Filling gaps in the policy package to decarbonise production and use of materials
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The time has come to get serious about decarbonizing the emission-intensive materials sector. The production of basic materials (cement, iron and steel, paper and board, aluminium and chemicals and petrochemicals) accounted for around 25% of global CO₂ emissions in 2014 (Figure 1). As non-OECD countries are developing infrastructure and housing in line with their economic growth, their demand for basic materials is particularly high. This demand accounted for around 80% of carbon intensive materials (by weight) contributing to about 75% of the global emissions from basic materials production.¹

While a portfolio of mitigation options exists to decarbonise the materials sector, progress in their realisation has been rather modest. Whereas the power sector is now well on its way to phasing in low-carbon technologies, improvements in the GHG-intensive materials sectors have been limited to incremental improvements to carbon-intensity of production processes.²

This is mainly due to two reasons. First, attempts to support clean production processes through the European Emission Trading Scheme (EU ETS) were repeatedly overwhelmed by concerns that stringent incentives create carbon leakage risk. Second, GHG emission reductions from material substitution, efficient use of materials, product sharing, re-using and recycling are only addressed with limited political support and without a climate focus in the context of resource efficiency and waste policies.

However, some of these past barriers to progress may be shifting. The GHG neutrality goal included in the Paris Agreement and the evidence of progress in other sectors is increasing pressure on the materials sector to raise its level of ambition. Some momentum is also emerging with plans of some producers to develop materials and processes with very low carbon impact.

¹ In Europe, the production of basic materials accounts for around 16% of GHG emissions (DIW calculations based on EEA (2016) and UNFCCC (2012)).
² Based on previous DIW Climate Strategies studies on the cement, steel and pulp-and paper sector (Neuhoff et al. 2014a, 2014b)
Nonetheless, the capital-intensive investments that are needed to move from early phase innovation to commercial scale for decarbonised production processes and products will not take place unless there are sufficient incentives from the surrounding policy framework. Europe has a history of supporting early stage development of promising low-carbon innovations for materials that in the end never reach the market. This has been unfortunate, not only from a climate perspective, but also from an industrial policy point of view.

The current lack of clarity regarding the policy framework and its further evolution results in an investment limbo: carbon-intensive choices are incompatible with emission reduction targets and face risks of more stringent climate policy; climate-friendly choices lack a clear investment case in the current uncertain policy regime. Europe still has the opportunity to be a first mover and thereby to safeguard the future of its basic material industries through favourable conditions for innovation within its internal market. Doing so will require filling the relevant policy gaps not only at the EU level, but also at the national and in some cases sub-national level.

Developing the necessary policy framework requires two things. Firstly, a broadly shared vision of feasible development pathways towards deep decarbonisation of material production and use is needed. Although such roadmaps can never produce complete consensus, this report illustrates how they can help to clarify key options in a systematic way. They can thus provide a basis for coordination between policy makers and decision makers in the private sector.

Secondly, further efforts are needed to identify and fill gaps in the existing policy framework for emissions reductions in the materials sector, to enable industry to more effectively unlock options for a shift to new technologies, processes, and materials. This report explores what could be a suitable policy package to allow the private sector to pursue this journey and to align the political support of constituencies interested in individual mitigation options. The focus is on the assessment of the inherent logic in such policy packages as a basis for effective implementation, as well as credibility and visibility to increase relevance for firms.

Section 1 of this paper discusses a portfolio of seven major mitigation options that will constitute the basis for decarbonizing the materials sector. Section 2 highlights an array of policy instruments for unlocking these mitigation options – including existing and not-yet existing tools. Section 3 discusses criteria for prioritizing policy instruments. Sections 4, 5 and 6 then discuss the three major gaps in Europe’s current policy package. These sections also set out specific policy options for filling these gaps and trade-offs that policy makers will face in choosing different instruments. Section 7 provides the concluding remarks.
The UN Sustainable Development Goals imply an increase of access to housing, mobility, education and multiple other services at global scale, and thus will result in an increased global demand for services from basic materials. This can be aligned with the objectives of reducing emission and limiting depletion of natural resources by pursuing and combining seven categories of mitigation options.

This can make the use of products and of the embodied materials more sustainable. For example, sharing of vehicles and buildings, which together represent the largest portion of European demand for steel, cement and aluminium, would enable a much more productive use of these currently underused assets (Materials Economics Report 2018).

Containment of materials use would likely imply positive side effects for other natural resources such as land, water, air or biodiversity, for which planetary boundaries are already or might be exceeded (see e.g., Jacob et al. 2015).

Currently, the utilisation of many of these assets in Europe is very low: about 2% for the average car, and about 40% for offices, even during office hours (Materials Economics Report 2018).

Recycling rates still vary across applications and material types. For example, 80-90% of end-of-life steel is collected for recycling, while across all uses of plastic only 18% is recovered (Material Economics Report 2018). Improvements depend on product design, suitable dismantling and separate collection of material to allow for materials to be recycled for the same purposes, rather than down-cycled to lower material quality. For steel a major concern is contamination, for example with copper and other elements, which reduces the quality of recycled steel.
Improved product design can achieve the same services with less but better tailored, higher value materials. For example, lightweight design (e.g. of steel beams used for construction and of aluminium alloys used for car bodies) can reduce the need of steel and aluminium by 25 to 30% (Carruth et al. 2011). This can reduce the loss of material during production processes and improve material reuse. For example, an improvement in material efficiency could reduce emissions and material costs in automobile manufacturing by 56% to 70% (Horton and Allwood 2017).

Substitution of materials with alternatives characterised by lower life-cycle emissions can allow further emissions savings. For example, wood-based construction components can have much lower CO₂ intensity than steel and concrete (Materials Economics Report 2018); and also clinker substitutes are already being developed (IEA 2018).

The introduction of production processes based on renewable energy (electrolysis or directly solar-derived hydrogen) or supported by carbon capture and sequestration or use can avoid or absorb most of carbon emissions linked to primary production of materials (Philibert/IEA 2017, Bataille et al. 2018).

In the short-term incremental efficiency improvements of conventional production processes may deliver small emission reductions. They need to be aligned with a perspectives of phasing-out carbon intensive processes to create space for new climate-friendly production processes.

Figure 2 illustrates, in relation to steel, how the portfolio of mitigation options listed above can align the materials sector with the objectives of the Paris Climate Agreement. The different mitigation options are interdependent and can be mutually supportive. For instance, conventional material production processes need to be replaced with so-called “breakthrough” technologies. However, these currently face uncertainty in terms of cost and performance. Furthermore, clean production processes will compete with other sectors for renewable energy resources (BDI 2018). Thus, reducing demand for primary material production will be essential to remain within available resource potentials. Where possible, the policy framework should therefore pursue such mutually supportive mitigation options through a coherent package of measures.

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5 Optimizing universal steel beams used for construction could save around 30% of the weight of a standard beam, while design improvements or alloy substitutions in car bodies are estimated to enable weight savings of 17.5–25% (Carruth et al. 2011). See Cooper-Searle et al. (2017) and Gonzalez Hernandez et al. (2018) on extent and reasons why the potential of material efficiency is yet unexploited.

6 For example, timber frame systems can have a strength similar to that of reinforced concrete and can save up to 50% of embodied carbon and 35% of embodied energy compared with traditional residential building methods and materials (Materials Economics Report 2018).
Illustration for European steel sector of how a portfolio of mitigation options can allow the shift to a low-carbon material sector.\footnote{Historic volumes are based on IISI, Steel Statistical Yearbooks (for years 2000 to 2017). Production from electric arc furnaces is used as proxy for recycled steel and from BOF process for primary production. For reference case, constant volumes are projected and mitigation potentials reflect average of estimates for mobility and construction demand in Material Economics Report 2018. Global recycling share is assumed to reach 75\% by 2050 reflecting the global nature of demand for steel. Residual production is assumed to be met by clean processes that are expected to be deployed by 2033.}

The potential to exploit different mitigation options is inherently uncertain and will depend on a variety of factors, including:

- Developments outside the materials sector (e.g. technologies, business models, consumer preferences, mobility patterns).

- Already achieved material efficiency in production, which may vary across sectors.

- Local resource constraints or other economic factors (e.g. availability of reliable and cheap decarbonised energy).

