

Choosing Efficient Combinations of Policy Instruments for Low-carbon development and Innovation to Achieve Europe's 2050 climate targets

How to stay competitive while reducing carbon leakage: A policy analysis from the steel sector in the EU



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LIST OF ABBREVIATIONS

BATs Best available technologies

BCA Border carbon adjustment

BF Blast furnace

BOF Basic oxygen furnace production route for steel

CIS Commonwealth of Independent States

CLL Carbon leakage list

EAF Electric arc furnace production route for steel

EC European Commission

EIB European Investment Bank

EUA EU allowance is the carbon credit traded under the EU ETS

EU ETS European Emissions Trading System

ITs Innovative technologies

GHG Greenhouse Gas

LCA Life-cycle analysis

NACE code Classification of industrial activities

NER 300 New entrance reserve 300

R&D Research and Development

RDI Research Development and Innovation

ULCOS Ultra-low carbon dioxide steel making

UNFCCC United Nations Framework Convention on Climate Change

WTO World Trade Organisation

1 Executive summary

High energy prices and greenhouse gas emissions costs in the EU are among the main factors considered by European energy-intensive industries to affect their international competitiveness. This results in carbon leakage when these industries relocate their production and investments in less carbon-mitigating countries. This study tries to address the concerns of carbon leakage and international competitiveness of the European energy-intensive industries, with a focus on the European steel industry, by examining policy options that would boost technological innovation. This would support the industry to reduce energy and material consumption of fossil fuels and greenhouse gas emissions and hence reduce energy and emissions abatement costs in the future, while simultaneously innovating their products. Consequently, this approach to carbon leakage and competitiveness would enable the European energy-intensive industries to compete at the international markets with innovative high value-added products and less on the basis of energy prices. At the same time, this approach would maintain the European Union's ambitious path in achieving the short and medium term 2020-2030 climate targets and long-term 2050 climate objectives on track. It would ensure a successful decarbonisation path of the European industry and represent the leapfrog chance to decarbonisation for other world industries through a spillover effect of innovative technologies.

2 Introduction

This report is conducted in the context of subtask 5.3a of the CECILIA 2050, which aims to identify instruments to mitigate the potential adverse effects of EU climate policies on competitiveness of European industries and leakage risks. Our assessment is essentially qualitative thus complementing subtask 5.3b which provides a quantitative analysis of similar indicators with the help of CGE simulations of the effects of anti-leakage policy instruments on global emissions and international trade and competitiveness against the baseline of the common CECILIA2050 global scenarios over the period 2010-2050 (Antimiani et al. 2015).

We pursue our objectives by focusing on policy instruments for technological innovation in the European energy-intensive industries with a focus on the European steel industry, as a case study. The European steel sector has been chosen as a case study because it is one of the major sectors under the EU ETS identified as being at risk of carbon leakage in the EU, as well as for the sector's potential of decarbonising other economic sectors.

The value added of this study in relation to previous ones consists in its approach. It is based on previous studies, such as Gerlagh and Kuik (2014), Burniaux et al. (2010) and Popp (2011), which emphasize the importance of technological innovation in industry and the consequent spillover effects of innovation. However, traditionally, the challenges on competitiveness and leakage would be addressed by taking a direct carbon leakage risk mitigating approach and focusing on how to protect through various compensatory measures the European energy-intensive industries facing international competitiveness distortion induced by climate policies in the EU (a summary of this latter approach can be found in van Asselt and Biermann, 2007 and Marcu et al, 2014).

Instead of only looking at the protective side of policy options for the European energy-intensive industries, however, this study integrates the emphasis on technological innovation in industry as an indirect carbon leakage risk mitigation measure. We contend that such an approach would not only enhance the international competitiveness of the European energy-intensive industries but would also avoid carbon leakage with the potential of inducing global negative leakage. The novelty of the approach stems from assessing not only the environmental effectiveness and dynamic efficiency but also the political and legal feasibility of such measures targeting technological innovation.

Our research is guided by the following central research question:

• Which policies can address carbon leakage and competitiveness concerns in the European energy-intensive industries with a focus on the European steel industry through technological innovation?

The following sub-questions are also addressed:

- Which are current measures addressing the impact of European climate policies on competitiveness of European energy-intensive industries, with a focus on the steel industry?
- o Do these policies comply with the criteria of environmental effectiveness, dynamic efficiency, political feasibility and legal feasibility as defined in this study?
- How can these policies be improved or redesigned in order to induce more technological innovation and complying with criteria of environmental effectiveness, dynamic efficiency, political feasibility and legal feasibility as defined in this study?
- What other policies for technological innovation can address leakage and competitiveness concerns in the European steel sector and comply with the criteria of environmental effectiveness, dynamic efficiency, political feasibility and legal feasibility as defined in this study?

This report has the following structure. The third chapter, the conceptual framework, discusses and defines the concepts of carbon leakage, channels of carbon leakage, energy-intensive industries and competitiveness and sets the approach to carbon leakage and competitiveness in the scope of this study. It also discusses four evaluative criteria relevant for assessing policy options in the scope of this study, namely: environmental effectiveness, dynamic efficiency, political feasibility and legal feasibility as well as several indicators for each evaluative criterion. The fourth chapter discusses characteristics of the European steel sector in the context of the analysis in this study with a focus on carbon leakage risk and competitiveness arguments. The fifth chapter discusses the methodology and how the empirical evidence was collected. The sixth chapter presents the assessment of policy options on the basis of the four evaluative criteria. The report ends with conclusions and recommendations.

The Annexes present detailed information on definitions of carbon leakage, energy and carbon costs in the European steel industry and some technical details on subsectoral differences in the steel industry in terms of production paths. Annexes also include the notes from the workshops on the topic of carbon leakage, interviews with policy experts, and two questionnaires with steel industry representatives.

Conceptual framework

The conceptual framework structures the observations from literature on carbon leakage and competitiveness of European energy-intensive industries with particular focus on the European steel sector. The chapter first defines the concepts of 'carbon leakage', 'channels of carbon leakage', 'energy-intensive industries' and 'competitiveness'. It then presents our approach of 'carbon leakage' and 'competiveness' in the scope of this study. Lastly, the chapter identifies a set of criteria and indicators that form the basis of evaluating the policy options to address carbon leakage and competitiveness in the scope of this study.

3.1 Definitions of concepts

3.1.1 Carbon leakage

Carbon leakage is understood as the emissions that are displaced from one jurisdiction to another because of carbon policy constraints in one jurisdiction and no or less constraining carbon policies in another jurisdiction (Reinaud, 2008; Marcu et al, 2013). It is measured by taking the increase in carbon emissions outside a country or region taking mitigation action and then dividing by the reduction in the emissions of the country or region (Barker et al. 2007).

As carbon leakage relates to unilateral environmental action it is associated with two major concerns. First, it may affect the economic competitiveness of European energy-intensive industries because EU climate policies induce direct and indirect carbon costs. Second, it may threaten the environmental effectiveness of EU climate policies because of an increased risk of global GHG emissions elsewhere.

More specifically, according to the EU ETS Directive (EC, 2009):

"In the event that other developed countries and other major emitters do not participate in this international agreement, this could lead to an increase in greenhouse gas emissions in third countries where industry would not be subject to comparable carbon constraints (carbon leakage), and at the same time could put certain energy-intensive sectors and subsectors in the Community which are subject to international competition at an economic disadvantage. This could undermine the environmental integrity and benefit of actions by the Community" (EC, 2009).

Likewise, DG Clima specifically associates carbon leakage with loss of business opportunities, describing carbon leakage as:

"the situation that may occur if, for reasons of costs related to climate policies, business were to transfer production to other countries which have laxer constraints on GHG emissions. This could lead to an increase in their total emissions. The risk of carbon leakage may be higher in certain energy-intensive sectors" (EC – DG Clima, 2014).

Different aspects of carbon leakage and its implications can be identified further, including:

- "increase in global greenhouse gas emissions" (EC,2009, 2012b), "shift of production outside the Union" (EC, 2012b, BusinessEurope, 2012), "significant loss of market share" (EC, 2012b);
- because of: "reasons of costs related to climate policies" (EC DGClima, 2014), "perverse effects" of the EU ETS scheme related to "shadow carbon costs through electricity prices" (BusinessEurope, 2012), "cannot pass on the cost increases induced by the EU ETS" (BusinessEurope, 2012);
- "put certain energy-intensive sectors and subsectors in the Community which are subject to international competition at an economic disadvantage" (EC, 2009), and "could undermine the environmental integrity and benefit of actions by the Community" (EC, 2009).

3.1.2 Channels of carbon leakage

The most important and most often cited channels of carbon leakage identified in the literature are:

- the competitiveness channel, where carbon-constrained industrial products lose international market shares because of the differences in cost structure to the benefit of unconstrained competitors (Reinaud, 2008, p.3, Marcu et al, 2013). The carbon costs induced by EU climate policies are argued to affect the international competitions of the European energy-intensive industries especially in cases when products are heavily traded internationally.
- the investment channel, where differences in returns on capital associated with unilateral mitigation action provide incentives for firms to relocate capital to countries with less stringent climate policies (Reinaud, 2008, p.3). The risk of carbon leakage in this case stems from future investments by European energy-intensive industries in less carbon mitigating jurisdictions in emitting technologies.
- the fossil fuel price channel, where reduced energy demand in climate-constrained countries might trigger reduction in global energy prices and higher energy usage and CO2 emissions in unconstrained jurisdictions (Reinaud, 2008, p.3).

The above described channels of carbon leakage are interconnected and the discussion is complex. Some studies claim that because of the fossil fuel price channel non-mitigating jurisdictions would consume more fossil fuels and emit more (Kuik and Gerlagh, 2007). Other studies emphasise that carbon leakage occurs because of increased international competition in energy-intensive goods, the competitiveness channel. Hence more production will move to countries with lower energy costs', the pollution haven hypothesis (Bohringer et al, 2000, Bollen et al, 2000, Paltsev, 2002, in Kuik and Gerlagh, 2007, p.2).

Moreover, because of the competitiveness and investment channels, more imports in the constrained jurisdiction occur from the unconstrained jurisdiction, characterised by a more emissions intensive production- (Reinaud, 2009). Carbon leakage occurs thus through trade of carbon intensive products (Branger et al, 2013, p.7). Both changes in trade patterns and in investment decisions are considered as main indicators of uneven carbon constraints (Reinaud, 2008, p.4). Some of these aspects are further discussed in Chapter 4 for the European steel industry, specifically.

3.1.3 Competitiveness

The definition of competitiveness varies depending on whether it is examined only in terms of price or cost competitiveness or the definition is broader; and whether it is examined as short-term or long-term competitiveness. For instance, if the EU's growth path is 'more dynamic,

socially inclusive and ecologically sustainable' (Aigingher, 2013b) then competitiveness is broader than if it only focused on cost related issues, and long-term.

This latter approach to competitiveness connects industrial policy with innovation and climate strategies (Aiginger, 2013a, p.2). In this context, aspects of technological innovation and environmental ambition need to be included in a definition of competitiveness (Aiginger, 2013b). Competitiveness in this regard is related to an understanding of 'industrial policy that is 'forward looking' and fosters 'broad technologies instead of picking single winners', supports 'long-term governments targets on clean energy', and 'long term societal needs with sustainability at the centre' (Aiginger, 2013a, Aghion et al, 2011, EC, 2012a, Rodrik, 2004).

3.1.4 Defining energy-intensive industries – focus on the steel sector

Industries that require an amount of energy above the average energy intensity of the entire industry in their production are defined as energy-intensive (EC, 2014d). The steel sector qualifies as an energy-intensive industry both through the electricity and gas consumption (EC, 2014d). This is added to the use of coal and coal bi-products in primary steel production, as input materials.

3.2 Technological innovation

Technological innovation induces a 'learning-by-doing' and technological spillover effect in non-or less-mitigating jurisdictions, reducing emissions globally and leading to negative leakage (Burniaux et al, 2010, Popp, 2011). By taking endogenous technological change into account, emissions are reduced through technological diffusion (Kallbekken, 2011, p.3). Directed technical change in a mitigating country also reduces the incentive to pollute in non-mitigating countries because of improved energy productivity and if the relative demand for energy is sufficiently elastic (Di Maria and van der Werf (2005) in Kallbekken, 2011, p.3). The argument on technological spillover is brought into discussion to emphasise the need for technological innovation leadership in the EU. However, while this report aims to identify ways for the EU to lead in technological innovation, a detailed analysis on how technological spillover occurs is beyond the scope of this study.

Technological innovation also comes in the discussion on competitiveness in a sustainable growth perspective as emphasised previously. The literature shows that, in general, countries that take a future-oriented approach emphasising innovation and knowledge achieve higher shares of technology-driven and skill-intensive industries and excel in achieving sustainable economic growth than countries that take a defensive approach focused on subsidies for energy-intensive industries (Aiginger and Sieber, 2006).

Several scientific and policy studies show that the future of the European industry lies in technological innovation and high-value-added products (Aiginger et al, 2013a, Branger et al, 2013, p.23, Neuhoff et al, 2014b, EC, 2012a). Studies show that the ambitious GHG reduction target of 80% is feasible to be reached without reducing growth but radical innovative technologies are needed with substantial energy efficiency improvements above historical trends and a carbon price around 250 euro/tone CO2 (EC, 2011c, Kupers et al, 2013, Schleicher and Koeppl, 2012). The challenge is how this high carbon price can be supported through policy options for technological innovation.

Regarding the discussion on competitiveness, addressing competitiveness in the short-term would mean opting for measures to ensure cheap energy prices for the EU energy-intensive industries. By opting for this strategy, efforts to increase innovation and resource efficiency are dampened and investments in clean technologies are proved to be less profitable (Aiginger, 2013a). On the other hand, the literature provides evidence that high energy prices resulting from higher carbon prices, carbon environmental taxes and regulations encourage the development of new technologies that would become less costly in the long run. It would induce energy-efficient technological change, boosting energy efficiency, reducing energy consumption and dependence on fossil fuels in industrial processes and hence decreasing energy and emissions costs in the long run (Popp, 2002, p.163, 176). While low energy prices in industrialised countries could be a short-term competitiveness solution, there are negative consequences in the long term in terms of sustainability (such as scarcity of resources and GHG emissions from an environmental perspective) and long-term competitiveness.

Therefore, one of Europe's responses to low energy prices could be to increase investments in technological innovation for energy efficiency, emissions (both combustion and process) abatement and specialization in high-value added products. This would result in so-called 'skilled technology intensive products' and improved productivity (Aiginger, 2013a). Indeed, in one of its recent reports, the Commission points out that 'high energy prices and structural and technological changes have been the main drivers of a reduction of energy intensity' (EC, 2013f, p.243).

A strategy that would enhance clean energy, higher energy efficiency and improved innovation is seen as the key to European competitiveness in the long run. Europe holds a competitive advantage in clean technology with a trade surplus in technology driven industries (Aiginger, 2013a) and could further explore this opportunity from a competitiveness perspective. The steel industry is a key sector in the manufacturing chain of clean technologies which can play a tremendous role in greening the industrial policy and transition to low-carbon economy in general in the EU. Within the steel sector itself, the literature shows that combining Best Available Technologies (BATs) with new innovative ultralow-carbon technologies (ITs) and material efficiency would meaningfully improve the carbon footprint of the steel sector (Moya and Pardo, 2013, Pardo and Moya, 2013, Neuhoff, et al., 2014b).

However, to further develop und up-scale such technologies, investments and strategies are needed. The European Commission acknowledges that among the key problems for the loss of European industrial competitiveness are: lack of investments, market opportunities and access to finance (EC, 2012a). Empirical evidence further revealed that clear policy frameworks are needed on the role of steel in future in the EU (interview 4) and that the European steel sector needs to be supported by the EU in finding new markets of high-quality products and refocus their activities (interview 7) and shifting the thinking from volumes to value of steel (Neuhoff et al, 2014b, p4), as well as in developing innovative ultra-low carbon technologies (Eurofer, 2013b).

In particular related to the case study for discussion, this study looks mainly at the *investment* and *competiveness channels* of carbon leakage for the European steel sector. It assesses policies that would incentivise and support the European steel industry to invest in technological innovation that would enable the sector to reduce carbon and energy costs and compete internationally with high value-added innovative products instead on energy prices and would ultimately avoid carbon leakage. The competitiveness channel of carbon leakage is also explored through a measure tackling the trade of carbon intensive products.

3.3 Evaluation criteria and indicators for assessing policy options

In line with the arguments presented above, this section provides the basis for assessing policy options for addressing carbon leakage and competitiveness concerns in the European energy-intensive industries, with a focus on the steel sector. It presents a set of evaluative criteria and indicators, for assessing several policy options in the scope of this study. This study focuses on policy design and adoption of policy instruments (arriving at policy outputs) and policy implementation (in terms of generating policy outcomes – delivering as expected) (Cecilia 2050, 2013, p.16). In designing policy instruments within the scope of this study, the interplay between carbon leakage, long-term competitiveness and technological innovation are important elements.

On the basis of the approach to addressing carbon leakage and competitiveness as presented above, the evaluative criteria relevant for this study are: *environmental effectiveness, dynamic efficiency, political feasibility* and *legal feasibility*, each criterion incorporating a set of indicators. These are presented in the next section on the basis of literature review and reference is particularly made to the case study – the European steel sector.

We focus on optimal policy instruments in terms of *political* and *legal* constraints when it comes to implementing various policy measures as well as on *dynamic efficiency* and *environmental effectiveness*. Optimality is often described as a 'trade-off between the criteria of effectiveness, cost-effectiveness and different aspects of feasibility' (Cecilia 2050, 2013, p.18). For the scope of this study, measures that result from the findings should balance the *environmental effectiveness* and *dynamic efficiency* with the *political* and *legal feasibility* when addressing the carbon leakage and competitiveness concerns of the European energy-intensive industries.

3.3.1 Environmental effectiveness

The first question regarding effectiveness of a policy is if it achieves its objectives (Cecilia 2050, 2013, p.7). In terms of policy output (achieving already set objectives), environmental effectiveness refers in the context of the European climate policies to reducing the concentration of GHG emissions as set in the 2030 target proposal of 40% and long term objective of 80-95% below 1990 level by 2050. The first indicator of environmental effectiveness is thus achieving the EU 2020-2050 climate targets and objectives.

The path in achieving these climate targets can result in several side-effects that the Cecilia project distinguishes as being 'both beneficial and undesirable, both intended and unintended, possibly related to other environmental domains or also to other policy objectives' (Cecilia 2050, 2013, p.8). For the scope of this study, positive side effects resulting from European climate policies and indicators of environmental effectiveness are: *improving energy and material efficiency, reducing dependency on fossil-fuels, and contributing to innovation and technological leadership in the EU* through moving to higher steel products and more efficient steel use (Cecilia 2050, 2013, p.8, Neuhoff et al, 2014b, p.4). These three set of indicators are particularly important with applicability to the case of the European steel sector, and are discussed in some detail below.

In terms of the potential for *improving energy and material efficiency*, the literature shows that several innovative technologies would enable the steel sector to improve its energy and input material efficiency which would consequently significantly improve the emissions abatement in the future. Improving the energy efficiency is a key feature in making the European steel industry less vulnerable to energy shocks in terms of prices and security of supply as well as to emissions reductions policies (Ecorys, 2008b, p.118). Moreover, the implementation of more energy efficient, cleaner and safer technologies represents an important solution in the search for new business opportunities (Ecorys, 2008b, p.119). In addition, the active management and conservation of energy in the steel industry is crucial for ensuring the sector's competitiveness and to minimize environmental impacts in terms of GHG emissions (Worldsteel Association, 2008).

