protocols for the recording of production levels and trade of goods. Reporting requirements under the Inclusion of Consumption may in many cases only be marginally additional to standard business reporting. As the consumption charge is not linked to the specific emissions of a product, Inclusion of Consumption does not require the tracing and allocation of emissions along the value chain.

Inclusion of Consumption could be implemented as part of the EU ETS Directive and thus apply homogeneously across the European Union as environmental regulation. A set of requirements for an environmental regulation are met, including that Inclusion of Consumption secures incentives towards environmental objectives. In order to ease administration and reduce transaction costs, it is merely implemented as a charge instead of an obligation to surrender allowances. An environmental regulation implementation at the European level is more acceptable for many member states that would object to an implementation of a European tax.

Inclusion of Consumption is compatible with WTO laws as long as it is implemented without any discriminatory components. Like other consumption charges, the proposed charge is independent of country of origin, thus avoiding concerns about discrimination. As part of a current Climate Strategies project,[18] international experiences with similar approaches have been gathered that suggest that other regions are experimenting with

17 Indirect emissions refer to emissions from production of the electric power that is used in the production process. EU State Aid Guideline on Power Price Compensation provides electricity benchmarks, at which EU member states can compensate producers for power price increases linked to the EU ETS. A consumption charge could re-instate the carbon price signal that is suppressed by such compensation payments as leakage protection measures.

18 Ismer, R. and Haussner, M. (2015): Inclusion of Consumption into the EU ETS – Legal Basis under European Law. Unpublished Manuscript.

a similar mechanism, and might potentially cooperate in the implementation—for example by sharing data to improve the quality of benchmarks. Better benchmarks would also bring the benefit of improving the quality of free allocation more generally.

While dynamic allocation and the consumption charge face disadvantages if implemented in isolation (Box), the combination of leakage protection using dynamic free allowance allocation with a consumption charge could facilitate effective carbon price signals to both producers and consumers. The dynamic upstream allocation limits carbon price pass through to, at most, the emissions above the benchmark allocation level, and thus creates the space for a consumption charge levied at the benchmark rate without creating the risk of double pricing. Thus incentives for innovation and modernization across the value chain could be provided. This may also foster credible business cases for breakthrough technologies like CCS as it creates a mechanism to allocate incremental costs to consumers of steel.

Inclusion of Consumption could offer a long-term stable framework for investment by aligning the interests of the main stakeholders. Consumers are not charged twice, as producers receive free dynamic allocation at the benchmark and thus do not pass on the corresponding carbon cost. Producers of carbon-intensive materials face a stable investment framework, and can make strategic choices as if the full carbon price is present throughout the value chain without facing concerns of carbon leakage. Environmental interests are also addressed, because the full carbon price creates incentive for mitigation along the value chain. Finally, fiscal concerns could be satisfied by creating resources to finance climate action that would have been financed otherwise from emission allowance auction revenues.

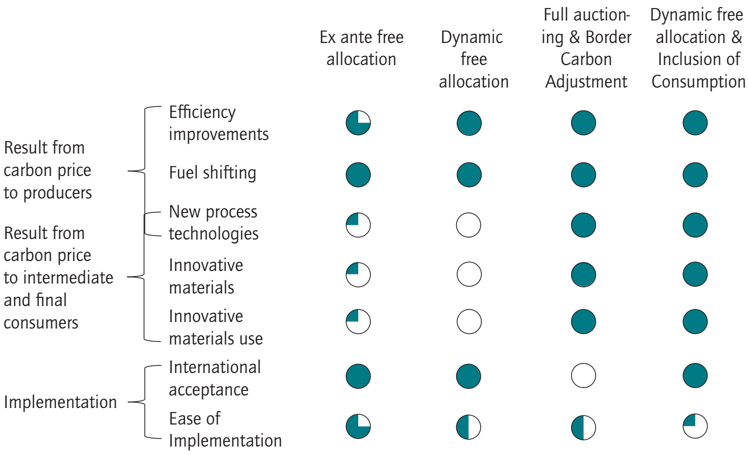
The qualitative assessments of the four options discussed above with respect to incentives for producers and consumers, as well as implementation, are summarized in Figure 3.

Further considerations

The analysis focuses on the specific situation of carbon-intensive materials, and is not necessarily transferable to other sectors with smaller carbon intensity of production, a smaller role for mitigation in the value chain, and less scope for definition of benchmarks relative to simple metrics like material weight. This may offer clear criteria for a differentiated use of leakage protection measures as already envisaged in the EU ETS Directive, which allows in its current form for the choice among different mechanisms for sectors on the carbon leakage list.