- Hidden or unforeseen practical barriers to increasing the proportion of recycled materials (e.g. consumer acceptance of alternative product design).

- Emergence of competition between materials (as has recently been the case between steel and aluminium for reducing automotive weight), which can enhance innovation and diffusion of new options.

- Political and technical trade-offs in the design of policies that may impact the degree to which a specific option can be fully exploited.

This uncertainty points to the desirability of a policy framework that supports the necessary portfolio of mitigation options.
Actors in a position to make use of mitigation options, like materials manufacturers, product designers and manufacturers, currently make choices that are not in line with the low-carbon roadmaps illustrated before. Among others, this can be explained by their prevailing decision modes (Grubb et al. 2014):

**SATISFICING:**
Actors rarely revisit material choices, product designs, and manufacturing approaches if the savings from improvements are not worth the effort and risks. Efforts tend to go into sales once a workable product design has been finalized.

**OPTIMIZING:**
Actors will not make low-carbon choices if these are not economically viable due to the lack of (certainty about) a carbon price or other regulation mandating the choices.

**STRATEGIC CHOICES:**
Actors will hesitate to make long-term investments in innovation and infrastructure if they cannot appropriate benefits because of technology spill-overs, regulatory adjustments, or complex value chains.
These decision modes are related to policy instruments (on the x axis in Figure 3). Engagement instruments and mandates typically focus on satisficing choices. Economic instruments primarily focus on optimizing choices, while strategic investments target long-term structural, infrastructure or process choices.

As represented in Figure 3, multiple policy instruments exist. They can be characterized by:

- **The jurisdictions** (colour). Most instruments are already implemented at national level (brown) or European level (blue) or both (green).

- **The stage of implementation**. Some policies are not universally applied in Europe (e.g. labels) or their implementation could be strengthened where they are applied (e.g. green public procurement, waste charges). Several policies are implemented for the materials sector but presently not with a strong decarbonisation focus (standards). Some other options are in use, but not yet for the materials sector (contracts for difference, consumption charges).

- **The relevance for mitigation options** (y axis): Different policies target different categories of mitigation options.

We will briefly introduce all these instruments by decision mode (x axis). Instruments that may require significant strengthening or are not yet introduced for climate friendly material choices are then discussed in more detail in the following sections and Annexes.

**The first group of instruments engages and informs actors to overcome satisficing behaviour.**

- Labels reflecting emissions or energy use during operation are part of EU energy labelling (Energy Efficiency Directive (2012/27/EU))\(^8\) and ecolabelling regulation (EU Ecolabel Regulation (No. 66/2010))\(^9\). They can be expanded to reflect life-cycle emissions through life-cycle-assessments (LCAs) based on a common standard, thus overcoming controversies in the current debate. This may also contribute to public awareness about emission intensity as a basis for policy action and facilitate comparison of different products thus contributing to low-carbon niche-markets.

- Disclosure in financial reporting is currently being strengthened as part of an EU Action Plan on Sustainable Finance. A key discussion revolves around the taxonomy, i.e. how will firms include the assessment of risks and opportunities of deep decarbonisation in (financial) reporting, and how will it be reflected in rating and financing decisions.

- Environmental Management Systems (e.g., EMAS) could be expanded to cover material management to create information and decision structures to realize efficiency potentials in production.

- Audit, advice, training and learning networks can further support climate-friendly choices and ensure harmonization and assurance of quality.
A second group of instruments mandates clean choices:

- The EU Eco-Design Directive (2009/125/EC) mandating minimum energy efficiency standards could be expanded to ensure that products sold to European consumers can be repaired and materials in products can be recycled without down-cycling. Improving the methodological basis towards such extensions is already envisioned under the Directive working plan 2016-2019.

- Norms like those of the International Organization for Standardisation (ISO) or European Standards (ENs) play an important role. They specify, for example, what cement type may be used in different construction applications. They have been formulated with other priorities and objectives in mind, and may constrain changes to new materials or building and product design. Adjustments are necessary, but experience suggests these may be slow, particularly given the need for broad consensus among experts pursuing different aims and often reflecting the perspectives of bigger companies. Therefore, such discussions will likely lead to incremental rather than disruptive changes. Standards for environmental performance are also common as part of plant-level permitting processes.

A third group of instruments improves the economics of climate-friendly choices relative to other choices, typically by internalizing environmental externalities and addressing regulatory uncertainty:

- Green Public Procurement (GPP) includes the environmental quality of bids (e.g. energy efficiency, use of low-carbon materials) in the award of public contracts. It can allow local and national governments to buy low-carbon products or infrastructure and create lead-markets for climate-friendly options by using a shadow carbon price larger than the ETS one. Especially at the local level, communities may be more inclined to pursue GPP, if potential incremental costs for climate friendly purchases are supported, e.g. through national funding.

- Waste charges (e.g. for construction and demolition waste) can encourage recycling and reflect end-of-life carbon emissions to complement carbon prices on production emissions.

Project-based carbon contracts for difference pay out the difference between the yearly average auction price of emissions allowances (EUAs) and an agreed strike price, effectively ensuring a guaranteed carbon price for the project. In exchange for this insurance, investors are liable for a payment if the carbon price exceeds the contract’s strike price.

- Consumption charges are levied on sales to final users based on the weight of carbon-intensive materials in product. They do not differentiate by production location or process, but are based on a benchmark of carbon emissions per tonne of material. They may be first introduced at national level to raise revenues to fund decarbonisation policies. Integration of a consumption charge in the European Emission Trading System could reinstate the full carbon price signal that is currently muted in the value chain with free allowance allocation (Neuhoff et al. 2016).

Finally, strategic investment in innovation and infrastructure should be supported with dedicated funding and suitable regulation respectively (See for example Neuhoff et al. 2017).

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The multitude of policy instruments is complex to manage from a decision makers perspective and costly to comply with by firms. It is therefore desirable to focus on a subset of policy instruments, which was selected based on the following criteria.\footnote{In the preceding Climate Strategies Project ‘Carbon Control and Competitiveness post 2020’ the sector specific experiences with the policy framework have been evaluated based on interviews, case-studies and econometric analysis (Neuhoff et al. 2014a,b). This helped to identify policy needs to unlock the mitigation options, which then were evaluated in the context of the Climate Friendly Materials Project and in related workshops focusing on cross-cutting as well as innovation instrument.}

**First, prioritize instruments that support multiple mitigation options**, to provide flexibility for private actors to find suitable solutions, increase political support by aligning the interests of different constituencies, and reduce the number of required policy instruments.

**Second, prioritize instruments that align private choices with long-term policy objectives**, so as to catalyse private initiative for transformation and to shift the large volume of existing investments into climate-friendly choices.

**Third, prioritize instruments that are complementary**, addressing all necessary modes of decision-making, to ensure maximum effectiveness in unlocking mitigation options, and to support political acceptability for the broader package of instruments.

**Fourth, prioritize policy and experimentation in individual Member States** (subsidiarity) to enhance local ownership and facilitate multiple policy learning experiences across Europe, notwithstanding the common approaches and opportunities for economies of scale of the European market.
The previous discussion allows the identification of the potential role of individual instruments as part of a policy mix. This process helped to clarify three key gaps in the existing policy package for the material sectors (Figure 4):

1. **How to enhance recycling?**
2. **How to create markets for climate-friendly options?**
3. **How to phase out carbon intensive production?**

Each of these questions involves choosing among policy alternatives. Some of the pros and cons of these alternatives are presented in the following three sections, each addressing one of the questions. Ultimately, trade-offs within these choices will have to be assessed by policy-makers with the mandate to formulate preferences and priorities.

Beside these choices, a set of policy instruments not primarily focused on materials may play a central role in determining the development of production and use patterns of materials. For example, allocation of car parking space can catalyse car-sharing and taxing online sales, or VAT rate reductions for repair services can make product repairs more economically viable.

### Relevant areas for policy interventions to support climate-friendly decisions, and three areas of trade-offs to fill policy gaps.
In this section we explore how recycling of basic materials can be enhanced. This involves decisions at the design stage as well as at the end-of-life stage. Two approaches are discussed: the extension of the Eco-Design Directive (2009/125/EC) focuses on the product design stage, while enhanced producer responsibility, including through advanced disposal fees, attempt to jointly address design and end-of-use choices. The most suitable approach may vary across product categories.