Energy and material efficiency management is different for the two main steel production routes (presented in detail in Annex 3), the Basic Oxygen Furnace (BOF) production route being coal-based mainly, needing limited quantities of other energy sources, while the EAF production route is very much electricity intensive. The literature is vast on technological options that can reduce energy consumption in steelmaking (just to mention some recent studies: UNIDO, 2011; Johansson and Söderström, 2011; Pardo et al, 2012; Okereke and McDaniels, 2012; Moya and Pardo, 2013; Pardo and Moya, 2013; SPIRE, 2013; Eurofer, 2013b, Neuhoff et al., 2014b). Technological choices would also imply a shift from coal to gas and electricity and consequently reduction in CO2. However, breakthrough technologies need further development and up-scaling on the market and policies should specifically address these aspects. In addition, a shift to electricity-based production routes would imply that large quantities of competitively priced electricity would need to be available for electrolysis processes to be economically viable (Neuhoff et al, 2014b).

In terms of *material efficiency*, in the steel sector, an important determinant in future emissions is the ratio between primary (ore) and secondary (scrap) steel production (Milford et al, 2013). A more efficient management and use of scrap, including increasing steel recycling rates, can save the steel sector significant energy and emissions (EP, 2013, p. 7, Laplace Conseil, 2012, Euractiv, 2013c, Milford et al, 2013, Neuhoff et al, 2014b, p. 5). Other material efficiency strategies for the steel sector are related to increasing products lifespans, product design features, manufacturing processes, etc. (Milford et al, 2013). From an environmental perspective, material efficiency means less GHG emissions but also a better management of scarce resources throughout the product lifecycle and avoiding further consequent polluting aspects derived from actions such as mining (a very preliminary activity in primary steel production), etc. Studies show that many products made of steel could be 25-30% lighter thus product design could offer potential for reducing metal requirements (Carruth et al, 2011 in Neuhoff et al, 2014b, p. 35).

The indicator of *reducing dependency on fossil-fuels* is relevant from an environmental effectiveness perspective, especially related to the steel sector, which is the second emitter of GHG emissions after cement among European manufacturing sectors, accounting for 9% of emissions under the EU ETS (Branger et al, 2013, p.6). Carbonaceous fuels are used in the steel making process both in the industrial processes and combustion processes, further developed below when discussing the indicators for dynamic efficiency. Ultra low-carbon technologies would enable significant reduction of fossil fuels use in steelmaking, but needs further development and hence financing is needed as well as engagement in strategic networks and knowledge sharing (Ecorys, 2008, p.128).

The fourth indicator of environmental effectiveness is *contributing to innovation and technological leadership in the EU*. This would enhance the credibility in environmental protection ambition of the EU through leading in developing innovative technologies that would achieve these goals. Contributing to innovation and technological leadership in the EU would also stimulate a spillover effect of innovative technologies beyond EU borders and consequently result in global negative leakage as explained in the previous section of this chapter. Innovation would not be limited to breakthrough technologies in the steel sector but would also involve innovating specialty products containing steel. Material efficiency and related product innovation would represent additional opportunities for deep emissions and would improve the EU's competitive position (Neuhoff et al., 2014b, p.33-35).

In sum, the indicators of environmental effectiveness used in this study are:

- Achieving the EU 2020-2050 climate targets and objectives.
- o Improving energy and material efficiency.
- Reducing dependency on fossil-fuels.
- Contributing to innovation and technological leadership in the EU.

3.3.2 Dynamic efficiency

The dynamic efficiency criterion is very much related to environmental effectiveness. Dynamic efficiency refers to 'minimising the cost of achieving climate targets over a given period of time, by giving emitters a continuous and ongoing incentive to search for cheaper abatement options' (Duval, 2008, p.17 in Cecilia 2050,2013, p.10).

The first indicator of dynamic efficiency is *providing continuous incentive to invest in abatement technologies*. This is also related to R. Hick's (1932) theory of induced innovation according to which 'changes in relative factor prices should lead to innovations that reduce the need for the relatively expensive factor' (Popp, 2002). Measures should have the capacity to induce innovation and diffusion of low-carbon technologies, in order to lower abatement costs in the future by reducing the consumption of energy and materials (Cecilia 2050, 2013, p.10 and Popp, 2002, p.176).

The second indicator of dynamic efficiency is *accelerating diffusion of innovative low-carbon technologies*. In general, upfront costs of innovative abatement technologies are very high including in the steel sector. A dynamic efficient policy would finance technologies that may appear inefficient (unnecessarily costly) from a static view, but that would deliver low-cost abatement potential in the future, thus making these technologies available sooner than predicted. In this respect, the carbon price would play an important role in determining if any of

the breakthrough technologies under development are or become competitive (Neuhoff et al, 2014, p. 32).

A third indicator of dynamic efficiency is avoiding fossil-fuel technological lock-in and emphasising technological competition. It is important that governments do not subsidise a specific technology as this may lead to a lock-in the wrong technology (Aiginger, 2013a, p.9), hence emphasise technology competition and technology neutrality (Warwick, 2013, p.42, interview 1). R&D can generate further abatement options driving down the cost of existing technologies (Cecilia 2050, 2013, p.12), can make these technologies available sooner than predicted, reduce some uncertainties on emissions abatement and energy consumption reduction of innovative technologies (Moya and Pardo, 2013, p.81) and moreover, lead to spillovers of technological innovations beyond the EU border (Burniaux et al, 2010). Nevertheless, it has to be taken into consideration that in the steel sector ULCOS (Ultra-Low Carbon Dioxide Steelmaking) technologies would cut CO2 but not production costs (Neuhoff et al, 2014b, p. 33). As such an integrative approach to industrial policy, discussed below, aimed at avoiding fossil-fuel technological lock-in, would open market possibilities for innovative steel products in a low-carbon economy.

A fourth indicator of dynamic efficiency is taking into account both process and combustion emissions. Emissions in industries can be classified in combustion emissions, resulting from burning fossil fuels for energy needs and process emissions which are specific to each sector related to the type of industrial inputs. Therefore, from a dynamic efficiency perspective, measures that adequately take into account process emissions in addition to combustion emissions in the design of policy measures are significantly more effective to prevent carbon leakage (Freidl et al, 2012, p.5). This aspect is particularly important for the steel sector, as process emissions account for almost half of the steel sector's carbon emissions in addition to combustion emissions (Freidl et al, 2012, p.8). Steel is foreign trade intensive, under intense international competition and more emissions intensive in non-EU world regions (Freidl et al, 2012, p.4). Combustion based emissions can be reduced by increasing energy efficiency or by switching the fuel from coal to gas or using electricity coming from renewable energy sources. Mitigation of process emissions, on the other hand, can be achieved by switching to a lowcarbon process, if it is available or improving the productivity of the industrial activity. As radical process innovation in the steel sector are rather difficult (Neuhoff et al, 214b, p.33) this aspect is worth assessing in relation to border adjustment tax measures, analysed later in the study, rather than in relation to driving innovation in the sector.

The fifth indicator of dynamic efficiency is related to the *integrative approach of policies*. Literature on industrial policy, argues that industrial policy, instead of being developed in isolation, it should rather integrate other policies and solve problems jointly in order to achieve the long term sustainable development goals thus avoiding conflict with other specific policies

(Aiginger, 2013a,). This 'systemic or integrated policy path' is supported by various policy documents (EC, 2010, EC, 2011c, EC, 2012a; Warwick-OECD, 2013) and also revealed during the interviews (interview 7). This so-called 'matrix approach' to industrial policy combines measures within the industrial sector and across the sectors of climate and energy (Aiginger and Sieber, 2006). By thinking in systemic terms, environmental standards are thus no longer seen as obstacles for competitiveness but as a driver for growth. One message coming from the steel sector related to the integrative approach of policies is the need of 'rebalancing the EU's industrial, energy and climate policies, that climate objectives, industrial growth and jobs are compatible' (Jakobs, 2013, p.28).

The life-cycle mitigating approach to GHG emissions advocated by the European steel sector is linked to the integrative approach of policies. Steel is indispensable in the production of technologies in several other sectors. The use of innovative steel products would reduce emissions in other European manufacturing value chains and contribute to innovation and transition to low-carbon technologies in other sectors (Eurofer, 2013b). An integrative approach to policies would thus promote the development of industrial sectors that require higher value-added steel products contributing to the European decarbonisation as a whole (Neuhoff et al., 2104b, p19). In this respect, the same study also highlights that the steel industry could be supported through direct regulations on material use but this cannot be an initiative from the steel sector itself or a price-based approach (Neuhoff et al., 2014b, p.36).

In sum, the indicators of dynamic efficiency as used in this study are:

- Providing continuous incentive to invest in abatement technologies.
- Accelerating diffusion of innovative low-carbon technologies.
- Avoiding fossil-fuel technological lock-in and emphasising technological competition.
- Taking into account both process and combustion emissions.
- Integrative approach of policies.

3.3.3 Political feasibility

According to Webber (1986), the term 'political feasibility' suggests that a 'policy proposal is acceptable to or at least not opposed by a sufficient number of the relevant policy-makers so that the proposal is likely to be adopted' (Webber, 1986, p. 549 in Munareto and Huitema, 2014, p.4). This study examines the support for policies by European policy-makers – assessed through the policy proposals of the European Commission in this case - and looks at a first indicator of political feasibility as being support for policies by the European Commission. The role of the European Commission in initiating policy and legislative proposals is crucial at EU

level. That is why for the purpose of this study, the policy documents of the European Commission are analysed for this first indicator of political feasibility.

Another interesting perspective on political feasibility relevant for this study is to consider how specific powerful interest groups are likely to react to various policies in a specific institutional context. This is an important aspect as it helps identify possible areas of conflict and/ or consensus for the adoption of instruments (Hahn, 1989 in Munareto and Huitema, 2014). Because the case study is the European steel sector, the position of Eurofer, as representative of the European steel sector, is analysed with respect to the policy options currently developed at EU level. Thus, the second indicator of political feasibility is *the position of Eurofer with regard to policy options*.

A third indicator of political feasibility is the *perception of distributional impacts in terms of benefits, costs and risks.* 'Interest groups react to their perception of costs and benefits to themselves and to others, regardless of the real costs and benefits' (Keohane et al 1998 in Munareto and Huitema, 2014, p.6). It is argued that if distributional impacts are perceived to be inequitable, interest groups who are affected could construct strong opposition to policy proposals (Munaretto and Huitema, 2014, p.6). For this study, particular attention is given to the perception of distributional impacts by Eurofer.

Finally, specifically related to policies targeted at trade, the relationship with key partners of the EU and the perception of stakeholders on the impact on trade relationship between the EU and third countries in terms of deterioration/ improvement must be taken into account as another indicator of political feasibility (van Asselt and Biermann, 2007, p.500). This is very much relevant in the discussion on border carbon adjustment measures. To really assess the improvement/deterioration of relationships between countries because of implementing some sensitive instruments like BCA is beyond the scope of this study. However, political feasibility is examined through perceptions of stakeholders on the sensitiveness of applying a certain instrument with regard to trade relationship between EU and other countries.

<u>In sum, the indicators of political feasibility relevant for this study are:</u>

- Support for policies by policy-makers the European Commission.
- The position of Eurofer with regard to policy options.
- Perception of distributional impacts (benefits, costs and risks).
- Perception of stakeholders of the impact on trade relationship between the EU and third countries.

3.3.4 Legal feasibility

In the international context, an important indicator for assessing legal feasibility of measures to 'adjust the unequal playing field' for energy-intensive industries is compliance with World Trade Law in the various agreements under the World Trade Organisation (WTO), with particular importance the General Agreement on Tariffs and Trade (GATT). These are important to mention specifically in relation to measures for trade. Much political and academic debate regarding WTO law is about the issue of 'like products', the aspects of 'energy efficiency standards' and 'import quotas' as to which extent trade restrictions could be acceptable (van Asselt and Biermann, 2007, p.499). Another agreement under WTO with important relevance is the Subsidies and Countervailing Measures (SCM), regulating subsidies. In deciding upon a certain measure, it is important to analyse 'to what extent subsidies for energy-intensive industries are compatible with the SCM Agreement' (van Asselt and Biermann, 2007, p.500). Thirdly, the WTO Agreement on Technical Barriers to Trade (TBT) is also worth mentioning as it aims at ensuring that 'technical regulations and standards do not unnecessarily restrict trade', such as regulations and standards on energy efficiency, on GHG emissions, climate labels for energy intensive-products or production process related standards (van Asselt and Biermann, 2007, p.500).

A second indicator of legal feasibility is compliance with the principles of differentiated commitments, responsibilities and capabilities under the international climate governance system – UNFCCC and with the principle of international cooperation. The former has stipulated a distinction between "trade measures that affect non-European industrialized countries and measures that affect developing countries" (van Asselt and Biermann, 2007, p.499). Secondly, different international treaties provide different obligations for countries like for instance, parties to the Climate Convention and Kyoto Protocol have had differentiated obligations. Thus taking account of the principle of international cooperation, before unilateral measures are adopted, countries should look into possible bilateral or multilateral solutions through negotiation and consultation (Sands, 2003, p249-251 in van Asselt and Biermann, 2007, p.499).

Thirdly, "any measure of the European Union, of its member states and of private entities residing in the European Union must respect EU law" (van Asselt and Biermann, 2007, p.500). A third indicator of legal feasibility is thus compliance with EU law. Relevant for the steel industry, compliance with the EU ETS Directive, the EU guidelines on state aid measures in the context of the greenhouse gas emissions allowance trading scheme post 2012 and the guidelines on environmental protection and energy state aid for 2014-2020 require particular attention. Because state aid is decided at member state level this may induce distortion of competition in the internal market and should also be considered in the analysis as an indicator of legal feasibility.

In sum, the indicators of legal feasibility relevant for this study are:

- Compliance with WTO law.
- Compliance with the principles of differentiated commitments, responsibilities and capabilities under and international cooperation.
- o Compliance with EU law.
- o Non-distortion of internal EU competition.

3.4 Concluding remarks

This chapter explained firstly the terms of carbon leakage, competitiveness, and energy-intensive industries. Secondly, it set the boundaries in terms of approaches to addressing carbon leakage and competitiveness in the European energy-intensive industries with a focus on the steel sector in the scope of this study. Thirdly, it described and explained four important criteria and indicators for assessing policy options for the scope of this study.

4 Carbon leakage and competitiveness aspects in the European steel sector

The European steel sector has been chosen for analysis as it is one of the sectors on the EC's list of sectors at risk of carbon leakage, it is under the EU ETS, has among the highest energy and electricity intensity, is the second emitter after cement among European manufacturing sectors and industrial emissions account almost half in addition to combustion emissions. It also has significant potential for inducing low-carbon transition in other sectors.

This section presents first the policy context at the EU level related to the steel sector being on the list of industrial sectors exposed at risk of carbon leakage. It provides a set of facts related to 'carbon costs' and 'trade intensity' as these are the main criteria for assessing the risk of carbon leakage in the current policy framework. These facts are linked to the competitiveness arguments in the European steel sector. This overview offers thus a better understanding of the European steel sector in the context of this study and provides informative support for the assessment of the policy options.

4.1 The policy framework for assessing carbon leakage risk at EU level- focus on the steel sector

The provisions of the EU ETS Directive (EC, 2009) set a list of sectors considered at high risk of carbon leakage for which compensatory measures have been provided. The first list of carbon leakage was agreed in 2009 for providing free emissions allowances for 2013 and 2014 (EC, 2014k) as a measure for protecting sectors at risk of carbon leakage. The list is reviewed every five years, with the next list reviewed for the 2015-2019 period (EC, 2014k). According to paragraph 24 of the EU ETS Directive, measures taken for sectors on the carbon leakage list are to be "taken where necessary and to avoid overcompensation" (EC, 2009, p.66). The analysis of the carbon leakage list (CLL) is done on the basis of the inability of the respective industrial sector to "to pass on the cost of required allowances in product prices without significant loss of market share to installations outside the Community which do not take comparable action to reduce their emissions" (EC, 2009, p.66).

The industrial sectors on the carbon leakage risk list are considered through a process, led by the European Commission, that assesses whether sectors meet the criteria and thresholds set out in Article 10a(16) (EC, 2009). Sectors on the CLL are exposed to at least 30% direct and indirect additional costs calculated as a percentage of the gross value added or the intensity of trade with third countries is above 30%. By combining trade intensity and carbon costs criteria, according to Article 10a(15) of the EU ETS Directive, sectors on the CLL, are exposed to

'intensity of trade with third countries above 10 % and the sum of indirect additional costs induced by the implementation of the ETS Directive would lead to a substantial increase in production costs, calculated as a proportion of the gross value added, amounting to at least 5 %' (EC, 2009). 'Carbon costs' and 'trade intensity' are thus the 'quantitative criteria' in assessing the risk of carbon leakage of a sector according to the EU ETS Directive. While the empirical observations gathered during the workshops on carbon leakage point out a fierce debate around the values and even the criteria of assessing carbon leakage themselves, this study limits itself by only looking at the values for 'carbon costs' and 'trade intensity' in the European steel industry and does not further assess if/how these values - percentages attributed through current legislation that set the risk of carbon leakage- could be changed. 'Carbon costs' and 'trade intensity' are thus important concepts when assessing policy options in this study.

As such, related to the European steel industry, under the EU ETS, the steel production activities are classified in NACE codes, referring to the main activity of the company. There are two main types of activities considered related to the steel sector and the values for 'carbon costs' and 'trade intensity' are presented in Table 1 and 2 for the two assessment periods as explained above. The two tables show that in the steel sector, the two quantitative criteria have been met in order for the steel sector to benefit from protective measures for sectors at risk of carbon leakage.

Table 1: Present assessment based on NACE Rev. 2 (for 2015-2019 list), source: EC, 2014k - Carbon leakage documents

	Present assessment based on NACE Rev. 2 (for 2015-2019 list)							
Code	Activity description	Costs/GVA	Trade	Quantit. Crit. met?				
24.10	Manufacture of basic iron and steel and of ferro-alloys	22,2%	25,1%	YES				
24.20	Manufacture of tubes, pipes, hollow profiles and related fittings of steel	1,6%	48,5%	YES				

Table 2: Assessment in 2009 based on NACE Rev. 1.1 (for 2013-2014 list), source: EC, 2014k – Carbon leakage documents

Assessment in 2009 based on NACE Rev. 1.1 (for 2013-2014 list)							
Code	Activity description	Costs/GVA	Trade	Quantit. Crit. met?			

27.10	Manufacture of basic iron and steel and of ferro-alloys	10,6%	32,3%	YES
27.22	Manufacture of steel tubes	0,9%	45,2%	YES

4.2 Carbon leakage risk for the European steel sector

4.2.1 Carbon costs

The discussion on carbon leakage occurs in the context of asymmetrical climate policies referring to worldwide fragmented regional climate policies with a different carbon price because there is not yet an international climate change agreement with the same burden on GHG emissions reduction for all parties. Uneven climate policies are argued to pose concerns about carbon leakage and competitiveness of energy-intensive industries (Branger et al, 2013, p.1) and create asymmetrical shocks for energy-intensive industries in terms of production costs. For instance, the European emission trading scheme (EU ETS), as climate policy imposing carbon constraints for EU's energy-intensive industrial sectors, could cause increase in production costs in Europe but not in the rest of the world (Ecorys, 2008).