Figure 3

Assessment of leakage protection approaches for carbon intensive materials



Source: Own illustration.

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Incentives along the value chain require either full auctioning with Border Carbon Adjustments or dynamic allocation with Inclusion of Consumption.

Another criterion to be considered with the further development of leakage protection measures is the compatibility with longer-term perspectives of globally converging climate policy. If allowances are allocated for free, then producers of carbon-intensive materials benefit from continued free allocation, even if international carbon prices converge. Thus they might lobby for continued free allocation, and if they are only successful in one of the regions covered by converging global carbon prices, there may be a risk of an extended lock-in situation with free allowance allocation. If dynamic free allocation were to be combined with Inclusion of Consumption, then all actors would face the full carbon price of the region and no one would benefit from or have an incentive to lobby for the continuation of the leakage protection mechanism. Thus the design of the leakage protection mechanism may create incentives for all actors to advance international climate policy so as to abandon the need for leakage protection.

Summary and conclusions

The emission targets embedded in the EU ETS generally offer a long-term perspective to guide strategic investments towards a low-carbon transition. This does require clarity on provision for carbon leakage protection, as well, which may be necessary for a longer-term perspective. The EU ETS directive has already started providing the space for the use of differentiated leakage protection systems for sectors considered at risk of carbon leakage. As such, it seems warranted to discuss, specifically, the possible options for carbon-intensive materials.

Continuation of ex-ante free allocation based on historic production levels and special provisions for new entrants, cessations, and significant changes in capacity require the least administrative effort of all options considered. Yet the extended debates on the level of benchmarks and free allocation have demonstrated the potential for this approach to dominate any constructive discussions on innovation and modernization of the sector, while reducing the credibility and thus the robustness of the incentives from the instrument with stakeholders.

The main concern about the use of free allowance allocation to provide leakage protection to carbon-intensive materials is linked to the failure to create a carbon price signal to intermediate and final consumers, thus not create incentives for a large share of the mitigation potentials in the sectors. Thus, ex-ante free allocation may only constitute a transition strategy warranted in the hope that the international climate change negotiations in Paris by the end of 2015 will result in an outcome that provides confidence in quickly converging international carbon prices.

A shift from free allocation based on historic to recent production levels (dynamic allocation) may marginally improve the incentives for process efficiency improvements by eliminating distortions from discrete activity level thresholds. Yet it further reduces the carbon price signal to consumers at the level of the free allocation, and thus reduces the incentives for innovation and modernization this shift can deliver.

Implementing Border Carbon Adjustment for selected carbon-intensive materials would allow for full auctioning of emission allowances and thus create an effective carbon price along the value chain. Administrative effort would increase, as not only primary carbon-intensive materials, but also products with significant shares of these materials would need to be covered. However, implementation is politically contentious and would require close international cooperation to avoid political repercussions.

Hypothetically excluding carbon-intensive materials production from the EU ETS, and only covering materials use with a benchmark-based consumption charge would eliminate incentives for all mitigation opportunities in materials production. It would also seriously undermine predictability of emissions under the emission cap from shifts between fuel-based and electricity based-emissions, and undermine credibility of the commitment to an overall emission trajectory and the role of the EU ETS. Thus the Inclusion of Consumption alone is not considered a viable policy option, but merely an element of a leakage protection strategy.

Yet combining Inclusion of Consumption of selected carbon-intensive materials in the EU ETS with dynamic allocation could create a credible long-term perspective in which not only producers, but also intermediary and final consumers are exposed to the full carbon price signal. Thus it could provide incentives and a long-term business case for all mitigation and innovation opportunities. Inclusion of Consumption could also result in revenues for national trust funds that are available for climate action, including for investment in innovative materials and processes. The details for the implementation are being explored in many regions with carbon pricing mechanisms, offering an opportunity for closer cooperation, for example to share data to guide the design on benchmarks.

The analysis shows that the various options for leakage protection for carbon-intensive materials sectors exhibit large differences in the extent that they create incentives for modernization and innovation in the value chain. These need to be in the focus when designing leakage protection measures for the period post 2020, such that the EU ETS can provide a robust investment framework for realizing low-carbon opportunities in the materials sector.

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