The extension of the Eco-Design Directive could include the requirement that products are more durable (via minimum lifetime of components), can be repaired (e.g. components can be easily replaced), and easily recycled (e.g. designing items that can easily be disassembled; marking large plastic parts; mandating less varieties to facilitate sorting; see Eco-Design working plan 2016-2019 and MEErP Report (Mudgal et al. 2013)). This would add to the current focus of the Eco-Design Directive on minimum energy efficiency standards during the use phase (see Annex 4 for more detail).

Such a mandate on producers helps align incentives and ensure all products can be covered, including those imported that need to meet the standard and products with long lifetimes, where producers might highly discount future disposal costs.

However, a narrowly defined technical requirement may prevent the exploration of new products and solutions. Is there, for example, an opportunity to make eco-design more innovation-oriented by not “only” phasing out inefficient products, but also setting tougher performance-oriented standards (e.g., based on life-cycle GHG emissions, toxic substance content, ease of recyclability). Product design requirements, however, cannot create demand for repair, reuse and recycling.
Enhanced Producer Responsibility (EPR) makes producers responsible for the management of their products’ end-of-life. In principle, this should ensure that a producer will optimize the material choice, product design, recollecting and dismantling of a product so as to achieve the formulated policy objective of high-value recycling. This recycling target can also be interpreted as a quota, in order to require producers that a given level of recycling of materials is achieved. Three groups of instruments have been explored to implement EPR and recycling requirements. Each involves different forms of responsibility (Lindhqvist 2000).

**Individual responsibility:** Producers have to take their products back (e.g. with Deposit Refund Systems, DRS) or contract with recyclers. Individual compliance allows almost full cost internalization but implies complex logistics in fragmented markets, especially those outside the applicable jurisdiction, in this case the EU (Massarutto 2014). It requires sufficient collateral is deposited for all products sold to ensure compliance at the end of the life cycle.

**Advanced disposal fees** (See Annex 3): Producers can meet their responsibility by paying advance disposal fees to a collective producer organisation (see PRO Europe 2018). Setting the appropriate fee level requires a governance structure, either producer-led or state-run, and quantification mechanism to ensure sufficient incentive for recycling-friendly material choice and product design. End-of-life collection may include collective take-back through collective DRS systems.

Advanced disposal fees allow the pooling of funding from producers for waste management, thus making it logistic-efficient (Massarutto 2014; OECD 2016). They can also ensure future waste management costs (address orphan goods; OECD 2016) and create incentives for eco-design, if fees are modulated according to environmental criteria (OECD 2016).

** Tradable recycling certificates:** Under this scheme, producers buy tradable recycling certificates from waste reprocessors, which show evidence of recycling. High demand of certificates should provide incentives to build recycling infrastructures. The approach on its own, however, does not create clear incentives to eco-design (because of volatile prices).
In order to make investments viable in material efficient product design and climate friendly materials and processes, a framework of incentives is needed. This requires first of all the creation of lead markets, to provide support in the short-term. It also requires funding to cover the incremental cost for more expensive products and processes. In the long term, the support provided at the beginning needs to be mainstreamed. Below, we illustrate policy options that can achieve this two-fold target.

**Policy Gap 2:**

**How to create lead markets for climate-friendly options?**

Early market opportunities are essential for the success of new production processes and alternative materials, so innovation can be tailored to consumer needs, experience can be created to adjust norms and standards based on the new approaches, and quality and cost competitiveness can be improved through learning-by-doing. Policies cannot rely only on a technology push, they also need market pull.

However, materials and traditional material production processes are typically cheaper (from a private perspective), as they reflect decades of research, learning by doing, and economies of scale of large production facilities. They are also associated with fewer uncertainties and risks about long-term performance of the material, or interactions with other materials, or characteristics of a product. Added to this, due to the inherent uncertainty about emission trading and other climate policies, the investment framework is insufficient for investors looking to make large-scale commercial bets on technologies that are currently more expensive.

Against this backdrop, it is important to create lead markets for material efficient design and low-carbon materials and processes. Three types of measures may help moving in this direction. The incremental costs incurred with these measures could be covered with a consumption charge or levy on carbon intensive materials.
• **Project-based carbon contracts for difference** (CfDs) pay out the difference between the yearly average auction price of emissions allowances (EUAs) and an agreed strike price, thus effectively ensuring a guaranteed carbon price for the project. In exchange for this insurance, investors are liable for a payment if the carbon price exceeds the contract’s strike price. CfDs would allow national governments to create lead-markets for low-carbon processes and materials (see Annex 1). An important aspect of CfDs is that they help cover the incremental (especially the operating) cost of low carbon innovations, so that commercialization becomes a viable economic option. This would help tackle a major gap in existing innovation funding, which has seen pilot projects abandoned despite public funding due to a lack of near-term marketability perspectives. In short, CfDs guarantee revenues linked to climate benefits, thus facilitating financing of projects.

• **Green Public Procurement** guidelines allow local governments to create lead markets for climate-friendly product design, manufacturing and usage patterns (Procurement Directives 2014/24/EU12 2014/25/EU13). Governments at all levels can address emissions embodied in infrastructure, buildings and transport systems that they procure and thus respond to local initiatives (e.g., Climate Friendly City etc.) as much as nationally and European-wide agreed targets (see e.g. the Buy Clean California Act (AB 262, 2017), or the Dutch Infrastructure Authority’s approach for the procurement of green infrastructure (e.g., van Geldermalsen 2015)). Contributing to overall climate targets can be achieved i) by considering a shadow carbon price to evaluate the environmental impact when ranking and selecting submitted offers, ii) giving weight to specific environmental dimensions in the scoring rule, or iii) setting limits on the carbon intensity that admissible offers need to comply with (see Annex 2).

• **National level consumption charges or levies** are based on the embedded basic materials multiplied by their carbon intensity benchmark. As such a charge is not related to production process or location and it is not contentious from a trade perspective. Charges or levies in national pilots may initially focus on material use (i) in the construction sector, as simple value chains limit the interaction of cross-border trade with national consumption charges or (ii) in car sales, as rules to prevent arbitrage of EU VAT differences limit the concerns of cross-border distortions (Annex 5).

Green public procurement and project-based carbon contracts will require extra funding to address incremental costs that arise in the short term. The consumption charge or levy could raise these funds. National consumption charges could also provide practical learning experience to guide a European design.

• **Harmonized labelling** would inform consumers of the scale of emissions embodied in products and buildings that they buy or rent. This labelling system would require an extension of the Ecolabelling Regulation (No. 66/2010) which has so far focused on energy performance of products and has thus contributed to the choice of energy efficient ones (Heinzle 2012, Hermansen et al. 2012). An extension could provide harmonized, and therefore comparable, information also on life-cycle emissions of products based on a common standard. For construction materials, harmonized labelling might have a particularly important role not only at the product level (e.g. cement) but also at the building level, as currently promoted by some EU initiatives (LEVELs framework) and sustainable construction rating schemes (e.g. DGNB, BREEAM). Similarly, effects may be expected in the automobile market. Thus, labels could have some potential to create niche markets, as demand from progressive consumer segments could encourage innovative low-carbon product design or material choices. They may also help raise awareness on emissions embodied in the value chain, and thus support further development of policies needed for the decarbonisation efforts of upstream segments.
Incentives from carbon pricing are particularly important for reducing the inherent emissions in basic materials. For example, if carbon prices of 30 Euro/t CO$_2$ are passed through to product prices, this would result in significant price increases for cement (27.6%), steel (11.2%) or plastic (5.5%) (Pauliuk et al. 2016). This would strengthen incentives for efficient material use in design and production and create market opportunities for higher value and lower carbon materials. Second, innovative low-carbon production processes will very likely incur incremental cost for additional equipment, substitution of coal with gas, and eventually renewable electricity, hydrogen, or the use of carbon capture and sequestration. Material producers will only implement alternative technologies if it is clear how these incremental costs are recovered, for example with carbon prices passed to final consumers.