4.2.1.1 Direct carbon costs

In discussing costs of industry incurred by climate policies, a distinction needs to be made between carbon pricing and carbon costs. Carbon pricing, resulting from complying with reducing emissions under the EU ETS Directive, is only one component of carbon costs, in the form of direct carbon (emissions) costs. Direct emission costs are more visible and result directly from provisions of the EU ETS on emission constraints on industry. They stem from the price of emission allowances an installation has to purchase or from the implemented abatement. Moreover, when analysing carbon costs, elements related to: CO2 intensity, electricity intensity (indirect carbon costs analysed below), costs passed through from other sectors, sectoral margins, abatement potential and cost of abatement, as well as long-term reduction targets need to be considered (Marcu et al, 2014, p.3).

The emissions intensity of a sector – the amount of emissions per output - influences thus the direct costs. Studies show that the carbon costs associated with complying with the EU ETS have not affected the competitiveness and carbon leakage impacts on European energyintensive industries nor for the first phase of implementation (2005-2007) (Reinaud, 2008), nor for the second one (2008-2012) (Marcu et al, 2013, p.1, de Bruyn, 2010, p.42).

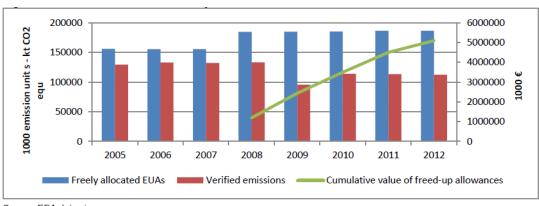
In the European steel sector, the little evidence of production leakage in the two periods of the EU ETS is mainly related to a high level of free allocation compared to emissions, with almost 360 million tonnes of CO2-eq in excess accounting for up to 5€ billion free allowances (see Table 3 and Figure 1), the reduction of economic activities following the economic crisis, as well as very low carbon prices compared to what had been anticipated (Marcu et al, 2013,p.1). Because free allocation was administered by member states, there were potential variations between installations though (Ecorys, 2013, p.31).

Table 3: Emissions in the iron and steel sector in the EU, source: Ecorys, 2013, p.31

	2005	2006	2007	2008	2009	2010	2011
Verified emissions (1000 t CO₂equ)	129.288	132.833	132.175	133.101	95.408	113.651	113.347
Freely allocated emissions allowances	155.956	155.394	155.409	184.681	184.921	185.150	186.243
Production of hot rolled steel (1000 tonnes)	173.079	187.548	187.669	178.073	129.795	156.435	161.429
Average CO ₂ intensity (t/t)	0,75	0,71	0,70	0,75	0,74	0,73	0,70

Sources: EEA data viewer, Eurofer. Note that the EEA data refer to "production of pig iron or steel" and both emissions and allowances related to other activities in steelmaking may be excluded.

Figure 1: Verified emissions and freely allocated ETS allowances for the European iron and steel sector, source: Ecorys, 2013, p.31



Source: EEA data viewer.

4.2.1.2 Indirect carbon costs as part of the energy costs

The second type of carbon costs are the so-called indirect carbon costs. Indirect emissions costs are less visible, also called 'shadow' carbon costs, and result mainly from the power sector being under the EU ETS and the parallel implementation of additional climate policies such as the renewable energy directive and the energy efficiency directive (Marcu et al, 2013).

The steel industry is very much an *electro-intensive* sector (especially the EAF route) hence very much dependent on electricity but also on gas. Decomposing the *electricity price* paid by steel producers, the energy component is the most important one, but various taxes and levies – especially the RES levy- have increased in the final electricity bill in the last five years (EC, 2014d, p.63). For gas, rising price differentials have been registered especially compared with the US prices. This is argued to drive DRI-EAF production outside the EU (Ecorys, 2013, p.34). Studies also show that the steel industry responded to the increase in the energy costs by improving the energy consumption, by almost 12% the electricity consumption and almost 8% the gas consumption between 2008 and 2011. The gross value added on electricity and gas consumption also decreased by 6% in terms of electricity and gas intensity. Both in 2008 and 2011 the steel and iron industry spent around 14,000 million euro on electricity, occupying the second position after the chemical industry (EC, 2014d). More details are provided in the figures in Annex 2.

The energy cost component varies within the steel sector because of different energy inputs for the BOF and the EAF routes. For the EAF and ferro-alloys production route, electricity prices especially can create substantial competitiveness (Ecorys, 2013, p.26). However, because of the possibility of large-volume contracts with discounts, it is often the case that large industries like EAF plants benefit from lower electricity prices (Ecorys, 2013, p.27). Moreover, the EU ETS and the EU's state aid rules allow member states to compensate for the carbon costs priced in on the electricity market (Matthes, 2013, p.4) in order to address the competitiveness concerns of the industry and risks of carbon leakage. In addition, energy-intensive industries are also exempted from grid utilization charges if they meet certain criteria and this takes place at national level hence differently across EU countries (Matthes, 2013, p.6).

Another aspect worth highlighting in relation to the costs of electricity for energy-intensive industries is that the wholesale electricity price has in general decreased due to the 'meritorder-effect' of increased share of renewable electricity. However, it is argued that energy-intensive industries have contributed with marginal sums for the RES in the electricity mix (Matthes, 2013, p.7). In terms of comparability of energy prices, in general the US is cited as benchmark for comparison. If taking into account the privileges and compensatory measures for energy price in the EU, then energy prices paid by energy-intensive industries in the EU and US are not that far off (Matthes, 2013, p.8).

To sum up, when discussing energy costs for the energy-intensive industries, while the business sector highlights that in addition to carbon costs passed through from the power sector, there are various electricity consumption taxes, upstream carbon taxes, costs associated with green certificates and fee-in-tariffs schemes for renewable electricity (BusinessEurope, 2012, p. 6), one also has to take into account the discounts, compensations, and the merit order effect of renewable energy - aspects discussed above - when comparing prices for energy in the EU and in the US, for instance.

4.2.2 Trade intensity

Trade intensity is an important pattern related to carbon costs and also one of the debated parameter used in the assessment of establishing the sectors at risk of carbon leakage according to the EU ETS Directive. If a product is heavily traded, carbon prices affect market share and investment decisions to a great extent. Trade intensity is a particular aspect relevant for steel industry because steel is widely traded, 28.7 % of finished and semi-finished steel products having been internationally traded in 2013 (WSA, 2013), being thus exposed to high trade openness (Branger et al, 2013, p.6). The trade indicators in the carbon leakage risk assessment also show high trends for both 'manufacture of basic iron and steel and ferroalloys' and 'manufacture of steel tubes'. While the former registered a decrease in trade, the latter registered an increase, by comparing the two periods of carbon leakage risk assessment (Tables 1 and 2 above).

Steel is also an intermediate product and its demand depends on the demand of steel-containing products (Ecorys, 2013). Literature on carbon leakage provides evidence that in the case of steel, most of the carbon leakage identified results from changes in world demand for steel hence through imports (Monjon et Quiron, 2009 and Climate strategies, 2012). According to Ecorys (2013), the EU-27 has an increasing net importer position in semi-finished products. This also reflects the trend that trade in semi-finished products is increasing and emerging economies are dominating exports (UN Comtrade, 2011 in Ecorys, 2013, p.20). In terms of volumes of flat products, EU-27 was a net importer, however, it was a net exporter in higher value products. This could show trends in increasing high-quality niche-products exports, but according to Eurofer the main part of steel trade is represented by highly competitive commodities (Ecorys, 2013, p.20).

Steel has a strategic importance for other industrial sectors such as terrestrial and naval transport, automotive and machinery, construction, energy and defense and a key material for Europe's industrial value chain (EP, 2013). The automotive industry mainly purchases high-volume and high-quality special products. Demand for steel products in this case is less elastic and geographical proximity can play a competitive advantage factor (Eurofer, 2013). Even for

large long products, geographical proximity plays an important role because of transport costs (Reinaud, 2008 and Droege, 2012 in Ecorys, 2013). This explains why the main trade flows in iron and steel occur between geographically close countries, such as between Turkey/CIS with EU, EU-internally and Japan with Asia (Ecorys, 2013, p.24, 28). A study of Steelconsult (2013) highlights that 'the only region that has a potential role to serve as a steel supply base to Europe is CIS' (Steelconsult, 2013, p.35). If geographical proximity plays an important role in trade relations between countries then this aspect must be taken into consideration in the assessment of carbon border adjustment measures.

4.2.2.1 Direct trade of steel

Trade intensity has decreased from 32.6% in 2005 to 26.1% in 2012 (EC, 2014d, p.157). If competition outside the EU continues to increase, it is argued that European steel manufacturers might consider relocating their production in the future in other regions outside the EU (EC, 2014d, p. 162).

4.2.2.2 Indirect trade intensity – trade of products containing steel

The 'indirect trade in steel', referring to 'exports and imports of goods that contain steel' (Worldsteel, 2012 in Ecorys, 2013) is also linked to the carbon leakage issue. Trade of such products reflects 'the true use of steel' and emissions embodied in such products. Decreasing numbers in both imports and exports of products containing steel for the EU-27 suggest a relatively stable domestic demand for products containing steel and a slightly falling demand for EU products containing steel outside the EU (Ecorys, 2013, p.20). This makes the EU market a stable steel market with relatively constant consumption. On the contrary, most of the investments in the steel industry and including in ferro-alloys before the economic crisis took place in Asia (mainly China and Russia) and has led to worldwide overcapacity and hence to competitive pressure. The high growth rates and shifting in market shares in Asia is explained by the development and production capacity in Asia (Ecorys, 2013, p.23).

4.3 The carbon leakage risk and competitiveness arguments in the European steel sector

Vulnerability to competitiveness is generally perceived in the energy-intensive industries in terms of the cost structure of the industry relative to carbon and energy intensity, trade exposure, market structure and abatement opportunities (Okereke and McDaniels, 2012), as well as the ability to pass costs through to other sectors and consumers (Marcu et al, 2013), further developed below. Steel is also among the industrial sectors most often identified in

modelling studies as being at risk of carbon leakage (Droege and Cooper, 2010, Droege, 2013, Vivideconomics with Ecofys, 2014).

Recent evidence shows that the European steel production has suffered structural changes in the last decade mainly due to increasing of the production in Asian and Oceania regions. It has halved its production over the last ten years. The EU is the second largest producer of steel in the world after China with a share of 11% in world output, followed by North America and CIS (Ecorys, 2013, p.23). As such, international competitiveness challenges for the European steel industry are argued to be mainly related to China's domination of the world production, the improved competitiveness of the US steel production with regard to energy costs due to the surge in shale gas production, the increased capacity of Russia, Ukraine and Turkey to supply the European market, increasing trends to protect the domestic steelmakers in countries like Brazil and India, as well as access to primary and secondary raw materials and maritime transport costs (EC, 2013a).

Moreover, the complexity of the steel sector and various challenges at sub-sectoral level must also be accounted for when presenting competitiveness and carbon leakage risk arguments. Primary steel production in particular, is characterised as being highly carbon intensive with relatively tight margins, widely traded internationally and with high labour employed (Okereke and McDaniels, 2012). Profits are derived from the integration of production processes. The investment cycles are very long (approximately 40 years) integrating both upstream processes such as coke ovens, electricity production, and sintering (Ecorys, 2013). Because it is very capital intensive with very large production capacities -at least 2 million tonnes steel production/year-, very high upfront costs and long payback periods for production relocation, it is more likely that future investments and only small parts of the value chain are relocated. High capital costs are an important barrier to exit (to shut down plants and relocate production) (Ecorys, 2013). It is also argued that it is expensive to adjust production to demand because of the costs associated with heating and cooling the furnaces (Ecorys, 2013, p.29). For secondary steel production facilities – using recycled steel -, variable costs are much more important with expenditures for scrap - recycled steel- and electricity dominating and it is characterised as being less capital investment compared to primary steel production (Ecorys, 2013, p.29).

In general, in the EU there has been a decrease in relative investment, which provides some evidence for investment relocation, according to one study (Ecorys, 2013, p.34). Main drivers of steel/ferro-alloys production relocation seem to be a shift in world demand and raw material and electricity costs (Ecorys, 2013, p.35). Energy and raw material inputs are considered the most important cost factors in the production of iron and steel (Ecorys, 2013, p.25).

Related to the cost structure of the industry relative to carbon and energy intensity, one of the arguments often put forward by the European energy-intensive industries, including the steel sector, is that EU high energy costs, as a result of carbon policy constraints, are claimed to be among the main factors that may drive relocation of steel industry in other regions of the world (EC, 2014b, p.108, Marcu et al, 2013, p.26, Aiginger, 2013a, Ecorys, 2013, Eurofer, 2013b, p.58). In terms of carbon leakage risk, one of the consequences of carbon policy constraints inducing high energy prices in the EU is that industries stop their investments in the EU because of perceived higher future energy costs (incurred by EU climate policies) than in other world regions. This leads to investments being made in those other world regions resulting in carbon investment leakage (EC, 2014b, p.108). However, with respect to investment drivers, GHG emissions mitigating policies are only one factor, some studies showing that climate regulations are not the main driver of production and investment relocation, other factors being more important such as transport costs, labour productivity, volatility in exchange rates, political stability, the location of industries (Oikonomou et al, 2006 in Branger et al, 2013, Vivideconomics and Ecofys, 2014, p.9). The empirical evidence gathered with regard to the European steel sector shows that indeed diverse factors can drive investment relocation outside the EU such as: differences in energy prices and emissions constraints, but also factors like proximity to raw materials and to new customers, favourable land prices, long-term investments friendly frameworks (Jakobs, 2014, p.12, presentation of steel representative during workshop 3 on carbon leakage) or geographical location (interview 7).

Two main narratives have in general been presented by the steel industry related to the competitiveness issues, namely: 'limited cost pass through ability' and 'technological limits to abatement' (Aiginger, 2013a). Related to the former argumentation, for the steel sector, it is worth highlighting that the downstream demand is argued to be subject to changes, while costs remain constant and that higher quality products can pass costs through more easily than long products (which are lower quality) (Droege, 2013, p.12). However, vulnerability to passing costs through ability is also argued to be a political issue containing informational asymmetry because firms are maximising profits rather than social benefits and it is also a matter of strategy to overestimate marginal abatement costs (Okereke and McDaniels, 2012, p.211) or it is a matter of strategic behaviour of firms and their choices (Marcu et al, 2014, p.2). That is why the ability to pass through carbon costs is not furthered analysed in this study nor incorporated in the design features of policies in this study. Rather, by shifting the debate on the latter argumentation and focusing on policies that would support overcoming 'technological limits', this would result in reduced carbon costs through fewer emissions and less energy consumption induced by implementing technological innovation. The 'limited cost pass through ability' - related to carbon costs - as an argument in the competitiveness discussion becomes thus of less importance.

Other studies emphasise that the real causes of the competitiveness problem in the European steel sector are more related to demand and supply aspects. The sector is suffering from overcapacity because the economic crisis led to a reduction in the demand for steel with 25% in the EU. Overcapacity is also claimed to have resulted in very strong intra-European competition and import substitution is seen as a secondary issue by a study (FTI, 2014, p.13). At the same time, China (accounting for almost 50% of global steel production) and India have increased their supply, adding pressure to the European steel sector which had to reduce production and shut down plants. The main solution suggested for the overcapacity problem is a shift to higher value-added products, more efficient steel use and a market reorientation of the steel sector (Ecorys, 2008b, p.ix, Neuhoff et al, 2014b, p.4,interview 7).

To sum up, the carbon leakage risk and competitiveness arguments of the European steel industry have two facets. On the one hand, the EU steel representatives claim that high energy prices in the EU have mainly affected the competitiveness of the sector and are among the main causes of deindustrialization in Europe (Eurofer, Steelguru, 2013, Euractiv, 2013a and b). Simultaneously, however, recent studies show that while the EU steel companies are indeed susceptible to competitiveness impacts of EU carbon constraints policies, there have also been exaggerations in terms of impact of carbon pricing on competitiveness (Okereke and McDaniel, 2012, p.204, Ecorys, 2013). Steel companies have adopted an efficient rent-seeking strategy during phase I-II of the EU ETS. Ex-post studies show that the industry benefited from significant over-allocation of free allowances during the first two phases of the EU ETS implementation (Ecorys, 2013). It further benefited from compensatory measures for high electricity prices (Matthes, 2013) and was able to pass costs through of the freely obtained allowances into the product prices (De Bruyn et al, 2010, Ecorys, 2013).

This evidence from the literature supports the decision of this study to tackle competitiveness and carbon leakage concerns through policies for technological innovation that would reduce the carbon costs component of production costs in the case of the European steel sector at least. It would enable the industry and policy-makers to take a more constructive approach to the issues of carbon leakage and international competitiveness while at the same time it would enable spending public resources more efficiently (these aspects are further developed in the chapter on assessing policy options). Other studies could further replicate this research and analyse the potential for taking a similar approach in other European energy-intensive industries. Technological innovation taken in an integrative approach of policies would also tackle the overcapacity, value added of steel products, more efficient steel use and market reorientation challenges in the European steel sector. Some of these aspects are further explored below.

4.4 Rethinking competitiveness - steel potential for innovation, a value-chain perspective

According to some studies, what the EU steel sector seems to lack is a movement to value-added steel products (Euractiv, 2013c, Ecorys, 2008b, p.ix, Neuhoff et al, 2014b, p.4). Steel can induce innovation in the sector itself but also in other sectors necessary in the transition to a low-carbon economy. Studies show that a greater demand of high-tech steel products is expected in the future for new markets in the form of clean technologies as an important source of materials and components required for these markets (SPIRE, 2013, p. 70). The potential for steel innovative products lies particularly in: renewable energy facilities like wind turbines, energy efficiency in buildings, energy efficiency through new light-weight steel products, steel in hybrid and electric cars (Climate Strategies 2014). Also, significant opportunities exist in the area of industrial symbiosis, highlighting the importance of 'broader systemic (cross-sectoral) impacts' (SPIRE, 2013, p.70).

It is thus important not to consider the steel sector in isolation but as part of a broader valuechain. Industrial policy needs thus to be linked with innovation policy and an ambitious energy and climate policy framework could provide the opportunity for the steel sector to move to higher value added specialty segments (Euractiv, 2013c, Aiginger, 2013a). This is considered an opportunity to improve the European steel sector's competitive situation on global markets and compete less on price.

In this context, one needs to consider that the general economic situation and the health of downstream industries influence the viability of the steel industry (OECD, 2013). Indeed, steel representatives posit that if steel is affected the manufacturing sector will be affected respectively (Euractiv, 2013a).

Recognising this concern, the European Commission set as a goal to ensure a competitive and sustainable steel industry that would compete globally and develop next-generation of steel products vital for other key European industrial sectors (EC, 2013a). One potential EU strategy could be to focus on its strengths and deliver high-quality and high value added products, hence focus on value creation, instead of engaging in price competition with non-EU countries in low-value added segment that is already too saturated with strong competition from China and India (Ecorys, 2008b, p. ix, Aiginger, 2013a, EC, 2013a). Knowledge dissemination and technological innovation are also vital in pursuing market opportunities and for enhancing the sector's position in product development and value creation (Ecorys, 2008b, p.ix). All in all, a new thinking on value not just volume but combined with sustainability and life-cycle analysis appears to emerge in the steel sector (Worldsteel, 2012, p.23).

5 Methodology

In order to explore the research questions and present empirical evidence four main research techniques are employed: literature review, analysis of documents, interviews technique, and direct observation – participatory method.

Literature review

Literature review of scientific articles, studies, legislative documents, policy documents and reports of governmental and non-governmental organizations as well as studies and reports of think tanks with regard to the aspects of: carbon leakage, carbon costs, trade intensity, competitiveness, evaluative criteria for policy options and several policy measures addressed to the European energy-intensive industries — with a focus on the steel sector - represent an important source of information for framing the scope of this study and for constructing the logic of argumentation.

Analysis of official positions of stakeholders

Policy documents of the European Commission as well as public official position documents issued by Eurofer, the representative organization for European steel companies, have been analysed. The detailed list is in Annex 4. Because the views of stakeholders are important in assessing the political feasibility, these documents represent a valuable information source.

Observations gathered during workshops on the topic of carbon leakage

A third source of empirical evidence for examining policy options are direct observations through gathered data collected during workshops organised by the Centre of European Policy Studies (CEPS), a think tank in European policies in Brussels. Four workshops were organized by CEPS (March – May 2014) on the topic of carbon leakage in the European energy-intensive industries with the aim of reviewing a paper written by CEPS on policy options for carbon leakage and competitiveness post-2020. This study has a different approach of analysis. However, the observations gathered during the workshops represent valuable information as various representatives of the European energy-intensive industries, European and national policy-makers, environmental NGOs, and members of academia and think tanks expressed their views on the topic. Annex 5 does not contain all ideas expressed during these workshops, but for the purpose of this study, mainly the ideas on carbon leakage and innovation are relevant. The observations are particularly relevant for examining the political feasibility of the policy

options. Data cannot be attributed to a certain person, country, institution, or company representative because of confidentiality.

Interviews with policy experts and written questionnaires from steel representatives

Some further 7 interviews by phone and in person with policy experts at European level from academia and think tanks with expertise on carbon leakage, structural reform of the EU ETS, European energy-intensive industries, state aid, and financing schemes for RDI were conducted in May and beginning of June 2014 in order to gain a better understanding of the current policy debates, challenges for the industry, and reactions on possible policy instruments to be adopted and how stakeholders could be affected by policies. Interviews were not recorded, only notes were taken. As these stakeholders do not represent particular interests, they were chosen so as to provide a non-biased opinion. Two written questionnaires, representing answers to interview questions that could not be conducted in person, were received from representatives of the steel sector in EU to get a better understanding of the challenges in the steel sector and reaction on policy measures.

Three main categories of stakeholders can be identified as described below.

Regulators and legislators at EU level, are the main actors proposing and designing policies, representing the political interests and objectives of the EU as a whole. For the purpose of this study the current policies under debate and structural reform and legislative proposals of the European Commission on carbon leakage provisions post-2020, the legislative proposal for energy and climate 2030, the steel action plan, and state aid rules for environmental protection and energy 2014-2020 and in the context of GHG emissions post-2012 represent the main source of documents representing the position of European policy-makers.

The European steel companies, represented by Eurofer at EU level, are stakeholders that have to comply with, approve, disapprove, negotiate European regulations and policy proposals addressing competitiveness and leakage and try to find trade-offs. Their opinions and experiences may be different than the ones of policy regulators and legislators. In terms of political feasibility, it is important to assess the position of the European steel sector in order to understand the challenges faced by the sector in terms of technological aspects, assess their reactions to the European policy proposals related to energy costs and measures for technological innovation, and perception of distributional impacts. The empirical findings are gathered from official public positions on the website of Eurofer and recent publicly available interviews with Eurofer, as well as through views expressed during workshop 3 on carbon leakage in which representative of the steel sector held a presentation on the topic of carbon

leakage and competitiveness. Two written questionnaires in the form of written interview questions, were also conducted with representatives from the steel sector.

Academic representatives, think tanks, and NGOs are interested in designing and promoting alternative approaches to current regulation, as well as concerned with delivering environmental and industrial goals. Their insights on policy options for competitiveness and leakage through technological innovation are analysed through literature review, interviews with European policy experts and observations from the workshops on carbon leakage.

Interviews and observations from workshops respect confidentiality and therefore names of persons, companies, institutions and organizations are not mentioned. Also the variety of opinions gathered from different stakeholders ensures the non-biased character of the gathered empirical evidence.

6 Results: Assessment of policy options

This chapter discusses possible policy instruments for addressing competitiveness and carbon leakage concerns of European energy-intensive industries with a focus on the European steel sector. The choice of these particular policy options for assessment takes into account current policy debates at EU level on provisions for carbon leakage up to and post-2020, on energy and climate policy proposals for 2030 and on competitiveness aspects in the steel sector as described in the European Commission's steel action plan. Secondly, they tackle the two 'carbon costs' and 'trade intensity', as indicators for assessing sectors at risk of carbon leakage derived from the provision of the EU ETS Directive (EC, 2009), which have also been debated during the workshops on carbon leakage. These aspects were explained in more detail for the European steel sector in Chapter 4. Thirdly, these policy options are in line with the approach to carbon leakage and competitiveness as presented in the conceptual framework and fourthly they are also based on observations raised by stakeholders during the workshops on carbon leakage.

The assessment of the policy options selected for analysis is done on the basis of the four evaluative criteria and indicators as presented in the conceptual framework. For environmental effectiveness, dynamic efficiency and legal feasibility, mainly reference to the literature is done but also ideas expressed by policy experts during the interviews conducted, as presented in the methodology. Political feasibility is mainly analysed on the basis of empirical evidence gathered from the various sources as presented in the methodology. An important part of the 'political feasibility' analysis is the position of the European steel sector, as expressed by Eurofer in the Roadmap to decarbonisation 2050 (Eurofer, 2013b), completed with observations gathered from the workshops on carbon leakage, interviews and questionnaires with stakeholders and policy experts.

The chapter evaluates first current policy options at EU level for protecting sectors deemed to be at significant risk of carbon leakage according to the EU ETS Directive. The second part of the chapter discusses alternative policy options to the current approach of protecting sectors at risk of carbon leakage, which are assessed according to the four evaluative criteria and indicators. One set of measures assessed can be taken in the European Union for reducing the carbon costs and inducing more technological innovation and the last policy option analysed is related to actions that can be taken by the European Union with regard to third countries on trade of carbon intensive products.

An important recurrent observation that can be derived from data gathered from the workshops on carbon leakage is that a streamline approach for all EU ETS sectors may not have been the best option. A repeated concern raised by several representatives of European industries has been that taking account of the various sectoral and even sub-sectoral

characteristics in terms of emissions reduction targets, benchmarking, free allowances and compensations would be better and a more realistic approach. In the context of this debate, while the policy options discussed in this study aim at general applicability in the European energy-intensive industries, some of them may be addressed to the European steel sector only, due to the sector's particular characteristics.

At the end of each subsection a table with the following values for the indicators of each evaluation criterion and a summary of the discussion is integrated:

- '+' means that the policy option is in line with the indicator and there is support for the policy option.
- o '0' means that there is limited support for the policy option or limited evidence available and requires further investigation.
- o '-' means that the indicator is not achieved or there is not really support for the policy option and no clear evidence.

6.1 Evaluating current measures for carbon leakage protection taken by the EU

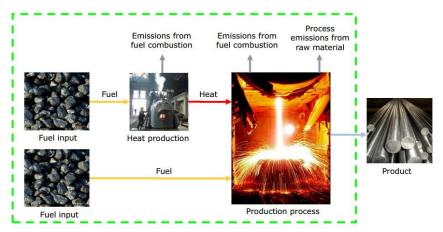
6.1.1 Free allocation for emissions costs

The current mechanism for supporting energy-intensive industrial sectors at significant risk of carbon leakage is 100% free allocation of emission allowances up to the sector's benchmark of 10% most efficient installations in a sector or a subsector in the EU (EC, 2009; EC, 2011a). The Decision on harmonized free allocation of emission allowances (EC, 2011a) set the procedure for free allocation for the 2013-2020 period. The following formula is applied:

Free allocation = Benchmark x Historical activity level x carbon leakage exposure factor x cross-sectoral correction factor (EC, 2011a)

Figure 2: Basic free allocation, Source: Ecofys, 2012, p.7

Basic free allocation: Product BM (t-CO₂/t-product) x Production (t-product)



The **benchmark** reflects the average performance of the 10% most efficient installations in a sector or sub-sector in the EU in the years 2007-2008. The benchmark represents the amount of GHG gases emitted by an installation per amount of product produced in the installation as shown in the figure above (EC, 2011a).

The **historical activity level** is based on average annual production levels during the years 2005-2008 or 2009-2010, whichever is higher (EC, 2011a).

The **carbon leakage exposure factor** is 1 for the sectors on the carbon leakage list. Therefore free allocation of emission allowances for CLL sectors is 100%. This factor ensures a decrease of free allowances pursuant to Art.10(a) of the 2003/87/EC EU ETS Directive and is 0.8 for 2013 decreasing to 0.3 in 2020 for the remaining sectors under the EU ETS that are not on the CLL (EC, 2011a, p.45).

The **cross-sectoral correction factor** has been applied because the preliminary allocation through the National Implementation Measures (NIMs) exceeded the maximum amount of allowances available in 2013. On the basis of calculations of verified emissions, according to article 10a.5 of the revised EU ETS Directive (2009), a 5.73% cross-sectoral correction factor for 2013 that will gradually increase to reach 17.56% in 2020 was calculated. This means that the number of free allowances will progressively shrink by 2020 (EC, 2014I).

The next section evaluates the current approach of free allocation on the basis of the four evaluative criteria and indicators.

6.1.1.1 Environmental effectiveness

Regarding the indicator on achieving the EU 2020-2050 climate targets, free allocation per se, as a measure for protecting sectors at risk of carbon leakage is argued by policy experts revealed through interviews to be a good measure as in theory it should not threaten the emission reduction when allowances are given for free under an established cap, as it does not change the carbon price (interview 5). For free allocation to be environmentally effective, it should not be understood as a specific target for each installation, as their own objectives. Final emissions should depend on the comparison between the carbon price on the market and companies' own reduction costs, but not on the amount of free allowances received (interview 5).

Secondly, regarding the benchmarking rule, its introduction in the third trading period (2013-2020) for allocating free emissions allowances up to the sector's benchmark of 10% most efficient installations in a sector or a subsector in the EU, can be argued as a positive aspect of the EU ETS. It is in line with the indicators of improved resources consumption in terms of energy and material efficiency and reducing dependency on fossil fuels. The progressive decrease of the cross-sectoral correction factor by 2020 also ensures that the cap is not distorted and that emissions are on track with the binding targets for 2020.

However, in terms of achieving the indicator of contributing to innovation and technological leadership, there is no evidence that the measure of free allocation as a protective measure for sectors at significant risk of carbon leakage has induced technological innovation. How this can be done is assessed in the section on redesigned free allowances to induce more technological innovation.

6.1.1.2 Dynamic efficiency

From a dynamic efficiency perspective, the benchmarking rule of free allocation rewards the most efficient and motivates the emissions-intensive installations to catch up to best available technologies (BATs) in order to receive full free allocation. The decrease of the cross-sectoral correction factor by 2020 maintains the stringency of allowances and provides a continuous incentive to emissions reductions. However, it can also be argued that because the values of benchmarks used are for the years 2007-2008, and if no revision is foreseen in the EU ETS Directive by 2020, there is not really an *ongoing* incentive to continuously reduce emissions. Therefore, regarding the indicators of capacity for accelerating diffusion of innovative low-carbon technologies, avoid fossil-fuel lock-in and emphasise technology competition, benchmarking rule solves the problem only partially.

A particular issue of interest is related to the reuse of waste gases in the steel sector, as according to current legislative provisions, they are not accounted for in emissions calculations and benchmarking rules for the steel (EC, 2013g). From a dynamic efficiency perspective, it can be argued to a certain extent that the current approach, of not including waste gases in the benchmarking, does not incentives the steel sector to produce electricity and heat from waste gases, which is a position that has been held by Eurofer for some time already (Eurofer, 2010). The issue of waste gases is however quite complex also from a technical point of view and further investigation is needed on how the steel sector can be incentivised to further reduce emissions by reusing waste gases. Eurofer also argues that because of the complexity of energy and product flows, it is difficult to determinate the CO2 emissions intensity of an installation (Eurofer, 2013b, p. 22). The benchmarking rule takes into account both process and combustion emissions, being dynamic efficient theoretically. But the issue is sensitive for the steel sector, explained below from a political feasibility perspective.

6.1.1.3 Political feasibility

In terms of political feasibility, because free allocation is an option proposed for debate for post-2020 carbon leakage provision by the EC, it can be argued that there is support for this measure by the EC (EC, 2014e). In general, also observations gathered during workshops show support for this measure as a measure for protecting sectors at risk of carbon leakage. The position of the European steel sector is that 100% free allocation for best installations can avoid further carbon leakage from Europe in combination with no further cross-sectoral reduction factor and no new auctioning factor 'at least until international distortions to competition are removed' (Eurofer, 2013b, p. 62; Jakobs, 2014). Eurofer argues that free allocation 'seems to be the most effective and practicable policy instrument' for carbon leakage protection (Eurofer, 2013b, p. 58). However, in terms of perceptions of distributional impacts, it can be argued that the steel sector does not fully support the current calculation of free allocation because of the reasons exposed above.

Also regarding the perception of distributional impacts, related to the benchmarking rule, one of the issues raised during the workshops about benchmarking is that the same plant produces different types of products, however the NACE code1 is for the whole plant; hence it was argued that there are inequalities across the sector (workshop 3). Regarding steel industry, for instance, Eurofer argues that the benchmark for hot metal is short of 7% with a huge impact on the cost of best performers (Euractiv, 2013b) and that the benchmarking rule failed to take into account all CO2 emissions from industrial process gases - waste gases -, therefore, Eurofer

¹ NACE = Nomenclature generale des Activites economiques dans les Communautes europeennes, refers to the classification of economic activities as used by Eurostat

requests for realistic and meaningful benchmarks (Eurofer, 2013b, p. 20). It can be argued that the benchmarking rule in free allocation is a sensitive political issue for the European steel sector and needs further investigation in future in terms of perception of distributional impacts and acceptance of the policy.

Again related to the indicator of perception of distributional impacts, ex-post studies show that the value of the additional allowances received by the iron and steel sector in the two phases of the ETS compared to verified emissions, is argued to amount to almost 5€ billion, as shown in Figure 1 in section 4.2.1 of Chapter 4 (Ecorys, 2013, p.31). Of course, variations exist within the steel sub-sectors and among installations. Because the secondary production route (EAF) is more electro-intensive and less emissions intensive, it did not benefit from ETS over-allocation as the primary production route (BOF), while having been faced with higher electricity costs (indirect carbon costs) (EC, 2013d). However, the EAF benefited from the electricity price compensatory measures, as discussed in section 4.2.1 of Chapter 4 (Ecorys, 2013, p.31).

Therefore the position of the steel sector that it needs free allocation because energy and climate policies have affected the sector's competitiveness is not justified in the context in which the sector has made windfall profits from having passed through the cost of free allowances (De Bruyn et al, 2010, p.42).

6.1.1.4 Legal feasibility

From a legal feasibility perspective, the benchmarking rule complies with the EU ETS Directive. Specifically related to the steel sector and its emissions intensity, is the reuse of waste gases. Waste gases have not been included in benchmarking calculations and therefore there is no free allocation for electricity generation from waste gases. This is so because sometimes waste gases are transferred from the steel plant to an electricity generator for electricity generator. But in the steel sector, the same carbon unit is first used in industrial steel processes (as inputs in primary steel production) and afterwards as energy production (waste gases resulted from the transformation of coal and coke). However, from the current legal perspective, there is no possibility to reclassify any of these emissions as industrial emissions (EC, 2013g) and that would require legislative changes.

Table 4: Current free allocation for emissions costs

Policy	Indicators for each evaluative criterion					
	Environmental effectiveness	Dynamic efficiency	Political feasibility	Legal feasib	ility	
	achieving the 2020-	providing continuous	support for policies by	compliance	with	

Current free allocation for emissions costs	2050 climate targets and objectives (+) in line with the climate targets if cap not distorted and decreased by 2.2% annually as of 2021 improving energy and material efficiency (0/+) to a limited extent because of benchmarking rule introduced in 3rd phase	incentive to invest in abatement technologies (0) limited evidence accelerating diffusion of innovative low-carbon technologies (0) limited evidence avoiding fossil-fuel technological lock-in and emphasising technological	policy-makers, - European Commission (+) it is discussed as a protective measure for sectors at risk carbon leakage, also for post-2020 the position of Eurofer with regard to policy options (0) support for the measure per se, no real support for the current calculation of free allowances	wto rules (0) applicable if third countries take comparative efforts in climate change mitigation compliance with the principles of differentiated commitments, responsibilities and capabilities and international cooperation (0) needs further investigation
	reducing dependency on fossil-fuels (0/+)to a limited extent because of the benchmarking rule introduced in 3 rd	competition and neutrality (0); limited evidence taking into account both process and	perception of distributional impacts (benefits, costs and risks) (0) needs further investigation; for steel	compliance with European Union law (+) yes, specifically EU ETS Directive
	contributing to innovation and technological leadership in the EU(-) not real evidence	combustion emissions (0/+): through benchmarking rules but needs more regular revision integrative approach of policies (0/-)	sector, in the benchmarking rule calculation, the issue of waste gases is sensitive perception of stakeholders of the impact on trade relationship between the EU and third countries (0)	non-distortion of internal EU competition (0) needs further investigation
		no clear evidence on this; more investigation needed	needs further investigation if third countries take comparable CO ₂ mitigation efforts	

6.1.2 Compensations for electricity costs

The second mechanism that enables member states to offer temporary financial compensation 'where it is necessary and proportionate' to sectors exposed to significant risk of carbon leakage for the electricity prices (indirect carbon costs), is by providing assistance schemes subject to the EU State Aid rules in the context of the EU ETS post-2012 (EC, 2012b). In determining the maximum aid amount, factors such as 'the installation's baseline production

levels or the installation's baseline electricity consumption levels as defined in the state aid guidelines, as well as the CO2 emission factor for electricity supplied by the combustion plants in different geographic areas' are considered (EC, 2012b). The manufacture of 'basic iron and steel and ferro-alloys including seamless steel pipes' is among the 15 'sectors and subsectors deemed ex-ante to be exposed to a significant risk of carbon leakage due to indirect emission costs' (EC, 2012b).

In addition, the new Guidelines on State aid for environmental protection and energy for 2014-2020 – adopted April 2014- (EC, 2014m) provide criteria on ways member states can grant partial compensations to energy intensive industries that are particularly exposed to international competition, in the form of reductions in the funding of support for energy from renewable sources. It determines the sectors, including the steel, which can be exempted from levies for the support of renewable energy (EC, 2014m, p. 46). The new Guidelines also apply retroactively regarding the assessment of reductions in the financing of renewable energy for energy-intensive users (EC, 2014g). As interviews with policy exerts revealed, this means that the energy-intensive industries do not have these costs anymore and this increases their competitiveness on the international stage (interview 6). Figure 3 provides evidence that in the European steel sector the RES levies have increased from 7% in 2010 to 12% in 2012 (EC, 2014d).

6.1.2.1 Environmental effectiveness

From an environmental effectiveness, more renewable energy in the electricity mix would reduce emissions in the long-term and contribute to achieving the climate targets for 2020-2050. The RES has had a merit order effect as the energy component of the electricity price has decreased in average in the EU (Figures 3 and 4). It could be argued that compensatory measures for electricity costs may have negative consequences for long terms sustainability despite being a short-term competitive solution for industries (Aiginger, 2013a).