All attempts to price carbon in material production so far have raised the same concern about international tradability of materials: incremental costs would trigger relocation of material production, resulting in carbon-leakage instead of emission reductions. To protect from this event, in emission trading systems allowances are allocated for free at a benchmark level per tonne of material produced. Post 2020, this allocation will be directly linked to production volumes. As a result, firms will not be able to pass through the carbon price to the material price because both allowance allocation and emissions increase with material production (per tonne of cement/steel). If carbon price is not passed through, however, the desired incentives from its application are muted and consumers will not contribute to incremental costs of clean production processes (Skelton and Allwood 2017).

Three strategies are discussed to correct this shortcoming:

1. **Spreading carbon pricing globally** with a vision to gradually aligning price levels and phasing out free allowance allocation (ICAP 2016).

2. **Adjusting carbon prices at the border** to protect against carbon leakage to regions without comparable carbon pricing levels and, in parallel, abandoning free allowance allocation.

3. **Including consumption** of carbon intensive materials in the EU ETS with a consumption charge at a benchmark level to reinstate incentives and revenues muted by free allowance allocation in upstream emission trading system. (Neuhoff et al. 2016).

While all three approaches aim to reinstate the full carbon price signal and related revenue, they may involve some limitations (Figure 5).
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<th>Global convergence of carbon pricing including phase out of free allocation</th>
<th>Full auctioning + Border Adjustment (BA)</th>
<th>Free allocation at BM + Inclusion of consumption</th>
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### Risks (WTO, politics)

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Comparison of the approaches for reinstating the full carbon price signal and related revenue

Global convergence of carbon pricing levels and phasing out of free allowance allocation remains very slow. This points to the importance of alternative approaches, either border-related or consumption-based. Both options are particularly suitable for basic materials, as they require a focus on a small group of materials and a clearly defined benchmark (carbon emissions per tonne of material).

A consumption-based approach could avoid the political opposition and the WTO concerns typically associated with border-related approaches.

It would also be in line with the increasing awareness at global level that not only producers, but also intermediary and final consumers, need to be part of successful climate change mitigation action. At the European level, these international dynamics are reflected in the revised European Emission Trading Directive. The EU Commission is mandated to assess the effectiveness of the current structure of the EU ETS in the global context and to make proposals to address shortcomings (Preamble 21, EU ETS Directive).

14 (*) Would imply moving from Art 20 to Art 3 of the GATT (Ismer and Neuhoff 2007).
Incumbent material producers are important for the implementation of low-carbon options, because of their existing organisation, access to human and financial capital, industry knowledge, and the fact that processes or materials are often a small part of an integrated value chain that is difficult to penetrate by third parties.

A credible risk that business-as-usual will not be a viable long-term option is an important motivation for management to engage in a low-carbon strategy to secure the companies’ long-term ‘license to operate’. This raises the question of what policies could be used in the longer-term to phase out carbon intensive production.

- **Incentives from carbon pricing.** A carbon price relevant for all decisions along the value chain (see previous section on creating long-term markets) can make climate-friendly production processes and materials competitive with existing processes and materials. As the sole policy instrument, however, a carbon price needs to be high enough to ensure the operational costs of an existing carbon-intensive process exceed the operational and investment costs of climate-friendly processes and materials. Given the capital-intensive nature of basic material production processes, this may require rather high prices, or the combination with other policy instruments to phase out carbon intensive production.

- **Labels (Certified trading schemes or Certificates of origin).** Once low-carbon options are available, it may become socially unacceptable to buy materials produced with carbon-intensive processes, including as part of other products or buildings (similar to the current situation of unsustainable rainforest timber). Extension of labelling to life-cycle emissions, as discussed in the previous section, could inform such choices. However, because final consumers rarely choose materials directly, a meaningful effect would
require that all products comprising materials are covered and that a large majority of consumers would actively avoid carbon intensive choices.

- **Product certification**: Certification of a clean production process could be required for all materials sold in Europe, including as part of products. This would preclude the sale of any material produced using a carbon intensive process. As the same rule would apply to imports and domestic production, the system would neither discriminate against foreign producers nor disadvantage domestic producers with respect to foreign ones. International cooperation would likely be required, however, to ensure that this approach is technically and politically feasible.

- **Emission performance standards** may be tightened to the extent that only clean production processes can be operated (see Annex 4). Equivalently, governments may revoke the operational license of carbon-intensive processes. Using environmental legislation, this is usually possible after an economic depreciation period, once the invested capital is considered to be “paid-off”. As the sole domestic instrument to incentivise a shift to clean production processes, such an approach would likely raise concerns about carbon leakage. It may be more viable to phase out residual carbon-intensive production capacity through a policy framework that already ensures the economic viability of clean production processes.

- **Disclosure of carbon-risk exposure of companies** (see Annex 5) is an important element in translating expectations about future climate policy into today’s investment choices. Initial steps are reflected in voluntary reporting, e.g. under the Carbon Disclosure Project (CDP - [https://www.cdp.net/en](https://www.cdp.net/en)), or mandatory reporting by listed firms as it is now required in France and the UK. Discussion is ongoing on disclosure rules and taxonomy as part of the recent EU action plan on sustainable finance ([https://ec.europa.eu/info/publications/180308-action-plan-sustainable-growth_en](https://ec.europa.eu/info/publications/180308-action-plan-sustainable-growth_en)).
In the wake of the Paris Climate Agreement, companies in Europe’s materials sector are looking to innovate making their investments and business models future-proof. To do so, they will need a sufficiently credible policy framework and set of incentives.

Efforts targeting deep decarbonisation, however, have so far been limited in the materials sector. Policy makers have been operating with limited knowledge of climate friendly alternatives, and incomplete perspectives over a possible package of policies and incentives that could drive the low-carbon transformation of these industries. Instead, much of the policy debate is focusing on carbon leakage risks, which inhibited implementation of stringent policy despite the availability of robust solutions.

This paper has identified a list of seven categories of mitigation options for the materials sector and mapped a broad portfolio of policy instruments that could unlock these options. Many of these policy instruments already exist. Decarbonising the materials industry, therefore, does not require “re-inventing the wheel”. However, with some exceptions, the application of many of these policies to the materials sector is limited (if not completely absent) and not climate-focused. As a result, some policies may need to be recalibrated or reinforced, while others may need to be replicated on the basis of successful experiences in other sectors.

To help narrowing down the options for discussion, this paper identified **three main policy gaps** that currently prevent substantial progress:

1. Partial and incomplete incentives to enhance recycling
3. Missing policy signals that carbon-intensive production will be phased out

**Conclusion**
These three policy gaps are interrelated and the solutions are highly complementary. For instance, the scale of the challenge in developing innovations for climate-friendly production processes can be made more manageable if the overall demand for primary materials is reduced with enhanced resource efficiency and recycling. Filling policy gaps 1 and 2 would also enable the industry to develop alternative business models and investments. This, in turn, can help making the timely phase-out of conventional high-carbon production processes more acceptable. Sending clear and early policy signals emphasizing policy makers’ commitment to phase our carbon-intensive production within a clear time frame, is necessary to get business buy-in for the transformation agenda.

Implementing a robust policy package to fill the above-mentioned gaps will ultimately involve choices and trade-offs between different policy instruments. This paper has presented several options. Key criteria for policy choices are:

- Focus on instruments that have the potential to unlock multiple mitigation options or that close several policy gaps at once.
- Focus on policy instruments that provide incentives to deliver long-term transformative objectives.
- Focus on subsidiarity to multiply opportunities for innovation and overcome national barriers.

For example, applying these criteria to the policy gap “Missing short- and long-term markets for climate-friendly options” helps prioritize three policies: first, green public procurements to create early lead markets for climate-friendly product design and material choice; second, project-based carbon contracts for difference to stabilize revenue streams and back investments in climate-friendly production processes and new materials; third, a consumption charge on basic materials to raise revenues to fund policies for climate-friendly materials. Integrated in the EU ETS, the charge will make the carbon price effective for all climate-friendly choices and enhance long-term credibility of carbon leakage protection.

Completing the policy framework for the low-carbon transformation of the materials sector will require a shared perspective among policy makers and industry. This means not only a long-term vision for the relevant sectors, but also a portfolio of policy instruments that enables the achievement of such objective. The dialogue with industry has tended to remain narrowly focused on individual pieces of policy (e.g. ETS anti-leakage rules), and innovation funding has been too focused on individual pilot projects for specific low-carbon production processes. In completing the policy package, governments should seize the opportunity to create a dedicated governance framework for GHG-intensive sectors.