Figure 3: Components of the electricity bill paid by the 17 sampled steel producers in Europe (€/MWh), Source: EC, 2014d

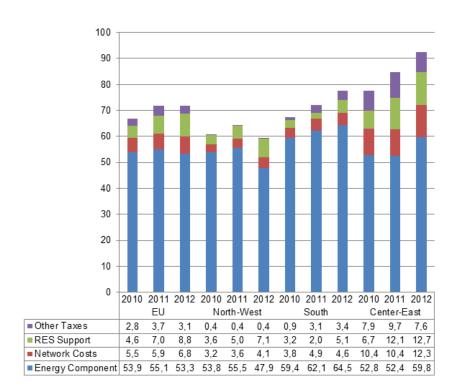
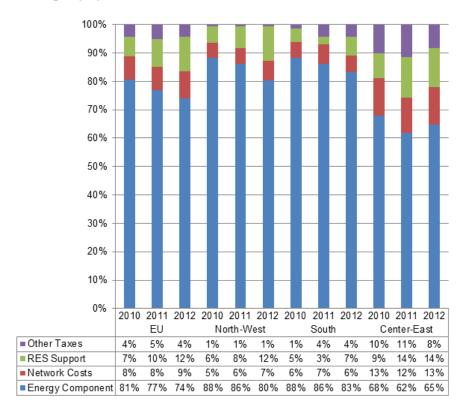


Figure 4: Components of the electricity bills paid by the 17 sampled steel producers in Europe (%), Source: EC, 2014d



6.1.2.2 Dynamic efficiency

It is claimed that state aid should minimize the risk of carbon leakage while at the same time achieve decarbonisation cost-efficiently and minimise competition distortions in the internal market (EC, 2012b). According to scientific literature, such a measure reduces the efficiency of the EU ETS by limiting the incentives for investing in abatement technologies and accelerating the diffusions of low-carbon innovative technologies in the sector, therefore its dynamic efficiency is arguable. Through the provision of economic advantages to energy-intensive industries in the form of lower energy prices, governments maintain the energy consumption of the industry (Diaz Arias and van Beers, 2013), not giving emitters a continuous incentive to invest in abatement technologies.

6.1.2.3 Political feasibility

From a political feasibility perspective, in terms of perception of distributional impacts, despite criticism of Eurofer that high electricity prices have affected the competitiveness of the sector, studies show that the sector has received sufficient compensations which made prices comparable to US energy prices (Matthes, 2013). Other studies also show that the 'overgenerous' exemptions offered to energy-intensive industries occurred in a context of continual decreasing of wholesale electricity prices because of more renewable electricity in the electricity mix (IEEP, 2014). However, it is argued that energy-intensive industries have contributed with marginal sums for the RES in the electricity mix (Matthes, 2013, p.7). Electricity prices are an important aspect in the steel sector, especially for the electro-intensive route. As presented in section 3.2.1 of Chapter 3 they represent an important element in the competitiveness arguments as well as in the choice of certain steelmaking technologies as presented in the Eurofer steel roadmap for low carbon Europe 2050 (Eurofer, 2013b).

6.1.2.4 Legal feasibility

According to state aid guidelines, the 'aid must not fully compensate for the costs of EUAs in electricity prices and must be reduced over time' so as to minimize distortion of compensation in the internal market (EC, 2012b). Therefore, a case by case analysis is required to determine if competition is distorted. Moreover, because the exemptions for electricity prices are done at member state level, there are differences in the amount of exemptions which can represent a threat to EU internal competition.

In terms of compliance with WTO law and impact on trade relations between the EU and other countries, a recent study points out that exemptions could become a source of tension in international relations if ' they cause carbon leakage in third countries or act as a brake on those countries raising carbon prices domestically' (Vivideconomics with Ecofys, 2014, p127). Observations during workshops also revealed that the EU should take account when offering compensations of the comparability efforts in terms of carbon price development in other jurisdictions outside the EU, as the big players like the US, China are already taking some carbon constraining actions. Also, as these countries are important trade partners, their actions make a difference, an observation during the workshops on carbon leakage (workshop 3).

Table 5: Current compensations for electricity costs

Policy		Indicators for each	evaluative criterion	
	Environmental effectiveness	Dynamic efficiency	Political feasibility	Legal feasibility
Current compensa- tions for electricity costs	achieving the 2020-2050 climate targets and objectives (-) possible threat to achieving the climate targets	providing continuous incentive to invest in abatement technologies (-) no incentive in this direction	support for policies by policy-makers, - European Commission (+) it is included in EU state aid regulations	compliance with WTO rules (0) needs further investigation if third countries take comparative efforts in CO_2 mitigation
	improving energy and material efficiency (-) no incentive in this direction	accelerating diffusion of innovative low-carbon technologies(-) no incentive in this direction	the position of Eurofer with regard to policy options (+) claims that needs compensations for high energy costs	compliance with the principles of differentiated commitments, responsibilities and
	reducing dependency on fossil-fuels (-) no incentive in this direction contributing to innovation and technological leadership in the	avoiding fossil-fuel technological lock-in and emphasising technological competition and neutrality (-) no incentive in this direction	perception of distributional impacts (benefits, costs and risks) (-/0) Eurofer claims that needs compensations for high energy costs; literature shows little evidence of contribution of	capabilities and international cooperation (0) needs further investigation compliance with European Union law (+) EU state aid rules.
	EU(-) no incentive in this direction	taking into account both process and combustion emissions (0) needs further	industry to financing renewable sources perception of stakeholders of the impact on trade relationship between	non-distortion of internal EU competition (-/0) compensations are at member state level -> risk of competition

investigation	the EU and third countries (0)	distortion; case	case by analysis
integrative approach of policies (-) limited contribution to the financing of national RES subsidies by the industry	needs further investigation if third countries take comparable CO ₂ mitigation efforts	required	

6.2 Redesigning current measures to induce more technological innovation

6.2.1 Redesigning free allocation to induce more innovation

The European Commission acknowledges that the system of allocating free allowances as a measure of protecting sectors at risk of carbon leakage should be more focused (EC, 2014e). Observations gathered during workshops also revealed that free allowances are scarcer and they should be used efficiently like any other public resource (workshop 4). In general, the observations during the workshop point out that the current list of sectors is considered too broad, that instead of having so many sectors, the list should be shortened so that sectors which are at real risk of carbon leakage benefit from protective measures. Moreover, instead of the current in-out approach, a tiered approach could be envisaged that would protect more the ones which are most exposed to risk of carbon leakage as revealed by observations during the workshops on carbon leakage.

As the focus in this study is on policies for technological innovation, this section assesses on the basis of the four evaluative criteria how free allocation could be redesigned for inducing more innovation in the European energy-intensive industries, particularly steel.

6.2.1.1 Environmental effectiveness

The current system of free allocation is in line with the indicators of achieving the climate 2020-2050 climate targets and objectives. In addition, it is not distorting the emissions cap, if the emissions cap is to be reduced by a 2.2% annual linear reduction factor starting in 2021 compared to 1.74% as it is currently. A redesigned free allocation system could focus more on contributing to innovation and technological leadership. In line with this argument, looking at current policy developments at EU level, the EC 2030 legislative proposal framework on energy and climate policies, provides an opportunity for new entrants and significant capacity

extensions to benefit from free allocation, while this may be reduced for closures and significant capacity decreases (EC, 2014c, p.51). This can be seen as a signal of encouragement of future investments in the EU and can be taken as an opportunity to reward investments in innovative technologies and innovative production with energy and material efficiency beyond best available technologies that would also reduce dependency on fossil-fuels (workshop 4).

An interesting approach to innovation in the steel sector is a life-cycle mitigating approach, which is advocated by Eurofer (2013b). The question is how to reward steel companies that induce emission reductions through the use of innovative steel products also in other sectors, in which steel cannot be replaced with other materials (Eurofer, 2013b). This approach could be further explored as a policy option for allocating free allocation for innovative products as it has the real potential of reducing dependency on fossil fuels also in other sectors.

6.2.1.2 Dynamic efficiency

Interviews with policy experts on the EU ETS revealed that the consultations for establishing the benchmarking rules can be argued to have played an important role in discovering technological innovation (interview 2). It is thus necessary that such consultations and reviews of benchmarks are taking place regularly as they enable updating the rules in line with policy and technological developments that would thus provide a continuous incentive to invest in abatement technologies and accelerate diffusion of low-carbon technologies.

Related to the steel sector, the life-cycle mitigating effort advocated by Eurofer (Eurofer 2013b) could contribute to diffusion on low-carbon technologies in other sectors, would avoid fossil fuel technological lock-in and could contribute to an integrative approach to policies. Case studies presented by representatives the European steel sector on eight selected steel applications including weight reduced car parts, electric motors or efficiency-improved power plants show that 443 million tonnes emissions could be cut by 2030 in such a scenario (Eurofer, 2013b). It is argued that by taking such a holistic approach, the contribution of emissions from European steel production -70 million tonnes for producing the eight steel applications – would be insignificant compared to the potential to reduce emissions in other production chains (Eurofer, 2013b; BCG, 2013).

6.2.1.3 Political feasibility

An important concern raised during the workshops on carbon leakage and throughout interviews with policy experts is on the role of the EU ETS in driving innovation. This can be linked to the acceptance of the instrument by stakeholders. An interesting recurrent remark

was that the EU ETS' role is not to drive investments in innovative technologies, for which other instruments such as R&D financing are needed, but to discover technological innovation for those who need to implement this (interview 2). Literature also provides evidence that at least concerning the first trading period, there is no strong evidence that the EU ETS has had an impact on innovation (Martin, Muuls, and Wagner (2011) in vivideconomics with Ecofys, 2014, p.26). One of the roles and importance of consultative processes with stakeholders is thus to gain a clear understanding on the role of the instrument in order to be accepted.

Regarding the support of stakeholders for free allocation for innovative products, interviews with policy experts revealed that in order for steel companies to redirect investments in innovative steel products, a clear message from European policy-makers and clear long-term policy framework is needed on the role of steel in future (interview 4). Eurofer argues that the importance of steel is to increase because more high-grade materials will be required for greening the economy to which steel can make an important contribution to decarbonising the economy (Eurofer, 2013b, p.16). The interviews with policy experts have also revealed that it is important for the steel sector to have clear messages at the European level in which sectors steel will be used in the future. Steel can pass to material science, however this is an important investment step and once the path for a new technology is done there is no way of turning back as the know-how is also lost (interview 5). It is thus important for the steel sector to have a clear and stable long-term policy framework.

Also, particularly related to the issue of waste gases in relation with benchmarking rule for establishing free allocation, this is a sensitive issue for the steel sector and needs further investigation and dialogue with industry stakeholders for the instrument to be politically accepted.

6.2.1.4 Legal feasibility

Regarding the benchmarking rule, the policy proposal on 2030 climate and energy policy frameworks states that because technological paths are different across sectors in terms of timing and investments, a reflection is needed if the current value of 10% best available technology for whole EU ETS sectors should be the basis for the benchmark or another basis (EC, 2014b, p.108). One idea raised frequently during the workshops on carbon leakage was if the benchmark should be sector/ sub-sector based. However, it was also mentioned quite often that this would add more complexity to the already complex EU ETS system (workshop 1). From a legal feasibility, this would require changes to the EU ETS Directive.

Also, if part of the free allocation is to be set aside and given to installations that pursue chain innovative paths through an ex-post analysis of the installation's performance, this would also require changes of the EU ETS Directive.

Table 6: Redesigning free allocation to induce more technological innovation

Policy Indicators for each evaluative criterion				
	Environmental effectiveness	Dynamic efficiency	Political feasibility	Legal feasibility
Redesigning free allocation to induce more innovation	achieving the 2020- 2050 climate targets and objectives (+) in line with achieving the climate targets improving energy and material efficiency (+)	providing continuous incentive to invest in abatement technologies (+) through regular review of benchmarking rules	support for policies by policy-makers - European Commission (0) through consultations on the role of the EU ETS in driving innovation	compliance with WTO rules (0) needs further investigation if third countries take comparative efforts in CO ₂ mitigation efforts
	by rewarding installations that take innovation paths beyond best available technologies reducing dependency on fossil-fuels (+) life-cycle analysis mitigating approach - reduce emissions and dependency on fossil fuels through use of innovative steel products in other sectors contributing to innovation and technological leadership (+) avoid investment leakage in innovation; innovative high-value added steel products can be developed	accelerating diffusion of innovative low-carbon technologies (+) continuous consultations on benchmarking rule for discovering technological innovation potential avoiding fossil-fuel technological lock-in and emphasising technological competition and neutrality (+) through regular review of benchmarking rules and development of innovative steel products taking into account both process and combustion emissions (+)	the position of Eurofer with regard to policy options (0) clear messages needed regarding the role of steel in future in Europe; further investigation needed perception of distributional impacts (benefits, costs and risks) (0) further dialogue with industry needed on the issue of benchmarking perception of stakeholders of the impact on trade relationship between the EU and third countries (0) needs further investigation if third countries take comparable CO2 mitigation efforts	compliance with the principles of differentiated commitments, responsibilities and capabilities and international cooperation(0) needs further investigation compliance with European Union law (0) EU state aid rules; EU ETS Directive changes needed if part of free allocation set aside for innovative products non-distortion of internal EU competition (0/+) free allocation at EU level; case by case analysis required

in reviewing benchmarking rules

integrative approach
of policies (+)

through life-cycle analysis mitigating approach to emissions reduction

6.2.2 Redesigning compensations for electricity costs to induce more technological innovation

The EC underlines in the energy price report that 'energy costs are determined by both energy price levels and by consumption' (EC, 2014d, p.122). This section assesses how compensations for electricity costs could be redesigned by offering compensations to electricity costs on the basis of conditionality that would incentivise the industry to reduce its energy consumption, abate emissions and respond to electricity price signal through some ideas explored below:

• Conditionality on taking energy efficiency and emissions abatement measures

For reducing energy consumption, the conditionality would be that the compensations for electricity costs are given if the industry takes energy efficiency and emissions abatement measures or contributes to financing innovation in industry. Another possibility mentioned during interviews with policy experts would be to lower the level of free allowances and deliver monetised incentives and subsidies for new investments in steel companies on the conditionality of delivering certain emissions efficiency standards. Differentiated approaches for sectors could be developed on the basis of benchmarking to trigger high efficient investments (interview 2) or approaches to compensations may differ according to sectors' needs (interview 3).

• Financing renewable electricity

This could be done through a minimum contribution of the industry to financing national RES subsidies in the context in which the industry benefits from reduced wholesale electricity prices due to the merit order effect of the renewable sources in the power grid.

• Participating in demand-response measures

Demand response refers to 'changes in electric usage by end-use consumers from their normal consumption patterns in response to changes in the price of electricity over time, or to incentivize payments designed to induce lower electricity use at times of high wholesale market price or when the system reliability is jeopardised' (FERC, 2008 in Weston, 2014).

For those participating in demand-response, the system manages the consumption of energy on the customer side in response to the requirements of supply in the grid system. According to the European Commission, this type of measure could save energy-intensive industrial consumers more than 10% on the electricity bills given that "many industrial processes have flexibility to shift large electricity consumption loads" (EC, 2013h, p.3). Electricity intense industries can benefit from this measure by shifting their consumption to low-cost periods (EC, 2014i) and give them the possibility to take advantage of the negative prices of energy driven by excess of renewable in the electricity mix, and use the extra energy (Energypost, 2013). Some recent studies show the potential of demand response in the steel sector, EAF route which is electro-intensive mainly (Klobasa, 2012, Platts, 2014 and Energy Pool, 2013). This could be technically feasible when there is flexible production by taking account of energy tariffs to reduce energy costs (WSA, 2010). However, the measure also has technical limitations in the steel sector, because if the installation works at its maximum capacity, it is not cost-effective to stop the production and restart it when the electricity prices are low (questionnaire 2 with steel representative). It could have more potential of applicability in future when the share of renewable sources is higher in the power grid (questionnaire 2 with steel representative).

As some ideas were raised during the workshops (workshops 3,4) and further examined through interviews, it is worth assessing this approach on conditionality on electricity costs compensations on the basis of the four criteria.

6.2.2.1 Environmental effectiveness

In terms of environmental effectiveness, if energy-intensive industries contribute to financing renewable electricity, as indicated in the environmental protection and energy guidelines for state aid, through 15% contribution to national RES subsidies (EC, 2014m, p.47), the industry would benefit from lower wholesale electricity prices in the long-term while contributing to

achieving the long-term climate targets. In terms of inducing innovation, more renewable electricity would further accelerate the development of 'green' steelmaking processes, explored below from a dynamic efficiency perspective.

Conditionality on receiving compensations for electricity costs would also incentivize the steel sector to look for energy and material efficiency solutions and reduce dependency on fossil fuels. Through demand-response companies reduce their carbon footprint and carbon costs.

6.2.2.2 Dynamic efficiency

An argumentation is that if compensations for electricity costs are reduced for the energy-intensive industries, this would result in higher energy prices increase for industry. It would provide a clear incentive for investing in technologies that would lower the energy consumption (Diaz Arias and van Beers, 2013). From a dynamic efficiency perspective, such a conditionality approach incentivizes companies to continuously invest in abatement technologies and would accelerate the diffusion of low-carbon technologies.

Taking a futuristic approach, more renewable electricity could be an important factor for the steel sector to accelerate the path in developing innovative ultra-low carbon technologies that are indeed more electricity consuming which are now most of them in research and pilot phase, but which can reduce substantially the input of carbonaceous fuels and hence of carbon emissions from industrial processes (Pardo et Moya, 2013, Kumar and Mehta, 2013 UNIDO, 2011, Johansson and Söderström, 2011). More renewable electricity combined with innovative technologies in the steel sector would reduce both energy costs and emissions abatement costs in the long term. This would keep reduction targets for 2050 on the right track while the sector would maintain its competitiveness and would keep innovating.

Financing renewable electricity and participating in demand-response measures would also be in line with an integrative approach to policies raised throughout workshops and mentioned in the European Commission's Action Plan for the steel sector (EC, 2013a).

6.2.2.3 Political feasibility

Governments would also save public money through reducing compensations, which can be invested in financing technological innovation in respective industrial sectors. On the other hand, companies would be affected as they would lose the current privileges for electricity costs but it is perceived by policy experts as a more efficient measure than the current system (interview 1). Regarding demand-response, where it can be technically applied, the EC's position is that this enables companies to save energy costs, depend less on energy prices and

provide additional investment capability and enhanced competitiveness. Companies are better prepared to compete with companies from countries with lower energy prices (EC, 2013h, p.5, 14).

In terms of perception of distributional impacts, no clear answer was received from representative of the steel sector when this issue was addressed in the questionnaire 1. Rather, regarding the position of Eurofer is that high energy prices are, 'a very significant threat to the competitiveness of the EU industry' (Eurofer, 2013, p.59). Other representatives of the steel sector emphasise that 'because of high energy prices there will be investment leakage out of Europe' (questionnaire 1 with steel representative) and that 'best performers should not have any shortage in their needs in free CO2 permits and CO2 costs passed through to them in electricity prices and that those costs need to be fully off-set' (Jakobs, 2013 - presentation during workshop 3). One observation during workshop 3 was that some sort of conditionality should be put in place in the case the CLL remains broad as it is the case currently.

On the other hand, if compensations for electricity costs are added to public funding source, according to a study, this could reach the value of 6.6€bn if state aid is saved (FTI, 2014). Taking into account also that the value of over-allocation of free allowances was 5.5€bn for the steel sector, the amount saved is 11€bn for the two trading periods. Doing a simple calculation, this represents around 12% of the whole Horizon 2020 budget (80€bn) - European programme for research and innovation for 2014-2020 (EC, 2013i) and the equivalent of 160 ULCOS project budget (75€million) for developing ultra-low carbon technologies in the European steel sector2 (EC, 2012c).

6.2.2.4 Legal feasibility

Paragraph 27 of the EU ETS Directive provides a legal possibility for an approach to conditioning compensations to electricity costs in investments in low-carbon solutions which could be further explored. It states with respect to temporary compensations to certain installations which have been determined to be exposed to a significant risk of carbon leakage that this support should provide 'incentives to save energy and to stimulate a shift in demand from 'grey' to 'green' electricity' (EC, Directive 29/2009/EC, 2009, p.67, paragraph 27).