Completing the policy package for material production and use is a shared responsibility between different levels of governance within a jurisdiction, across the EU, as well as across global jurisdictions. Some policies relevant to the EU internal market (e.g. carbon pricing, eco-design or labelling, infrastructure) are best addressed at the EU level. However, many important policy options (e.g. creating lead markets through CfDs, public procurement, reforming national building codes, training workers in new materials and processes) involve clear subsidiarity and national industrial policy considerations. Policy makers in all jurisdictions, therefore, can contribute to an effective policy design, tailored to local and national preferences and priorities. The EU’s new Energy Union Governance and the related National Climate and Energy Plans present an important opportunity for coordination and mutual commitment.

The basic materials sector in Europe is in a precarious limbo. They have often depreciated and relatively CO₂-intensive assets whose value largely derives from their ability to serve their downstream (higher value-added) operations. In the next 10 to 15 years, these assets will require major decisions on reinvestment or closure. Carbon-intensive choices are incompatible with existing emission reduction targets and thus face the risk of more stringent climate policies. At the same time, the investment case for climate-friendly choices remains weak and uncertain in the current policy regime. This limbo situation can be broken if the EU and its member states provide the missing conditions and policy incentives within the internal market for the materials sector to develop, demonstrating and commercialising innovative climate-friendly materials production. For multinational companies involved in these processes and their technology suppliers, which are often based in Europe, the opportunity to advance on new technologies and practices could be the basis for future improvements in their global operations. This could become an additional motivation for reinvesting in Europe, to the benefit of European workers, regions, consumers, and industrial innovation.
Project-specific long-term carbon contracts for differences (CfDs) could apply to large scale, innovative projects in the industrial sector to reduce emissions. They moderate regulatory and market risk (Richstein 2017), shift the benefits of mitigation to earlier years and, thanks to lower variability of revenue streams, reduce financing costs. Carbon contracts for differences work as a complement to innovation funding.

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

CfDs thus guarantee investors a fixed price for each ton of emissions reductions below today’s emission benchmark, given current best available technology and expected CO₂ price developments for the contract duration (for example, 50 €/tonne CO₂ for a 20 year duration).

The contract should apply only to the emission reductions achieved with the climate friendly investment. This is calculated by subtracting the verified emissions of an installation from the emissions of a traditional technology multiplying production volumes by the EU ETS benchmark of emissions of the best available technology per tonne of material production at time of investment.

Each carbon contract for differences would be linked to a specific investment. It would only be granted where the new production process, practice or substitute material results in emission reductions compatible with long-term climate objectives. As only highly innovative projects currently reach deep emissions reductions, the process can be simplified by offering carbon contracts for difference to projects that qualify for innovation support, e.g. through the EU ETS or national innovation funds. Where national long-term decarbonisation strategies exist, another option could be to only allocate CfDs to projects that are explicitly identified as having a role in a National Low Carbon Strategy to 2050, or are expected to deliver equivalent performance. An iterative process of reviewing and adjusting the technological scope and design of tenders would be necessary.

The counter parties to the CfD would be primarily national governments. These would incur a cost in the initial years, when the CO₂ price is below the strike price, but are likely to benefit in the longer-term, when the CO₂ price exceeds the strike price. The legal anchoring will have to be tailored to the budget laws of a given country.

CfDs, in combination with innovation grants, would bridge the valley of death on the road to commercialization by helping scaling up abatement solutions to a commercial level, which becomes competitive once the carbon price rises to a sufficient level.

The key benefits of CfDs as a policy instrument for supporting innovative projects are: 1) increased stability of revenues, lowering the financing cost for low-carbon investment projects, resulting in a reduced need for innovation funding; 2) potential for governments to recover costs as the carbon price rises; 3) full incentives for investment and operations, as revenues are linked to delivered emission reductions with integration in the EU ETS and its monitoring requirements; and 4) clear signalling of governments’ commitment to long-term policy goals.

CfDs also have other important benefits. They can serve as a commitment tool for governments to demonstrate their support for a high carbon price, as they will sustain financial losses if carbon prices do not increase (Chiappinelli and Neuhoff 2017). Conversely, they can be budget neutral or even profitable if the carbon price increases beyond the contract’s strike price.
Technical implementation will be primarily at the national level, as EU institutions lack the standing to serve as the counter party for the required scale of such long-term contracts. It is also in the interest of EU member states to offer such contracts, and thus improve the national investment framework. Regional cooperation, however, could be used to coordinate strike prices giving them credibility as a signal for long-term perspectives and strengthening predictability for international investors.

Due to the long lead time in technological development, the longevity of assets in the materials sector and related business cycles, it is important that investments in breakthrough technologies start as soon as possible. A key milestone would be a national pilot in conjunction with traditional innovation grants, which could then be extended to a coordinated carbon contract for difference program in several EU member states.

CfDs should focus on decarbonisation projects in the industrial sectors, as similar instruments guaranteeing an (implicit) carbon price have already been established in other sectors. For example, the German renewable energy law effectively provides 20-year price guarantees for power produced per MWh of electricity produced. For wind power, the difference between price level and realized wholesale prices corresponded to an implicit carbon price of 57 Euro/tonne CO$_2$ for the period 2006-2010 (Marcantonini & Ellermann 2014). In the power sector it is more suitable to link CfDs to the power rather than the carbon price, as this allows to insure investors against various regulatory risks related for instance to power market design or grid expansion.

CfDs can be integrated with other policies for innovation support. Upfront grants may for example be necessary to make pre-commercialisation projects economically viable. Complementing such grants with CfDs increases the incentives for projects to achieve emissions reductions. It also reduces overall public support requirements by reducing regulatory and carbon market risks and thus financing costs. This reduces support costs and can thus help to address limits of innovation funding.

In the EU context, the design of the scheme needs to reflect that a carbon strike price exceeding the average expected carbon price over the 20 year project duration could be considered as state aid. Such state aid could be justified on environmental or innovation grounds.

As production with climate-friendly processes or of climate-friendly materials will increase over time, it will be increasingly important that incremental costs are born by the consumers in the respective sectors (i.e. products and services). If they are funded from public budgets or cross-subsidised from other sectors, political acceptance of further projects will decline and the risk of environmental rebound effects from public subsidies to carbon intensive sectors will increase. CfDs do therefore not reduce the importance of an effective carbon price signal pass through along the value chain, either by phasing out free allowance allocation possibly in combination with border adjustments or by inclusion of consumption in emission trading systems.
Annex 2: Green Public Procurement (GPP)

CHARACTERISATION OF THE INSTRUMENT

Green Public Procurement (GPP) considers in the award of public contracts the environmental quality of bids (e.g. their level of energy efficiency and use of low-carbon materials).

There is a legal framework at the EU level (Procurement Directives 2014/24/EU and 2014/25/EU), explicitly considering the use of GPP and indicating the implementation options. However, the use of GPP is not mandated and no binding targets are set. The actual extent and the specific modes of implementation in Member States are determined at the national and local level.

The regulatory framework allows for two GPP implementation options:

**Technical requirements:** environmental quality dimensions are specified as technical requirements in the call for tenders, and only bids that satisfy certain (minimum) environmental standards or specifications are admitted to the competition. Examples so far: recycling requirements (e.g. concrete, paper), sustainable timber, LED lighting (Chiappinelli and Zipperer 2017 and references therein, UN 2017, GPP2020).

**Most Economically Advantageous Tender (MEAT):** environmental quality is part of the award criteria. In this case the regulation allows for two sub-options:

1. **Shadow prices of carbon and of other environmental damage** are used in the evaluation and ranking of bids (i.e. are monetized in the offered price), which allows for a full accounting of environmental externalities, possibly on a life-cycle cost (LCC) basis, of the product/service/infrastructure purchased.

2. **A weight is given** to specific environmental quality dimensions relative to the economic part of the bid (i.e. price offered) and the bid with the higher weighted average wins the tender.

A LCC-based shadow price approach has been used by the Dutch Infrastructure Authority with the very successful experience of achieving 24 to 50% emission reduction compared to standard tenders (GPP2020, Baron 2016).