² The ULCOS project has been running since 2004 in which 48 companies and 15 Member States are involved in developing breakthrough technologies for the steel sector. Since 2012, the project entered its second phase advancing pilot and demonstration steel plants with the aim of leading a market breakthrough by 2020-2030 in low-carbon technologies such as CCS, top gas recycling, and electrolysis using renewable electricity (http://cordis.europa.eu/estep/ulcos en.html)

Related to demand-response, the literature shows evidence that the industry is well aware of it, that the European Commission has been investigating how to develop it in the EU by making large energy-intensive industries actively participate in the energy market or enter demand response programs offered by operator of the system (EC, 2013h, p.7). This would require developing legislation on how it could be implemented in the EU.

Table 7: Redesigning compensations for electricity costs to induce more technological innovation

Policy		Indicators for each	evaluative criterion	
	Environmental effectiveness	Dynamic efficiency	Political feasibility	Legal feasibility
Redesi- gning compensa- tions for electricity costs to induce more technologi- cal innovation	achieving the 2020-2050 climate targets and objectives (+) through minimum contribution by industry to financing RES national subsidies & conditionality on energy efficiency and emissions abatement improving energy and efficiency (+)	providing continuous incentive to invest in abatement technologies (+) through conditionality on energy efficiency and emissions abatement accelerating diffusion of innovative low-carbon technologies (+)	support for policies by policy-makers - European Commission (0) needs to be further explored the position of Eurofer with regard to policy options (0/-) no clear answer, needs further investigation; high EU energy costs mentioned as a threat	compliance with WTO rules (0) needs further investigation compliance with the principles of differentiated commitments, responsibilities and capabilities and international cooperation (0) needs further
	through conditionality on energy efficiency and emissions abatement reducing dependency on fossil-fuels (+) through conditionality on energy efficiency and emissions abatement	through conditionality on energy efficiency and emissions abatement avoiding fossil-fuel technological lock-in and emphasising technological competition (+) through reduced abatement costs	perception of distributional impacts (benefits, costs and risks) (0) governments save public money that can be invested in industrial innovation, but high energy prices in the EU 'a very significant threat to the competitiveness of	compliance with European Union law (0) EU state aid rules need to be revised if part of compensations for electricity costs are reallocated to other purposes; legislation on demand-response
	contributing to innovation and technological leadership in the EU (+) incentive for further developing 'green steelmaking' routes	taking into account both process and combustion emissions (+) process emissions are reduced significantly	the EU industry' according to Eurofer (Eurofer, 2013b, p.59) perception of stakeholders in terms of the impact on trade	needs to be developed non-distortion of internal EU competition (0) needs further investigation

through electrochemical	through green steelmaking processes	relationship between the EU and third
processes	integrative approach of policies (+) integrating industrial, energy and climate policies through demand-response measures and contribution to RES financing)	countries (0) needs further investigation

More support to the European industrial innovation

Long term sustainable growth and sustained industrial competitiveness can be achieved through development of low carbon technologies and high value added goods which requires continuous investment in research, development and innovation (RDI) (Nunez and Katarivas, 2014). Funding RDI could include subsidies to private R&D, strengthened patent rules, technology prizes, basic governmental research, and demonstration projects. Technology deployment policies include subsidies and tax exemptions for early adopters of newly developed technologies (Howlett, 2011 in Munareto and Huitema, 2014). There are as well many arguments for international R&D spillovers (Coe and Helpman, 1999).

More support to industrial innovation can be achieved through the following ways:

• Strengthening European RDI programmes for demonstration projects

Research, development and innovation programmes in the EU typically have a prominent public and EU investment component, demonstration programmes a strong industrial drive, accompanied by public support, both EU and national; and market replication measures, have large participation from industry (EC, 2009 on SET-Plan in Medarova-Bergstrom, 2013, p.33). In the steel sector, a need was identified on up-scaling and piloting phase for demonstration plants of innovative technologies instead of only focusing on the research phase (EC, 2014j, Neuhoff et al, 2014a, Eurofer, 2013b). A recent study shows that while significant public R&D funding goes to the EU steel sector, only few public resources are dedicated to process innovation in the EU steel industry (Neuhoff et al, 2014b, p.57). The long path ranging from one to two decades until a technology it becomes commercially available requires increasing demonstration processes and corresponding scales of financial requirements. Hence clear policy strategy to secure funding, commitment and continuity are crucial. The current R&D Horizon 2020 does not seem to secure investment perspectives in line with technology development timeframes as currently funding is provided ad-hoc, on a project basis and constant risk that funding stops (Neuhoff et al, 2014b, p. 58). Moreover, technological progress is seen as a key criterion for public funding of R&D.

• Role of revenues from auctioned EU ETS emissions allowances in a European programme for industrial innovation

In addition to EU and other public and private resources, carbon price can play an important role in financing RDI and demonstration projects in the energy-intensive industries through recycling revenues from sale of allowances in a European financing programme for industrial innovation. The value of the carbon price should reflect a credible constraint in the short term (existing capital) as well as in the long term (investment decisions). However, the current price has very low values, incapable of inducing emissions abatement and stimulating technological innovation and adopting low-carbon technologies (EC, 2011b, Clo et al, 2013, observations from workshops and interviews).

So far, at EU level, the revenues from the sale of emissions allowances, have been used in the NER3003 initiative aimed at developing breakthrough technologies for the power sector and renewable energy technologies mainly. The development at EU level of a financing programme for industry with revenues from the sale of allowances similar to the NER300 is mentioned in the climate and energy legislative proposal package for 2030 of the European Commission from January 2014 (EC, 2014b, p.111) and has been raised several times and further discussed during the workshops on carbon leakage.

• Role of risk sharing for maturing of commercial scale processes

Neuhoff et al (2014b, p. 59) point out to 'an integrated approach to risk management and competition policy to overcome market entry barriers for new technologies. Risk sharing arrangements would reduce the risk or costs for the steel makers that deploy the initial low-carbon steel production (Neuhoff et al, 2014b, p. 59). Currently, the EIB offers through a mechanism of shared risk with the European Commission –Risk Sharing Finance Facility-

The current NER300 programme is based on Art10(a)8 of the revised Emission Trading Directive 2009/29/EC which contains provisions to set aside certain number of allowances to subsidise installations of 'innovative renewable energy technologies that are not yet commercially available and carbon capture and storage (CCS) (EC, Directive 2009/29/EC, p.74)

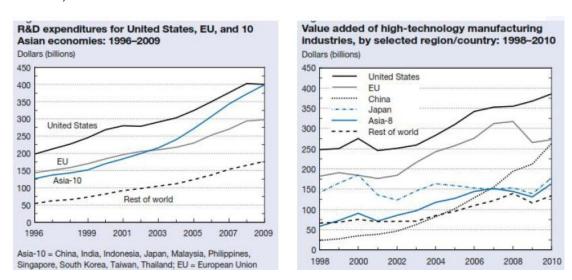
possibilities for financing (in the form of loans) the development of innovative steel products with potential of reducing emissions in other sectors, such as ultra-high strengths steel grades of the highest quality especially for the mobility and energy sectors. The support of the EIB is argued to make a major contribution to long-term financing of research projects in innovative segments of the steel market (EIB, Voestalpine's research project, 2012; EIB, Gestamp Group RDI and Convergence, 2010, EIB, ThyssenKrupp Technologies RDI RSFF, 2009). However, the Risk Sharing Facility is a debt financing product and the money provided must be paid back with interest (Neuhoff et al, 2014b, p. 58).

The section analyses potential for supporting the industry to invest in innovation on the basis of the four criteria.

6.3.1 Environmental effectiveness

Financing RDI is relevant with respect to the indicator of innovation and technological leadership in the EU in the context of closing the technology gap between EU, China and US (National Science Board, 2012 in Schleicher, 2013).

Figure 5: Science and Engineering Indicators, source: National Science Board, 2012 in Schleicher, 2013.



The EU should also take account of the fact that much of the private RDI investment is performed by companies operating internationally, and those based in the EU could shift RDI investment and market launch to other regions, preventing the EU to lead in technological innovation. The investments in technological innovation are therefore important in relation to

the potential loss of positive externalities. Clustered activities that incorporate production, recycling and R&D activities could disappear (Marcu et al, 2014, p. 4). That is why, in addition to the financing capability for RDI, also the regulatory framework and macroeconomic conditions are important (Nunez and Katarivas, 2014, p.13). This is also important in relation to tackling innovation investment leakage.

Revenues reused from sale of emissions allowances represent an important resource in financing technological industrial innovation. This can take the form of technology funds or targeted technology policies (Schleicher, 2013), complying with the indicator of contributing to innovation and technological leadership. It would also stimulate the development of technologies that are less fossil fuel dependent. Moya and Pardo (2013) provide an analysis of several low-carbon innovative technologies in the steel sector.

6.3.2 Dynamic efficiency

From a dynamic efficiency perspective, the use of public revenues from the sale of allowances in financing schemes for industrial innovation in a program at European level would not directly alleviate the carbon leakage. A stronger carbon price in the short-term is argued to expose certain sectors to 'significant international competition and thus risk of carbon leakage' (EC, 2014c, p.49). However, in the long-term, a stronger carbon price drives investments in energy efficiency and low-carbon energy sources (EC, 2014c, p.54).

Such an approach would ensure the industrial sectors' successful transition to low carbon production, reduce costs to meet long term objectives and create technological advantage (EC, 2014b, p.111-112). European Commission policy documents also mention that 'revenues for technology subsidies should be specific rather than general, targeting technologies that suffer from pervasive market and coordination failures in development and / or take-up by individual firms.' (EC, 2014b, p.113). From a dynamic efficiency, technological competition and neutrality need to be emphasized. The more resources from EU ETS sale of allowances are redirected to such a European program for creating breakthrough technologies, the more projects can be financed, which from a dynamic efficiency perspective can enhance technological competition and prevent fossil-fuel technological lock-in.

RDI at EU level is a very good instrument for an integrated approach of policies as it enhances cooperation between member states on developing and diffusing low-carbon technologies through reducing the risk of duplicating national and regional initiatives and allowing spread of knowledge and transfer of best practices across the EU (Nunez and Katarivas, 2014). It enables a broad exchange of experience and learning and brings together different experts from various organizations. It allows spinoffs that go beyond the respective programme and ensures rapid

transfer of technology towards industrial applications (Ball, 2000, p.8). It fosters links between R&D to mass deployment, accelerating the market to uptake energy efficiency innovations (Nunez and Katarivas, 2014, p.24). During workshop 4, an idea mentioned related to the integrative approach to policies was that 'it is the clustering of industries which makes industry competitive: forming industrial clusters that create synergies is an element to investments in innovative technologies'.

6.3.3 Political feasibility

The perception of distributional impacts is an important aspect in this case as part of political feasibility because it would require reallocation of public resources as well as the involvement of the industry in investing in abatement technologies. Several aspects raised during workshops, as well as revealed by interviews and completed with information from the literature are presented in this subsection.

- Related to the impact of using EU budget for innovation, the impact factor of past European framework programmes for research and innovation in terms of value added to the business sector was estimated to approximately 13 times the initial EU investment (Nunez and Katarivas, 2014, p.2). From a dynamic efficiency such an approach could thus accelerate the diffusion of low-carbon technologies.
- One of the frequently raised issues by the industry, and particularly in the steel sector, regarding investments in innovative technologies is that the industry is ready to innovate but it cannot do it by itself and it needs public finance support as the vast investments required exceed the industry's financing capabilities (Eurofer, 2013b, questionnaire 1 with steel representative).
- o It is very difficult to estimate future cash flows of RDI projects as they, if at all, are generated only in the future. There is the risk that RDI projects may encounter technological or industrial failure (EIB, 2013). The Risk Sharing Finance Facility instrument, a joint instrument between the European Commission and the EIB, aims at fostering additional investment in European research and development particularly by the private sector. The instrument has allowed for a larger volume of EIB lending and guarantees for a certain risk level, in accordance with FP7 rules (EIB, 2013) and now with Horizon 2020 rules. Therefore, from a political feasibility perspective, if such programs are encouraged, risks and costs are reduced for final beneficiaries, large energy-intensive industries. The EIB has been invited by the Commission to consider long-term financing applications for steel projects (EC, 2014j).

- The recycling of auction revenues or other form of EU ETS related revenues in 'demonstration and deployment of promising new technologies for the energy intensive industries under the EU ETS' is mentioned in the legislative proposal of the Commission on the 2030 climate and energy framework (EC, 2014b, p.111 and EC, 2014c, p.26). In terms of support for an instrument based on reusing carbon revenues, if the industry has more information on the potential of recycling revenues from the sale of emissions allowances they may be incentivized to accept a higher carbon price as long as revenues are redirected in schemes for industry as revealed through interviews with policy experts and observations from workshops on carbon leakage. However, investigations need to be further done regarding the value of carbon price to be accepted by industry.
- A recurrent concern raised during the workshops on carbon leakage when discussing measures to trigger more technological innovation was how to find the balance between free allowances, auctioned allowances that would provide revenues for innovation and other type of innovation support. A solution to this dilemma, according to the findings of a recent study, is that if investments are targeted in R&D and clean technologies, benefits from abolishing carbon leakage exemptions outweighs costs both in terms of GDP gain and employment gain (FTI, 2014).
- Because of market oversupply of allowances, structural reforms of the EU ETS will diminish the cap progressively by 2020 leaving fewer allowances for auction in the system. Regarding scarcity of allowances, studies show that even in the context of scarcity of emissions allowances, an increase in public revenues induced by a higher carbon price would exceed a decrease in total amount of allowances sold via public auction (Capros et al, 2011 and Cooper and Grubb, 2012 in Clo et al, 2013).
- On the one hand, additional funding from private sources can be leveraged -the NER300 leveraged over 2€ billion in addition to 1.2€ billion, program's allocation- and secondly, such projects sustain de-risking as more private banks come into play in financing such projects (interview 1). Moreover, a recent study (FTI, 2014) found that the benefits from recycling revenues from auctioned allowances can generate from 1 to 30 bn euro, for a carbon price ranging from 5 to 40 euro (FTI, 2014).

Table 8: Estimates of additional auction revenues range from €1 billion - €30 billion, source: FTI, 2014

Estimate of EUA auction revenue (€ billion)					
EUA price (€/ tonne)	Auctioning percentage				
	34%	70%	100%		
5	1.3	2.6	3.7		
20	5.0	10.3	14.7		
40	10.0	20.6	29.5		

6.3.4 Legal feasibility

A legal framework option for designing a program at EU level for financing low-carbon technologies in industry could be through the revenues generated by the allowances released from the market stability reserve (EC, 2014b, p.111). This could be an option similar to the NER300 programme.

Regarding subsidies for RDI, an important observation raised during interviews with policy experts is that subsidies for innovation should be assessed in terms of the existence of the market failure or if the market would have been able to deliver innovation without subsidies (interview 3). This is important related to the distortion of internal EU competition.

Table 9: Supporting more industrial innovation programmes

Policy		Indicators for each	evaluative criterion	
	Environmental effectiveness	Dynamic efficiency	Political feasibility	Legal feasibility
Supporting more industrial innovation program- mes	achieving the 2020- 2050 climate targets and objectives (+) stronger carbon price would finance low- carbon technologies	providing continuous incentive to invest in abatement technologies (+) through stronger	support for policies by policy-makers - European Commission (+) Horizon 2020 EU level programme for RDI,	compliance with WTO rules (0) needs further investigation
	improving energy and material efficiency (+) stronger carbon price would finance technologies that	accelerating diffusion of innovative low-carbon technologies (+) through using auction	European programme for innovation in industry mentioned in EC policy documents the position of Eurofer with regard to policy options (0):	compliance with the principle of differentiated commitments, responsibilities and capabilities under UNFCCC (0) needs further
	would improve the energy and material efficiency reducing dependency on fossil-fuels (+) stronger carbon price would finance low-carbon technologies that would reduce dependency on fossil-fuels	revenues in financing industrial innovative technologies; greater role could be played by the EIB in financing innovation in steel; more EU budget allocated to RDI would attract the leverage of other public and private sources	further investigation on level of carbon price acceptable; further investigation on other R&D related issues perception of distributional impact (benefits, costs and risks) (0/+) revenues raised from carbon price exceed	compliance with European Union law (0) EU state aid rules need to be revised if part of compensations for electricity costs are reallocated to other purposes
	contributing to	avoiding fossil-fuel	the decreasing amount of allowances for	non-distortion of internal EU

innovation and technological leadership in the EU (+) revenues gathered from sale of allowances would finance 'demonstration and deployment of promising new technologies' in industry	technological lock-in and emphasising technological competition (+) more auction revenues allow more technologies to be tested and developed taking into account both process and combustion emissions (+) developing ultra low-carbon technologies	auctions; further investigation on level of carbon price acceptable by industry perception of stakeholders of the impact on trade relationship between the EU and third countries (0) needs further investigation	competition (0) needs further investigation on market failure aspects
	integrative approach of policies (+)		
	innovative steel products -> reducing emissions in other sectors		

6.4 Policies including third countries – Border carbon adjustment measures

Particularly targeting trade, the European Union could adopt measures to restrict imports from countries that face less stringent environmental regulations especially related to low energy prices. Through border cost adjustments (BCAs) for imports applied at the EU border, the additional costs incurred by the EU energy-intensive industries could be adjusted in order to tackle the problem of less stringent environmental and climate regulations in countries outside the EU (van Asselt and Biermann, 2007, p.502). These could take the form of 'border tax adjustments', such as adjustments for higher energy prices because of the EU climate related energy taxation policies in many European countries (van Asselt and Biermann, 2007, p.502). There could also be 'border costs adjustments related to the additional costs through the European emission trading scheme' (van Asselt and Biermann, 2007, p.502).

This section assesses border adjustment measures as a potential measure for addressing the trade of carbon intensive products. This is a relevant discussion with regard to the steel products which are both carbon and trade intensive. Empirical evidence revealed first of all technical barriers to border cost adjustments measures for primary products such as commodities in terms of difficulty in measuring the carbon content of a product – how much

carbon, where and how it was produced- (interview 5). Recent studies show that such an option has not yet proven its practical applicability and despite the fact that it targets the underlying cause of carbon leakage, unequal carbon price (vivideconomics with Ecofys, 2014)

The variety of industrial processes in the steel sector results in a great range of carbon intensity in the sector, therefore applying a generic benchmark carbon intensity might be inefficient and less accurate in tackling competitiveness effects in steel production (vivideconomics with Ecofys, 2014, p. 135). Eurofer points out some of the technical obstacles mostly related to the long value chain of the steel sector: "Imposing a CO2 tax on imports of crude steel would inevitably displace the problem to the next step of the value chain, namely hot rolled products, and so on down to fabricated products in which the amount of steel, its origin and carbon footprint would be almost impossible to trace back" (Eurofer, 2013b, p. 58).