IMPACT AND POTENTIAL OF THE INSTRUMENT

A major share of public sector emissions is linked to procurement of infrastructure, transport systems and buildings. Given the large purchasing power of public authorities, GPP can play a central role for decarbonisation. By including a shadow carbon price exceeding current EU ETS prices and considering LCC emissions, GPP can create lead markets for climate-friendly product design, manufacturing and usage patterns. This is particularly valuable in the context of materials where the ETS price is currently muted due to dynamic free allocation of allowances. GPP can support multiple mitigation options (recycling, share-repair-reuse, efficient material use, material substitution, efficient product design) in all the basic materials sectors.

Furthermore, public procurement may offer the opportunity, especially at the local level, to explore multiple options of services and products that may succeed in reducing emissions, and to create demand for a variety of these options. It may also make the low-carbon options more visible, both strengthening the effect (e.g. lighthouse projects) and enhancing support (as transparency on the use of public funds is prioritized).

BARRIERS TO IMPLEMENTATION

Despite this potential, GPP has been so far little used for such purposes. A recent study finds that in Germany, only 2.4% of all large public contracts awarded in 2015 included environmental criteria (Chiappinelli and Zipperer 2017) and other countries follow similar patterns (CEPS 2011, UN 2017). There are two main barriers for more extensive uptake and they are related to incentive structures and capacity constraints.

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First, GPP typically implies that purchasing costs for the contracting authorities will be higher (e.g., LED light bulbs vs. standard bulbs). Especially at the local level, where budget constraints are tighter and commitment to climate policy lower, this substantially hinders the willingness to uptake GPP.

Moreover, GPP increases the complexity of procurement for both the contracting authority (extra effort, time, capacity and resources are needed to include environmental criteria in procurement documents, check environmental compliance of tenders, provide legal certainty and secure compliance with competition and procurement law, consult external parties) and the bidders (e.g., extra effort and cost to check compliance of bids with environmental criteria, e.g., via label or certificate). The latter can strongly deter participation in tenders, which leads to follow up problems as the services and products to be procured are needed on time and setting a new procurement process is costly. Since the main objective of public purchasers is to ensure that procurement processes are fast, efficient, not too demanding in terms of capacity and expenses, and legally certain, the use of GPP is strongly hindered, especially at the local level where administrative capacity is smaller.

**POLICY OPTIONS FOR OVERCOMING THE BARRIERS**

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

First, central transfers could be designed and allocated to sustain the incremental cost of GPP. These could be financed out of consumption charges.

Second, initiatives should be taken to improve the administrative capacity of procurement teams, especially at the local level. These could include: i) training programs for public officials to learn how to implement GPP (e.g., on technical characteristics, legal compliance, usage of LCC analysis and software), ii) handbooks for the classification and simplification of green technical qualities, iii) free and timely legal and technical consultancy services (e.g., to check compliance with data protection, competition and procurement law), iv) development of platforms and networks for sharing experience and joining efforts.

If consumption charges on carbon intensive materials are used to finance the transfers needed to cover incremental costs of GPP, especially at the local level, their societal and political acceptance is likely to increase. The assumption for the success of this theory of change is that there is enough support for climate policies at the political and societal level so that there is i) willingness at the political level to allocate funds for supporting implementation and ii) willingness at the societal level to sustain extra costs via consumption charges.
Advance Disposal Fees (ADF) should reflect the estimated cost of collection and treatment of products (OECD 2016). They are used to collect funding for waste management.

Collective systems: In most waste flows, consumed products are dispersed in household garbage, which makes it difficult to recover individual branded goods. Hence, producers may rather collectively fulfil their responsibility and realize economies of scale (e.g. avoid duplicated infrastructures; OECD 2016). Besides, governments encourage collective schemes for durable goods, as these are a form of insurance against future management costs (e.g. in case a firm goes bankrupt; OECD 2016).

Incentives to eco-design: So far, most cases show the use of fixed fees averaging costs across producers, which can work well in covering waste management costs, but fail to reward or penalize individual producers for their design choices. (Massarutto 2014). To provide incentives to eco-design, ADF should be eco-modulated, i.e. adapted according to the product’s environmental criteria or degree of circularity (OECD 2016). Eco-modulation of ADF is now becoming increasingly relevant and is progressively implemented (e.g. in France for packaging, electronics and graphic papers).

### Variable ADF (packaging)

Usually, the fee for packaging is weight-based (€/kg) and differentiated according to the packaging material (OECD 2016). The weight-based approach was adopted because of its easy implementation and was said to reflect adequately waste management costs (Didier and Sittler 2014). Incentives for light-weight packaging for the same material are provided, but other circular aspects are not taken into account.

### Fixed ADF (waste electrical and electronic equipment (WEEE) and end-of-life vehicles (ELV))

For WEEE, a fixed fee is paid according to the type of product (e.g. computer, refrigerator). A fixed-fee system was adopted because of the difficulty to assess the preferred environmental features of such complex products. Besides, there is great uncertainty about future waste management costs. Hence in many systems, fees account for today’s waste and not for future waste induced by producers’ current sales (“pas-as-you go” systems; OECD 2016). Collective systems for ELV are also characterised by fixed fees (e.g. 45€ per new car in the Netherlands regardless of the brand or the type; OECD 2016). Fixed fees only provide weak incentives to eco-design, if any.

### Eco-modulated ADF

Eco-modulation consists in penalizing or rewarding individual design choices of producers (e.g. inclusion of recycled contents, use of disruptive substances, mono-materialization, etc.) by inflating or deflating base fees. Eco-modulation allows to better internalise waste management costs at the firm-level and strengthens incentives to eco-design. This approach has been implemented in France for packaging and WEEE. So far, no empirical evidence exists on its efficacy.

ADF is an instrument that enables covering costs of waste management by responsible producers, and gathering efforts to build a common market for collection, dismantling and recycling. If modulated correctly, ADF contribute to internationalisation of waste processing costs by individual producers.

However, the often-embraced flat fee approach provides little incentive for improved eco-design. This can cause dynamic inefficiency: if producers do not offer more recyclable products, costs of recycling may not decrease sufficiently, reducing the importance of eco-modulation. While further analysis is needed to explore the results of early experiences and test the feasibility of its application to CO₂-intensive materials.
more specifically, in principle eco-modulation appears feasible for a range of material intensive products.

Efforts should initially focus on non-highly traded goods and services, as the supply to consumption chain remains within the jurisdiction. Once non-traded systems are well established, testing can begin for more traded goods.

There is also a need to prioritise the extension and reinforcement of existing schemes for products with high usage of CO\textsubscript{2}-intensive materials. In particular, for new fixed construction or renovation products, automotive products, industrial equipment and machinery, etc.

**BARRIERS TO DEVELOPMENT AND POLITICAL ACCEPTANCE**

- ADF should be sufficiently high to influence producers’ choices. There is a trade-off between upstream and downstream effectiveness (Massarutto 2014). It may not be acceptable to increase ADF more than what is needed to finance waste management. If the incentives provided are too weak, increased fees could in principle be justified only in the presence of complementary regulation on waste, e.g. increased material recycling targets. Further, the combination of end-of-product use targets, like material recycling and ADFs, could be a stronger incentive to eco-design at product inception.

- ADF are often decided by producers themselves (producer-led central organisation), even if they are controlled by public authorities. The decision process of modulating or increasing ADF can be complex (OECD 2016, Didier and Sittler 2014) and encourages collusion and possibly abuses of market power (ibid). Consensus among producers is therefore hard to achieve (Didier and Sittler 2014), as they struggle to decide which environmental criterion has to be put forward (Walls and Calcott, 2005) or how to assess trade-off between upstream and downstream effectiveness (Massarutto 2014). Independent expertise would therefore be needed for cost assessment of alternative modulations of ADFs.
The Eco-Design Directive (2005/32/EC, revised in 2009) established a regulatory framework for the energy efficiency requirements of energy-using products. It mandated minimum energy efficient standards specific to consumer and industrial product groups with a high volume of sales and trade in the EU internal market. The Directive seeks to integrate environmental aspects into the product design in order to improve its energy performance throughout the life-cycle. The main focus thus far has been the phase out of high-energy use products.