6.4.1 Environmental effectiveness

In terms of environmental effectiveness, BCAs can be considered an effective measure in preventing carbon leakage globally and reducing the dependency on fossil-fuels as it would incentivise international competitors to invest in abatement technologies and would ensure a level playing field internationally. Its environmental effectiveness derives from shifting abatement from abating countries to non-abating countries (Boehringer, Carbone and Rutherford, 2011 in vivideconomics with Ecofys, 2014),

6.4.2 Dynamic efficiency

Dynamic efficient BCAs measures would need to take into account the level of both combustion and process emissions incorporated in a product (emissions intensity) and would reflect the technological development of a certain installation. For instance, a dynamic BCA measure that would sustain investment in carbon-free innovative technologies would have different values according to the level of emissions intensity of the installation (Freidl et al, 2012, p.27). Process emissions are thus eliminated when a process emission free production technology is available at competitive cost (Freidl et al, 2012, p.24). A debate identified in literature is important considering when designing such measures is whether the costs adjustment should be made based on the costs of production based on the best available technology or on the emission coefficient of the predominant method of production in the importing region (van Asselt and Biermann, 2007, p.501; Kuik and Hofkes, 2010, p.1742). If revenues from BCAs are reallocated to investments in innovative technologies, it could be argued that BCAs are dynamic efficient.

6.4.3 Political feasibility

In terms of affecting relationships between EU and trading partners, the design of border adjustment measures would require multilateral negotiations between EU states before being applied unilaterally as taxation is a requires unanimous support of the European Council. In terms of relations with developing countries, if such a measure would be applied it would need to be complemented as well as by trust building measures and at least informal international cooperation (Neuhoff et al, 2014b, p. 9). Moreover, interviews revealed that this is not seen as a constructive measure to incentivise third countries to engage in climate friendly business, at least not in a friendly and open way (interview 5). Eurofer refers to the experience in the aviation sector arguing that "border measures are likely to trigger retaliatory measures by trading partners" (Eurofer, 2013b, p.58).

Regarding support for this policy, a member state stated during the workshops on carbon leakage that it is supporting this instrument and it is willing to test it by beginning with a sector similarly to the BCA program in California in the US in the cement sector (CARB, 2014).

6.4.4 Legal feasibility

Border adjustment measures are mentioned in the EU ETS Directive (EC, 2009) in paragraph 25 describing a system in which importers would need to surrender allowances and that any action taken should comply with the UNFCCC principles, especially the principle of common but differentiated responsibilities and respective capabilities as well as with international obligations of the EU, including the obligations under WTO agreement (EC, Directive 29/2009/EC, 2009, p.67, paragraph 25).

From a legal feasibility perspective, questions related to the compliance with WTO need to be asked in designing such a measure. An interesting argument is that it would be compatible with WTO law and would 'never take effect' because 'key developing countries would undertake emissions mitigation measures and thus would not be vulnerable to the imposition of border adjustment measures' (Shoyer, 2008, p.60 in van Asselt and Brewer, 2010, p.45). Different development levels of countries should also be taken into account and the compliance with common but differentiated responsibilities principle (van Asselt and Biermann, 2007, p.502).

Table 10: Border carbon adjustment measures

Policy	Indicators for each evaluative criterion					
	Environmental effectiveness	Dynamic efficiency	Political feasibility	Legal feasibility		

Border carbon adjustment measures

achieving the 2020-2050 climate targets and objectives (+)

would tackle the unequal world carbon price

improving energy and material efficiency (+)

third countries would be incentivised in taking emissions abatement actions

reducing dependency on fossil-fuels (+)

third countries would be incentivised in taking energy efficiency and emissions abatement actions, hence dependency on fossil fuels would decrease

contributing to innovation and technological leadership in the EU (0)

needs further investigation how BCAs could be designed to induce innovation providing continuous incentive to invest in abatement technologies (+)

by taking the level of emissions of a product into account

accelerating diffusion of innovative low-carbon technologies (0/+)

through reusing revenues from BCAs in developing innovative technologies; needs further investigation

avoiding fossil-fuel technological lock-in and emphasising technological competition and neutrality (0)

needs further investigation

taking into account both process and combustion emissions (+)

important in steel sector where process and combustion emissions have almost same values

integrative approach of policies (0)

needs to be further explored

support for policies by policy-makers -European Commission (0)

no evidence on this, needs further investigation

the position of Eurofer with regard to policy options (-)

Eurofer argues that BCAs are 'likely to trigger retaliatory measures by trading partners' (Eurofer, 2013b)

perception of distributional impacts (benefits costs and risks) (-)

Eurofer argues: 'it would move the problem to the next step of the value chain' (Eurofer, 2013b)

perception of stakeholders of the impact on trade relationship between the EU and third countries (-)

not seen as a constructive measures in incentivising third to engage in climate friendly business compliance with WTO rules (-/0)

needs thorough further investigation how BCAs measures would be designed in line with WTO rules

compliance with the principle of differentiated commitments, responsibilities and capabilities and international cooperation (-)

requires multilateral negotiations before it is applied unilaterally and needs further investigation

compliance with European Union law (0)

needs further investigation

non-distortion of internal EU competition (0)

needs further investigation

7 Conclusion and recommendations

This study tried to offer another perspective in addressing carbon leakage and competitiveness concerns in the European energy-intensive industries, with a focus on the European steel industry, as a case study, by shifting the discussion on technological innovation as core part of the solution. The approaches to carbon leakage and competitiveness together with the evaluative criteria and indicators used for assessing several policy options form the conceptual framework of a constructive policy-making thinking integrating environmental protection as part of the solution to carbon leakage and competitiveness of European energy-intensive industries.

A constructive thinking integrating environmental protection in the competitiveness aspects of industry is needed if sustainable growth is the path forward. The EU has the chance by taking such an approach to carbon leakage and competitiveness to offer a real transformation to the European energy-intensive industries in the path to decarbonisation. Technological innovation and an integrative approach of policies incorporated in the decarbonisation thinking would enable the industry to reduce carbon and energy costs as part of the production costs and seize new real market opportunities through developing innovative value-added products.

One main conclusion which can be derived from this research is that there are several differences that cannot be ignored at the sectoral level among the energy-intensive industries and even at subsectoral levels in the European steel sector. The steel sector is a complex industry and one-solution-fits-all is not a right approach. Such an approach led to situations where while some subsectors made windfall profits out of free allowances, other subsectors have been affected in terms of competitiveness.

The study showed several ways in which the European steel sector can be incentivised and supported to improve its energy and material consumption, reduce dependency on fossil fuels technologies and invest in innovative technologies and products which in the long term, would reduce carbon costs as part of the production costs and improve international competitiveness. The European steel sector could thus compete internationally through innovative high value-added products rather than on energy prices and volumes.

A second conclusion is that for a real constructive and systemic thinking to emerge among policy-makers and the industry, continuous dialogue is necessary with the involvement of as many and diverse stakeholders as possible. An idea which could be further explored is that instead of organising consultations with all energy-intensive industries, consultations with each industry individually would be more efficient. A tailored approach could thus be explored. In this context, subsectoral differences and challenges could be better understood and addressed. Such consultations need the presence of the industry but also the presence of policy and technical experts, environmentalists and academia so that ideas emerge out of a balanced representation of interests. The European Commission has as such a crucial role in facilitating such dialogues at EU level through diverse frameworks for stakeholder consultations.

Regarding more specific measures, the issue of benchmarking is important from an environmental effectiveness and dynamic efficiency perspective. One recommendation is that benchmarking should be revised more regularly taking account of technological developments and also somehow taking account of sectoral and subsectoral differences in terms of abatement possibility. Consultations with stakeholders would thus enable a clearer understanding of the role of benchmarking for the instrument to be accepted.

A stronger carbon price would not necessarily represent a direct threat to competitiveness for the energy-intensive industries. Rather, a stronger carbon price is needed for finding alternative ways of production that are less fossil fuel dependent and more energy and material efficient. If revenues from the sale of emissions allowances and compensations were redirected in measures supporting the industry to invest in abatement technologies, this could help the industry reduce carbon costs (both direct and indirect) and hence reduce its carbon footprint and keep innovating.

Further, the need of continuous thinking about solutions for the EU steel sector in connection with other industrial sectors to which steel contributes with its products is important. The current overcapacity and low margins faced by the EU steel sector risk to limit investments and improvement of existing facilities. By seizing opportunities that reduce emissions not only in the steel sector itself but looking at ways for developing innovative steel products that would contribute to the decarbonisation of the whole economy represents a great step forward in terms of integrative policy thinking.

One final remark is that by taking such a systemic thinking, as presented in this study, other countries and regions can be awaken from their unsustainable use of resources and industrial practices. Scarcity of resources and pollution because of GHG emissions is not only an issue the EU is confronted with. Only by continuing on its path on environmental protection ambition can the EU represent a model for other countries. In the face of this radical crisis of scarce resources and pollution that threatens the survival or our planet, the reaction of the EU is crucial. The EU can take the opportunity, by taking real leading position towards environmental protection and sustainable industrial development, to give the leapfrog chance to the developing nations to follow its model.

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9 Annexes

9.1 Annex 1 – Definitions of carbon leakage

Table 11: Definitions of carbon leakage

Definition	A	
'the situation that may occur if, for reasons of costs related to climate policies, business were to transfer production to other countries which have laxer constraints on GHG emissions. This could lead to an increase in their total emissions. The risk of carbon leakage may be higher in certain energy-intensive sectors' (EC – DG Clima, 2014).	DG Clima of the European Commission	
'an increase in the global greenhouse gas emissions when companies shift production outside the Union because they cannot pass on the cost increases induced by the EU ETS to their customers without significant loss of market share' (EC, 2012b).	European Commission, 2012, State Aid Guidelines in the EU ETS context	
'In the event that other developed countries and other major emitters do not participate in this international agreement, this could lead to an increase in greenhouse gas emissions in third countries where industry would not be subject to comparable carbon constraints (carbon leakage), and at the same time could put certain energy-intensive sectors and subsectors in the Community which are subject to international competition at an economic disadvantage. This could undermine the environmental integrity and benefit of actions by the Community' (EC, 2009)	Recital of paragraph 24 of the EU ETS Directive, 2009	
'the increase in CO_2 emissions outside the countries taking domestic mitigation action divided by the reduction in the emissions of these countries' (IPCC,	IPCC -Intergovernmental panel on climate change,	

2007).	2007
'the ratio of emissions increase from a specific sector outside the country (as a result of a policy affecting that sector in the country) over the emission reductions in the sector (again, as the result of the environmental policy)' (Reinaud, 2008, p.3).	OECD, Reinaud, 2008, p.3
'Carbon leakage is the result of the increase in the CO2 component of electricity prices (indirect emission costs) which firms may not be able to pass on or to bear. It occurs when EU greenhouse gas emissions "migrate" to third countries because companies that cannot pass on to their customers these increased electricity costs either lose sales to competitors in countries where no CO2 constraints exist, and/or leave the European single market and move their production to such countries' (BusinessEurope, 2012).	BusinessEurope – the umbrella standing for companies in Europe

9.2 Annex 2 – Data on energy and carbon costs in the European steel industry

Steel industry qualifies as an energy-intensive industry both through the electricity and gas consumption.

An industrial sector is *electricity intensive* if its electricity consumption is above the average electricity intensity of the entire industry. It refers to the amount of electricity needed to produce a unit of value-added (e.g. one million euro) in a given industrial sector. Among the *electricity intensity* of EU industrial sectors, steel registers the highest values (Figure 6).

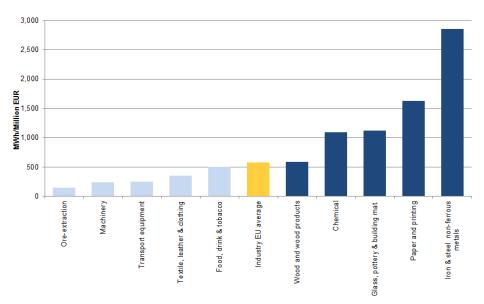
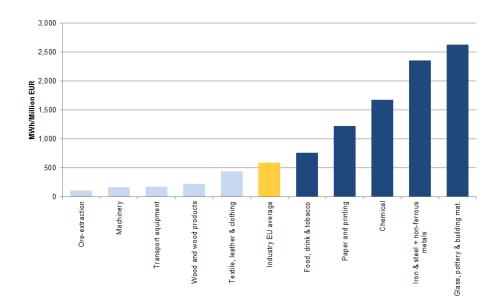


Figure 6: Electricity intensity in industrial sectors of the EU (EU average);

Note: The breakdown in national accounts is based on 2-digit NACE codes. Industry is manufacturing industry minus 'Other manufacturing' (no electricity and gas consumption data). Refining industry is not included (no final electricity and gas consumption in national balances). Industry average includes Mining and quarrying. Source: (EC, 2014d)

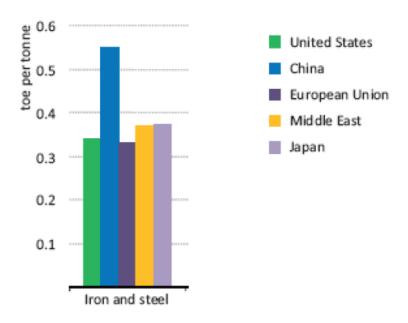
An industrial sector is *gas intensive* if its gas consumption is above the average gas intensity of the entire industry. Gas intensity refers to the amount of natural gas needed to produce a unit of value-added (e.g. one million euro) in a given industrial sector. In terms of *gas consumption*, steel also has very high values (Figure 7) (EC, 2014d).

Figure 7: Gas intensity in industrial sectors of the EU (EU average) Source: (EC, 2014d)



Compared with other world countries (Figure 8), the European iron and steel has the best energy intensity compared to other regions, as shown in figure below. It has similar values with the US.

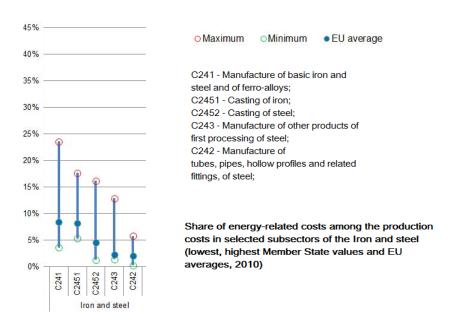
Figure 8: Energy intensity of iron and steel by region, 2011, Source: EC, 2014d, p.238



• Share of energy-related costs among the production costs in selected subsectors of the Iron and steel

The estimated share of energy costs compared to total production costs are up to 30% in the steel industry, however there are variations in the subsectors with 5% for BOF and 12-15% for EAF, as shown in the figure below:

Figure 9: Share of energy-related costs among the production costs in selected subsectors of the Iron and steel (lowest, highest Member State values and EU averages, 2010), Source: (EC, 2014d)



• Electricity prices in the EU for the steel industry

The electricity prices paid by a sample of 17 EU steel producers (€/MWh) increased in average by 6.9% from 2010 to 2012, with three plants from Central and Eastern EU registering 19% increase, while 9 plants from North-Western Europe registered in average a decrease of -2.1%. Moreover, in average, electricity prices for BOF increased by 9.5% while for EAF by 2.8%. The table below provides more details on this.

Table 12: Descriptive statistics for electricity prices paid by 17 sampled EU producers of steel (€/MWh), Source: EC, 2014d

Electricity price (€/MWh)	2010	2011	2012	% change 2010- 2012
EU (average)	66,8	71,2	71,4	6,9
EU (minimum)	51,8	51,0	46,5	-10,2
EU (maximum)	89,6	93,5	104,4	16,5
Central and Eastern EU (average)	77,7	84,7	92,5	19,0
Southern EU (average)	67,7	68,8	74,2	9,6
North-Western EU (average)	60,7	64,3	59,4	-2,1
BOF Average	67,5	73,9	73,9	9,5
EAF Average	65,2	67,0	67,0	2,8

North-Western Europe includes 9 plants: FR, BE, LU, NL, IE, UK, DE, AT, DK, FI, SE

Central and Eastern Europe includes 3 plants: PL, SI, HU, RO, BG, CZ, SK, EE, LV, LT

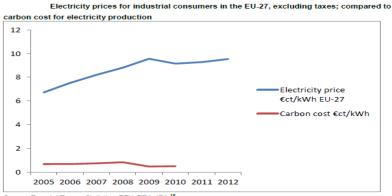
Southern Europe includes 5 plants: IT, ES, PT, EL, MT, CY

Note that sampled plants do not come from all the MS in one region. The specific countries cannot be indicated due to confidentiality reasons.

Source: CEPS, calculations based on questionnaires.

The study also shows a decrease of the energy component from 53.9 €/MWh (81% of price) in 2010 to 53.3 €/MWh (74% of price) in 2012 in the EU. The component of the electricity costs that registered the highest is represented by the RES levies. RES levies registered a value of 8.8 €/MWh in 2012 (an increase of 91% compared to 2010) and in 2012 they represented 12% of the final electricity bill. In addition, network costs increased by 24% and other taxes and levies by 10%. It is important to be noted that the steel industry is outside of the scope of the Energy Taxation Directive (EC, 2014d, p. 65).

Figure 10: Electricity prices for industrial consumers in the EU-27; compared to carbon cost for electricity production, Source: Ecorys, 2013, p. 28.



ource: Eurostat Energy Statistics, EEX, EEA, IEA. 15 Source: Eurostat Energy Statistics, EEX, EEA, IEA. ¹³
Electricity prices shown are the average national prices in Euro per kWh without taxes applicable for the first semester of each year for medium size industrial consumers (Consumption Band Ic with annual consumption between 500 and 2000 MWh). Until 2007 the prices are referring to the status on 1st January of each year for medium size consumers (Standard Consumer le with annual consumption of 2 000 MWh). Note that figures may still differ due to tax differences, and prices can be expected to be lower for large size industrial consumers. Also note that there are some data gaps (e.g. Italy 2008 and 2009).

"EUA Y+1" refers to the forward price of an EU allowance unit (ETS emission forward price, used here because it is more stable than the certains).

Figure 11: Electricity price: comparison between three US-based plants and seventeen steelmakers in the EU (€/MWh), Source: CEPS, calculations based on questionnaires, in EC, 2014d, p.157

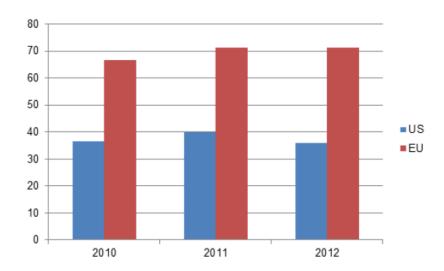
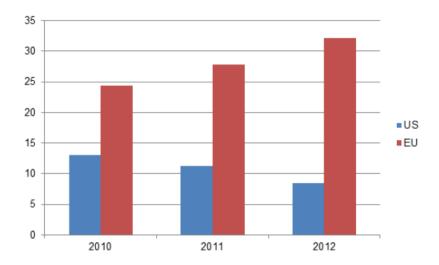


Figure 12: Natural gas price: comparison between three US-based plants and fifteen steelmakers in the EU (€/MWh), source: CEPS, calculations based on questionnaires, in EC, 2014d, p.241



Comparing the electricity prices in the US and EU, they were almost double in the EU compared to the US in 2012 (Figure 11) and natural gas prices in the EU were at least four times higher than in the US (Figure 12). This is without taking account of compensatory measures for electricity costs.

9.3 Annex 3 – Technological production paths in the European steel sector

The description of different technological production pathways in the steel sector is important because there are different challenges at sub-sectoral level and products differ according to the production path.

Primary steel production path is carbon intensive (inputs of coke, coal and iron ore) while secondary steel production (melted scrap as input) is electricity and gas intensive. Primary steel production is specialized in products with high quality requirements (often flat) while secondary production is more suited to lower added value, bulky products (Mohr et al, 2009 in Ecorys, 2013, p.15). In the EU, production of flat products —hence high quality requirements - is about twice in volume compared to long lower-quality products (Ecorys, 2013, p.19).