The Eco-Design Working Plan (2016-2019) seeks to contribute to the European Commission’s new initiative on the Circular Economy taking the complete life-cycle of products and used-materials into account. The EU Commission proposes to improve the Eco-design framework with the inclusion of resource efficient design of a wider range of products, for example by:

- providing consumers with information regarding maintenance and end-of-life of the product, as it is already the case for heaters and freezing equipment
- enhancing the design for recycling and resource efficiency for domestic products
- designing vacuum cleaners to support easy disassembly and dismantling
- assessing the whole life cycle of the professional refrigerating and freezing equipment
- increasing product-specific durability via minimum lifetime of components
- increasing availability of spare parts to facilitate the sharing, repairing and re-use of products.

So far, the directive has been implemented primarily for white appliances (fridges, washing machines) and consumer electronics. The adoption of the Eco-Design Directive, along with the Energy Labelling Directive, has contributed significantly to the EU’s Energy Strategy by reducing total energy consumption. According to the European Commission, the share of refrigerators in the highest energy efficiency labelling classes (A and above) increased from less than 5% in 1995 to more than 90% in 2010. The Commission also estimates that the Directive may help achieve half of the 20% energy savings target by 2020.

The directive contributes to the long-term decarbonisation of the materials sector by reducing emissions of greenhouse gases and other pollutants through the dissemination of current low-carbon and energy-efficient technologies. We do not expect the eco-design standard to be a major catalyst for innovation, however. The extent to which innovation can be encouraged is likely to differ between materials and consumer-oriented products, and depends on the level of ambition of European standards.

The key assumptions for the success of the extended Eco-Design Directive is the ability to standardise the accounting and evaluation methods for the measurement of embodied emissions at a reasonable cost. More generally, the benefits and the costs of mandating product design to unlock mitigation potential of resource efficiency are unknown.

The level of implementation is the EU but the Directive only sets minimum standards. The legislation is a mandate that needs to be enforced by EU member states.

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4 Also see the MEErP project report (Mudgal et al. 2013) supporting explicit integration of “increase of material efficiency” in the objectives of the Eco-Design Directive
states, with each of them having sufficient monitoring and market surveillance to ensure compliance.

There is scope at the regional or even country level to go beyond the requirements of the directive.

For example, it would be useful to:

1. Identifying functional units (as defined in LCA) that have largely the same features within products and across competitors (e.g. dishwashers, phones, and computers), and differ mainly in the layout and assembly of these parts. Extended requirements would apply to both new and existing product groups affecting the full supply chain of production. This would help integrating circular objectives into the directive (for example, having reparation services, waste recycling and composting facilities);

2. Establishing generic standards within product groups reflecting both energy and material efficiency savings.

POLITICAL ACCEPTANCE AND THEORY OF CHANGE

The Eco-Design Directive may increase upfront consumer costs but also protects them from high long-term operating costs and end-of-life expenses. At the same time, it increases investment in energy and material efficiency from the producer side. These benefits and costs have to be weighed in calculating any consumer welfare changes. A study from 2016 (Dalhammar 2016) finds that the manufacturers in the EU have become increasingly positive towards eco-design standards for energy efficiency, but maintain reservations when it comes to overall resource efficiency. The study finds that “most interviewees were positive towards eco-design rules that improve product durability and enable more recycling, but less favourable towards requirements on recycled content, longer consumer guarantees, and maximum disassembly time”.

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7 Joint industry letter on ecodesign and Don’t let energy product policy freeze this winter, the European Partnership for Energy and the Environment, both 25 October 2016.
Under a national consumption charge pilot, a charge would be imposed on the consumption of carbon-intensive materials such as aluminium, steel or cement within one nation’s territory. Accordingly, the charge would also be imposed on final sales of products from other EU Member States and third countries. Exports to other Member States or third countries, in contrast, would not be covered by the charge. In total, only materials consumed within one territory would be subject to the charge. The level of the charge could be informed by the EU ETS carbon price and the EU carbon-intensity benchmark used for the free allocation of allowances, so that the materials and product price would reflect the costs of CO₂ emissions linked to the production and consumption of carbon-intensive materials.

At the national level, the charge would most likely have limited impact on resource efficiency or materials innovation but would nevertheless bring two benefits. First, it would create a revenue stream that could be used for climate mitigation action (in line with EU state aid rules) or state liabilities, e.g. under contracts for differences. In doing so, it would create acceptance of the charge among industry and clarify to both consumers and industry that the charge aims at supporting a low-carbon transition of industry. Second, a national pilot could inform EU climate policy, and provide a valuable experience for the phase-in of carbon-related consumption charges at EU level. A national pilot would also allow a faster implementation of climate policy compared to EU climate action since coordination at EU level is not required.

Consumption charges are widely considered trade neutral if applied equally to imported and domestic products. As such, they are in use all around the world. Within the EU, several consumption charges are currently in place. The best known among them are excise “sin” taxes, e.g. on tobacco, alcoholic beverages, and energy, which are harmonized at the EU level (General Excise Directive 2008/118/EC, Energy Taxation Directive 2003/96/EC, Taxation of Alcoholic Beverages Directives 92/83/EEC and 92/84/EEC, Tobacco Taxation Directive 2011/64/EU). Under the EU excise tax scheme, the charge arises upon production, extraction or importation of excisable goods (Art. 2 DIR 2008/118/EC). However, the charge is enforced only if the excisable product is served to the EU market. Excise taxes can be suspended along the value chain under so-called duty suspension arrangements if products are traded between qualified persons.

Some EU Member States operate similar schemes for the purpose of environmental goals. Among them are e.g. the French General Pollution Tax, the Danish tax on raw materials and the UK aggregate levy. They all have in common that they are applied only to sectors with short value chains. The number of participants in the scheme is therefore limited by the ease of administration, in particular with regard to imports and exports. Further limitation of administrative effort is provided by de minimis exemptions for imports (i.e. minimum sizes of transactions).
Sectors and materials

For ease of administration, the pilot should focus on the consumption of specific materials within one specific sector. If successfully implemented, the charge could be gradually applied to other materials and sectors. The charge could be implemented for the consumption of steel and aluminium in the automobile sector first, as these materials are used in large quantities. Even more, the automobile sector provides for an ideal setting for a cost-efficient implementation of the charge, in particular with regard to imports and exports, due to special VAT provisions on the intra-community acquisition of new means of transportation. These rules require a self-assessment of VAT by the private purchaser when the product is actually used and registered in the member state. Finally, the automobile sector has access to consumers willing to pay a premium for low-carbon materials if the vehicle can be branded as such (i.e. “green

A short guide to VAT

VAT is harmonized at EU level and puts a final burden on the consumer of goods and services in the country of destination. From an administrative point of view, it subjects to tax transactions at each stage of the value chain down to retail trade stage (Art. 1(2) sub-para 3) DIR VAT). Suppliers of goods and services can credit the VAT paid against their own liability (Art. 1 (2.2), Art. 167 et seqq DIR VAT). As a result, only the final consumer – the one who does not independently carry out an economic activity (Art. 9 (1) DIR VAT) – must bear the tax. In general, the tax is payable – where goods are not dispatched or transported – at the place where the goods are located when the supply takes place (Art. 31 DIR VAT). Were goods to be dispatched or transported, the charge is payable in the country where they are located at the time of dispatch or transportation (Art. 32 sub-para 1 DIR VAT). In case of importation from third countries, VAT is payable in the member state of import (Art. 32 sub-para 1 DIR VAT). In case of intra-community transaction (a cross-border transaction between two persons engaged in economic activities), the general rules on VAT would run afoul to the destination principle, so a special legal regime applies. On this basis, the intra-community acquisition of goods between economic actors creates liability to VAT in the country of destination (Art. 2(1)(b), 20 et seqq DIR VAT), while the transaction is exempted from VAT in the country of origin (intra-community supply, Art. 138 et seq DIR VAT). These rules only apply to B2B cross-border transactions. In case of B2C, regular rules apply and VAT is payable in the country of origin even where goods are transported and used in another member state. An exemption applies to the acquisition of cars, as explained in the subsequent paragraph as well as to certain dispatches exceeding a predefined threshold (Art. 33 et seq DIR VAT).

A special regime applies to cross-border B2C and C2C transactions of new means of transport (Art. 2(1) (b)(ii) DIR VAT), i.e. motorized land vehicles, if the supply takes place six months from the date of entry into service or if the vehicle has travelled for no more than 6,000 kilometres (Art. 2(2)(b)(i) DIR VAT). Applying the general principles referred to above, any B2C cross-border transaction would be subject to tax in the country where the car is located at the time of purchase. C2C transactions would not be subject to VAT at all. Consumers could therefore take advantage of different VAT rates and avoid paying VAT in jurisdictions where rates are higher. To prevent this and to apply the destination principle properly, the VAT Directive mandates, for the acquisition of new means of transport, the application of the rules on intra-community transactions also to B2C and C2C transactions. Accordingly, the acquisition of new means of transport is subject to tax in the country of destination, that is the state where the car is actually used. Were cars to be sold to natural persons who do not qualify as taxable under VAT, the transaction is exempted from VAT in the country of origin but subject to VAT in the country of destination (Art. 138(2)(a) DIR VAT).
Design of the tax

Based on this, we suggest the implementation of carbon sales charges on new means of transport (cars not older than six months or cars which have travelled no more than 6,000 kilometres) which would be calculated on the basis of the amount and GHG intensity of steel and aluminium incorporated in the vehicle, a material-specific carbon intensity benchmark and a carbon price informed by the EU ETS. For such purpose, the car industry would have to provide information on the weight of steel and aluminium incorporated in their car models. Liability to the charge would be created upon the following:

- Transactions between car producers and end-consumers. End-consumers shall be defined as legal or natural persons whatever their business, with the exception of car salesmen.
- Importation of cars from third countries, except where cars are imported by car salesmen.
- Importation of cars from EU member states by natural persons who do not qualify and act as taxable persons under VAT law, either in the course of B2C or C2C transactions.
- Importation of cars by legal or natural persons who qualify and act as taxable persons under VAT law (B2B transaction), except car salesmen.

In case of domestic transactions, the charge would be imposed when the car is sold to the end-customer. The charge would be collected by the car salesmen or, where the car is sold ex works, by the car manufacturer. Were the car to be imported from third countries, the charge would be due and payable upon importation. If the car is imported from an EU member state, similar administrative procedures could apply as under the VAT regime on the intra-community acquisition of new means of transport. Accordingly, the customer would have to self-assess its tax liability and pay the charge to the tax authority. The vehicle registration office would then have to report the registration of the car, as it is already doing for such transactions, to the tax authorities. In cases the charge were not paid by the customer, the authority could mandate the registration office to withdraw the car registration. These rules would then be extended to the importation of cars by a VAT taxable person who does not qualify as a car salesman.
Carbon and climate-related risk disclosure instruments address information asymmetries about carbon risks and carbon intensity of firms. Risks are mainly due to future market, price and cost changes, driven by anticipated climate and energy regulation and their impact on the profitability of current investments or businesses. This can include CO$_2$ price increases under the EU ETS leading to lower cash-flow expectations, future compliance costs and their impact on firm risk, value and cost of capital. Physical risk from climate impacts related to location of assets is also relevant.

While traditionally reporting has focused on ex-post analysis of GHG intensity and emissions, there is a drive (for example in the sustainable finance action plan of the European Commission), to consider firms’ strategies for compliance with science-based emission reduction targets based on forward looking, scenario analysis rather than historical emission trends.

Reducing information asymmetry, and therefore uncertainty, about these factors would enable investors to better evaluate firm-specific carbon risk and reflect it in their financing decisions. Such effects on firm value and cost of capital could in turn could incentivise firms to further reduce emissions.

Voluntary disclosure of CSR (corporate social responsibility) performance has been common for decades, in line with the economic theory on voluntary disclosure (good performers’ incentive to differentiate themselves from poor performers, see e.g. Akerlof 1970, Milgrom 1981, Verrecchia 1983, Healy and Palepu 2001). It is also related to value-relevance of CSR information (Margolis and Walsh 2001, Dhaliwal et al. 2011, Matsumura et al. 2014). There has been a strong increase in voluntary climate reporting under the CDP (formerly Carbon Disclosure Project - https://www.cdp.net/en). What is more, mandatory reporting has been introduced for listed companies in some EU member states, e.g. in the UK (since 2013) and France (since 2016). The obligation for non-financial reporting has been strengthened also at the EU level, by the Non-financial report Directive, which is scheduled for review in December 2018.

For the disclosure instruments’ impact, we could in principle differentiate between external and internal effects.

**External effects** are produced if disclosure of climate-related risk information provides a signal to the capital market on how well a firm is managing its exposure to climate change risks. In line with this expectation, recent empirical evidence focuses on the relationship between specific carbon disclosure and firm value (Dhaliwal et al., 2011, Hartmann et al. 2013, Matsumura et al. 2014). “Focusing on carbon disclosure provides an opportunity to empirically test whether investors recognise liabilities that the accounting system does not recognise”.

**Internal effects** are related to (additional) incentives for decarbonisation decisions in firms subject to enhanced disclosure regimes. Internally, carbon-risk can be captured by the introduction of internal carbon pricing, motivated among others by the incentive to reallocate resources toward low-carbon activities, the business case for R&D investments, and the interest in revealing hidden risks and opportunities (Bartlett 2017, Krueger 2017).

Empirical literature has shown a historically positive effect of voluntary CSR/ESG disclosure (particularly when combined with above average performance) on cost of capital and firm value. Two recent trends add further traction. Since the Paris Climate Agreement (end of 2015), financial institutions increasingly focus on “positive impact financing” and divestment. More recently, the EU’s High Level Expert Group (HLEG) on Sustainable Finance report (https://ec.europa.eu/info/publications/180131-sustainable-finance-report_en) and the European Commission’s sustainable finance action plan (https://ec.europa.eu/info/publications/180308-action-plan-sustainable-growth_en), published in early 2018, have moved the debate from a general awareness of the importance of climate-related risk to at least some concrete policy action.

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**Annex 6: Carbon (risk) disclosure and extra-financial reporting**

**Characterisation of the Instrument**

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**Impact and Potential of the Instrument**

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17 Directive 2014/95/EU lays down the rules on disclosure of non-financial and diversity information by large companies.
Both these trends should increase the price of uncertainty about carbon intensity of firms in the short-term. Capital market actors should increasingly reflect both short-term emissions reductions and long-term strategic decarbonisation decisions in lending and financing decisions, and this is expected to impact the cost of capital.

In the EU context, climate risk disclosure featured prominently in the HLEG on Sustainable Finance final report and informed the European Commission Action Plan for financing sustainable growth, which proposed to “foster transparency and long-termism in financial and economic activity” as one of its three overarching aims. Concrete actions of the Action Plan related to climate-related risk disclosure include:

- Amending the Credit Rating Agency Regulation mandating credit rating agencies to explicitly integrate sustainability factors into their assessments
- Explicitly require institutional investors and asset managers to integrate sustainability considerations in the investment decision-making process and increase transparency towards end-investors on how they do this
- Reviewing the EU Directive on the disclosure of Non-Financial Information (NFI) and revising the related EU guidelines
- Evaluating relevant aspects of the International Accounting Standards Regulation within the fitness check of EU legislation on public corporate reporting.

Instruments enhancing transparency and hence the functioning and efficiency of markets are generally welcome in the sense that they represent a minimally invasive approach to policy making compared to more regulatory policy instruments. This is underlined by the fact that the G20 set up the Financial Stability Board’s task force on climate-related risk disclosure and its final recommendations were embraced by more than 250 major international organisations and companies.

Two arguments are generally used against corporate reporting requirements. First of all, there are concerns about data protection and, in particular, the risk of disclosing information to competitors, if only firms in a certain jurisdiction are affected while competitors are not (maintenance of a “level playing field”). Secondly, there are administrative costs related to the gathering and reporting of requested data.

The growing number of firms that decided to voluntarily disclose climate-related information (e.g. 6300 companies responded to CDP questionnaire in 2018) and the support given by the corporate sector to the TFCD-recommendations ([https://www.fsb-tcfd.org/supporters-landing](https://www.fsb-tcfd.org/supporters-landing)) seem to implicitly address both concerns. Harmonised approaches at the G20 (TFCD) and EU (action plan) level will help address concerns about competitiveness distortions. In line with e.g. the differentiated reporting requirements for EU-funded projects or the World Bank’s environmental safeguard policy, a proportional approach could help address concerns about the administrative burden, for example with lower reporting requirements for small enterprises.
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