• Inputs in steel production

Raw or pig iron is produced from iron ore, coke and limestone – in a blast furnace (BF), cast into ingots – pig iron, or transferred directly as hot metal to a steel furnace;

Iron ore is transformed by using gas instead of coke as a fuel in ironmaking, resulting in lower quality iron;

Scrap – recycled steel – has lower quality because of tramp metal which occurs in scrap;

Ferro-alloys are used to add more chemical elements into molten metal, in the production of different types of steel. Ferro-alloys are produced from manganese, chrome and nickel in a submerged electric arc furnace involving high electricity consumption.

These inputs ensure the two production routes for raw steel: primary steel production and secondary steel production.

Primary steel production - the iron ore is melted in blast furnaces (BF) and basic oxygen furnaces (BOF) through burning of fossil fuels (Ecorys, 2013, p.15).

Basic Oxygen Furnace - BOF (Ecorys, 2013, p. 16):

- o Main energy inputs are: coal and coke;
- Relies on BF pre-process and transforms raw iron into steel by removing impurities in a basic oxygen furnace;
- Limestone and other flux are added to raw iron with high purity oxygen;
- Outputs: molten steel and slag;
- Further inputs for BOFs are: scrap steel and DRI and other metals/ferro-alloys can be added to create alloy steel (Ecorys, 2013, p. 16);
- Main variable costs in production: coking coal and iron ore, to a limited extent scrap and fluxes (Ecorys, 2013, p.25).

The second production of crude steel is by melting scrap – recycled steel-, which is mostly done in electric arc furnaces (EAF) using electricity. EAF are mini-mills - secondary steelmaking processes -, comprising only steel furnaces and rolling and finishing facilities (Linares and Sanatamaria, 2012, Johansson and Söderström, 2011, p.5). EAF is also capable of primary production (Ecorys, 2013, p.15).

Electric Arc Furnace – (Ecorys, 2013, p. 16):

- Main energy input is electricity;
- o It melts scrap and/ or DRI through heat created by an electric arc;
- Its main inputs are: scrap, DRI and electricity, as well as raw iron and energy fuels in small quantities;
- EAFa are small, flexible and less integrated;
- More difficult for EAF to produce high-quality steel products because of the tramps metal from scrap;
- Hence EAF tends to specialize in bulky, long products;
- DRI could contribute to improving the quality of EAF steel, but it depends on gas and in Europe it is not cost-effective (Mohr et al, 2009) (Ecorys, 2013, p.17);
- Main variable costs in production: electricity and scrap (Ecorys, 2013, p.25)

Literature distinguishes also a third production route: *Direct reduced iron (DRI)* using DRI ore and scrap (IEA, 2010. P.178).

Figure 13 shows the different production routes, the transformation installation (in blue), as well as the inputs, semi-finished products, and outputs (in green) (Ecorys, 2013, p. 17) and Figure 14 the production in main European countries by type of technology. The division of the European production between the two types of plants is quite balanced, with a growing share of the EU's crude steel being produced in electric furnaces. BOF facilities are fewer than EAF but they are characterized by strong economies of scale. The small players are EAF and ferro-alloys producers (Ecorys, 2013, p.18).

Figure 13: Main activities and products in the steel production process, source: Ecorys, 2013, p.17

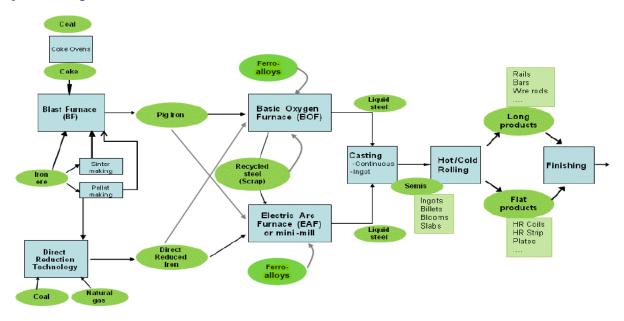
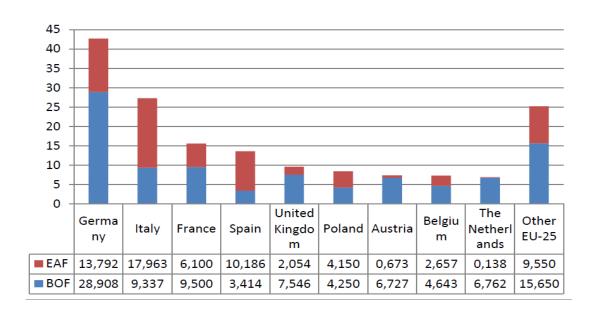


Figure 14: Production of crude steel by production technology, 2012 (in million tonnes), source Ecorys, 2013 based on World Steel, 2013



9.4 Annex 4 – List of documents consulted representing main policy and legislative documents of the European Commission and documents for the position of Eurofer

European Commission

• EU ETS Directive (2009)

EC – European Commission (2009). Directive 2009/29/EC of the European Parliament and of the Council of 23 April 2009 amending Directive 2003/87/EC so as to improve and extend the greenhouse gas emission allowance trading scheme of the Community (text with EEA relevance), available online at: http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:L:2009:140:0063:0087:EN:PDF

 Communication on Guidelines for state aid in the context of the greenhouse gas emission allowance trading scheme post-2012 (2012)

EC – European Commission (2012b). Communication from the Commission, Guidelines on certain State aid measures in the context of the greenhouse gas emission allowance trading scheme post-2012, text with EEA relevance, available online at: http://eurlex.europa.eu/LexUriServ/LexUriServ.do?uri=OJ:C:2012:158:0004:0022:EN:PDF

 Action Plan for a competitive and sustainable steel industry in Europe (2013) and overview of actions taken (2014)

EC – European Commission (2013a). Action Plan for a competitive and sustainable steel industry in Europe , Communication from the Commission to the Parliament, the Council, the European Economic and Social Committee and the Committee of Regions, COM(2013)407, available online at: http://ec.europa.eu/enterprise/sectors/metals-minerals/files/steel-action-plan en.pdf

EC - European Commission (2014j). Overview of actions to be taken under the Steel Action Plan (COM(2013)407)

Energy prices and costs report (2014)

EC – European Commission (2014d). Commission staff working document, Energy prices and costs report, accompanying the document, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, Energy prices and costs in Europe, SWD (2014) 20 final/2, available online at: http://ec.europa.eu/energy/doc/2030/20140122_swd_prices.pdf

Carbon leakage new list 2015-2019 and consultations

EC – European Commission (2013e). Carbon leakage: new list 2015-2019 Stakeholder consultation meeting Brussels, 23 May 2013, available online at: http://ec.europa.eu/clima/events/0076/boneva en.pdf

EC – European Commission (May 2014h). Commission starts written consultation on post-2020 carbon leakage provisions, available online at: http://ec.europa.eu/clima/news/articles/news 2014050801 en.htm

Policy documents on the 2030 energy and climate policy framework (2014)

EC – European Commission (2014a). A policy framework for climate and energy in the period from 2020 to 2030, Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, COM(2014)15 final, available online at:

http://ec.europa.eu/energy/doc/2030/com 2014 15 en.pdf

EC - European Commission (2014b). Impact Assessment accompanying the document Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions, A policy framework for climate and energy in the period from 2020 to 2030, available online at: http://ec.europa.eu/clima/policies/2030/documentation en.htm

EC - European Commission (2014c). Commission staff working document, Impact Assessment, Accompanying the document, Proposal for a Decision of the European Parliament and of the Council concerning the establishment and operation of a market stability reserve for the Union greenhouse gas emission trading scheme and amending Directive 2003 / 87/EC, SWD (2014) 17 final, available online at:

http://ec.europa.eu/clima/policies/ets/reform/docs/swd 2014 17 en.pdf

Eurofer

Interview with Gordon Moffat, Director of Eurofer, 2013 realised by Euractiv:

Euractiv (22 January 2013b). Steel chief: Industrial policy 'needs the support of Barosso', available online at: http://www.euractiv.com/specialreport-europe-industry-ha/steel-chiefindustrial-policy-ne-interview-517220

Eurofer position on carbon leakage provisions:

Eurofer as part of the AEII – Alliance of Energy Intensive industries (2013a). Carbon leakage protection for EU industry is under threat, urgent call to safeguard Europe's industrial competitiveness, available online at: http://www.eurofer.be/?&wtd=MtTKqrvSyBoQisbe

Eurofer roadmap for a low carbon Europe 2050

Eurofer (2013b). Eurofer presents Steel Roadmap for a low carbon Europe 2050, available online at: http://www.eurofer.be/News%26Media/Press%20releases/LowCarbon.fhtml

• Eurofer position on the environmental protection and energy state aid for 2014-2020

Eurofer (April 2014a). Energy and environmental state aid, available online at: http://www.eurofer.be/News%26Media/Press%20releases/Energy%20and%20Environmenta l%20State%20Aid.fhtml?&wtd=MtTKqrvSyBoQisbe

• Eurofer Manifesto

Eurofer (2014b). Manifesto 2014-2018, available online at: http://eurofer.org/lssues%26Positions/Communication/201403-Manifesto.pdf

9.5 Annex 5 – List of notes from the workshops on carbon leakage on the aspects mentioned about carbon leakage and technological innovation

Workshop1: Carbon leakage options for the EU post 2020, London - main ideas raised about carbon leakage and technological innovation

Date: 20 March 2014

- It would be interesting to have a graduated approach to the carbon leakage risk list taking into account flat/steep abatement potential. While risk was not identified at sectoral level, the analysis at sub-sectoral level shows discrepancies with some manufacturing sub-sectors having been at short of allowances.
- EU ETS initially had the intention to reduce emissions at the lowest costs but triggering innovation/ abatement was not an inherent part of the EU ETS design. To trigger major innovation investment, a price of at least 50 euro/ tonne needed. The question is if a price of carbon 30 euro/ tone, is a good indicator when looking for long term investment decisions and impacts?
- There is a surplus of allowances in the system which will affect the future; the question is how to deal with this surplus while sectors have been affected differently by the economic recession due to variations in market characteristics. Hence is there a need to take sector characteristics into consideration in carbon leakage risk mitigation?
- Points raised regarding allocation based on benchmarking:
 - Look at the marginal impact -> the difference permits can make in a specific sector; look at the different distribution around the benchmark.
 - Benchmarking is different for fuel and process emissions; process emissions are different hence the performance is different even if there is same fuel based benchmark level for all sectors.
 - There should be different target paths for the power sector and even between steel, cement, chemicals, etc. The supply mechanisms would react on these as the stringency for each sector would be different in terms of permits allocation.
 - However, we need something that can be applied to all sectors not exposable to manipulations.
- As the value of the carbon price increases the industries need to see these values recycled in long-term low carbon innovation project. One solution would be more powerful incentives related to R&D support coming from auctioning the allowances.
- Border carbon adjustments could be implemented more for commodity products, but would add more complexity to the system.

Workshop2: Carbon leakage options for the EU post 2020, Paris - main ideas raised about carbon leakage and innovation

Date: 15 May 2014

- In terms of ex-post evidence of carbon leakage risk in the EU ETS, it was mentioned that many other factors besides carbon costs played a role in carbon leakage study.
- It was argued that regarding the CLL, so far till end of EU ETS phase two, there was no carbon leakage as set in the Directive. However, it was argued that there was investment leakage, but it is possible that this started before the EU ETS. This means that the choice for investment leakage is not very clearly understood and it needs further studies;
- It was agreed that the CLL should be more focused and also a tiered approach as an alternative to the current in-out approach was mentioned to be more relevant.
- It was also mentioned that while there should be one objective in terms of GHG emissions reduction, there should be flexibility in the approach and that market-oriented measures should be combined with technology push R&D program and the option of differentiated constraints on power and industry was also raised.
- The ability to pass through costs was also raised as an important issue that needs further investigated as there are different parameters affecting the pass through ability. It was also mentioned that the carbon costs should be used as an indicator of CL risk and not the carbon price.
- It was mentioned that there is an emergence of carbon costs also in other
 jurisdictions outside the EU and that some analysis demonstrated explicit or implicit
 carbon costs for power producers in third countries implying higher power prices.
 Also, it was mentioned that the carbon efforts of actors in other jurisdictions should
 be acknowledged and this changes the situation of carbon leakage debate in
 comparison with previous years.
- Another issue raised is that monitoring and measurement of competitiveness and carbon efforts in third countries should be accounted for in the carbon leakage risk assessment.
- The support for industrial innovation and the idea of a NER300 programme for the deployment of low-carbon technologies was raised as well. The question is: where does money to finance the technological innovation come from?
- The issue that currently there is no instrument for fighting against the imported emissions was raised. Such a measure could be tested for one sector as it is the case in California. However, it was also argued that because of technical reasons it would be difficult to implement such a measure.
- Another issue raised was that in terms of compensation measures for carbon leakage risk, countries have had different compensatory measures which created inequality across member states in the level of protection. This is thought to create possible distortions between countries and sectors.

- The role of the EU ETS purpose and particularly of the carbon price was brought into the discussion. It was pointed out that there should be balance between support measures for carbon leakage risk and reforming measures for the EU ETS that would trigger a carbon price signal.
- One member state expressed that it is supporting border carbon adjustment measures and that it would be willing to test this type of mechanism in a sector as it is currently potentially happening in California in the US which proves that the mechanisms can be put in place.

Workshop3: Carbon leakage options for the EU post 2020, Berlin – main ideas raised about carbon leakage and innovation

Date: 21 May 2014

- It was argued that so far industry's concerns proved to be greatly exaggerated and that there has not been evidence detected for the occurrence of carbon leakage. One idea mentioned was that there was no proof that the EU ETS induced carbon leakage, however it is important to think how future will evolve and economic growth should be accounted for.
- Regarding the carbon leakage debate, it was argued that there are aspects that are very political and that rational, analytical and political aspects are combined. The political context is related to various layers of decision-making.
- It was also argued that there should be a broader understanding of risk factors in terms of impacts of size of carbon costs, of abatement abilities, of pass through of carbon and abatement costs. The interactions in the EU ETS relevant to carbon leakage are constructed around the causality chain between stringency of allowances, carbon price, carbon costs, abatement activities by technological change and abatement costs, as well as the relationship between total carbon costs and value added.
- It was also argued that carbon leakage risk will always exist as long as there is no level playing field in the form of one price of carbon worldwide.
- The risk of carbon leakage was expressed as a risk of carbon and job leakage and that more recently there is risk of investment leakage.
- Carbon leakage protection was mentioned to be "not nice to have", "not a treat for the industry", "not a donation" but that it is absolutely necessary to compensate for serious disadvantages and cost burden that no other competitors outside the EU has to shoulder.
- The need to think about both direct and indirect carbon leakage (related to indirect costs through electricity prices) was raised.
- One of the questions raised was how to address the real risk of CL? One position was
 that there should be more focused approach, to really focus on the sectors at risk and
 it was considered that the actual list is too large and the new list is even larger. It was

- acknowledged that the carbon leakage list is not focused in the EU and that the new carbon leakage list is almost very same list as previous one. One the one hand, it was felt that the list should be cut at the minimum, to be for the ones really at risk of CL.
- A broader definition of carbon leakage is argued to take into consideration the impacts of carbon policies on operating and investment decisions.
- It was mentioned that carbon leakage has effects on de-investments in Europe and that there has been evidence for de-investment from the EU and this is also translated in carbon leakage. This is related also to the fact that there are ecological implications for the credibility of the EU goals.
- It was also mentioned that there is an investment leakage in the European steel sector not only due to carbon costs. There are various factors that must be considered. Other factors for carbon leakage de-investments mentioned are: energy prices (claimed to be very high in comparison with US energy prices and taxes and fees having increased in the last years), access to raw materials, favourable land prices, long-term investment-friendly frameworks (further details in presentation: Jakobs, 2013).
- Another aspect raised was that it would be interesting to assess free allocation and how this can tackle different leakage channels. The question raised was: is free allocation a way to avoid investment leakage?
- On the other hand, it was argued by industry representatives that more stringent linear reduction factor should come in combination with sufficient carbon leakage protection.
- It was also argued that the one possibility of the EU ETS reform should ensure that all permits are auctioned which would provide more funds for industrial clean-tech research.
- It was also argued that the more stringent linear reduction factor should be in combination with carbon leakage protection post-2020 given that for the time being there is no signal of international agreement on climate change.
- It was also argued that industries should contribute minimally to RES deployment and that should be interlinked with the benchmark. The contribution should be there if the CLL is long otherwise the list should be more focused.
- One of the questions raised was if there would be a 30 euro price and that if not this represents a serious problem. Pricing is seen to be more due to hedging strategies, but not because the cap is fighting. The 30 euro price is seen as an outdated parameter.
- It was also argued that the role of the carbon price is still not well understood in abatement activities and that in some cases the carbon price is not an enough incentive for abatement and that a whole restructuring of the industrial process may be needed in certain industrial sectors.
- It was argued that in Germany the problem of data quality is related to the fact that data for companies are aggregated across value chains. The same location is used for

- producing various products. However, the NACE## code is for the whole plant which results in significant inequality in the measurement of the sector.
- One question raised was if free allocation was the right way forward. Also, if the number of free allocations is decreasing in the future how to deal with carbon leakage?
- Another concern raised was what can be learned from having allocated free allowances? Is actually industry better off if support given to all?
- It was argued that the excess of free allocations resulted in a decrease of the CO2 price.
- It has been mentioned that the 2030 climate and energy package represents a political commitment to continue with free allocations however, it was argued that it is imperative for more focused free allocation and that it is important how to create the focus on CL leakage risk sectors so as to reflect those in real need otherwise the support for those in real need is considered to be diluted.
- Another issue raised about free allocation is that by providing free allocation to companies this means less auctioning revenues which is translated in less auctioning revenues for governments in the transition to low-carbon economies.
- It was mentioned that a solution to this for post-2020, is that free allocation should be combined with ambitious benchmarks as an option if the overall ETS cap is aligned with the EU long-term target.
- Financial support to for energy-intensive industries is claimed to have been given without conditions as conditioned to low-carbon investments. Compensations in some MS is argued to leading to overcompensation.
- Tax incentives were mentioned as an alternative to free allocation. This would give full incentive to abate carbon.

- Measures for Innovation

- Continuous commitment to decarbonisation could be continuous support for both free allocations and innovation support. The questions raised on innovation and free allocation were:
- how to support through free allocation industries that want to innovate?
- should there a percentage put aside for industries wanting to do more innovation?
- how many free allowances should be for innovation support and how many to be left at member states for support for industries?
- Another issue related to investments in innovation in industry was highlighted with respect to the "concept of an expanded NER300 system as a means of directing revenues from the ETS towards the demonstration of innovative low carbon technologies in the industry and power generation sectors" as mentioned in the European Commission' Communication of the 2030 energy and climate package.
- However, another issue raised was that if there is more free allocation for innovation this will reduce the resources to be allocated to the NER300 programme.
- Another issue raised was if that innovation is about expanding the scope of what kind of technologies can get funding from NER300 project.

- Another idea raised is that for 2030 there will be both technological and political challenges and that it is important to find the right balance for decarbonisation and also to provide adequate protection for those in need.
- It was mentioned that the industry is leaving in the past and that there should be more constructive position from the industry. The industry should propose how to deal with competitiveness aspects post-2020 in a more constructive way. This is missing on the industry side so far.

Workshop 4: Carbon leakage options for the EU post 2020, European Parliament, Brussels – main ideas about carbon leakage and innovation

Date: 10 April 2014

- It was mentioned that carbon leakage is already a hot topic since the beginning of the FLLETS
- The need of a more focused system was argued. Free allowances are scarcer, need to be used efficiently as any public resources. Industry should go together with climate policy, to see the whole picture; link with international negotiations taking place in Paris.
- It was argued that to reach the 2050 target we need innovation, a lot of research has been done but not much put in practice. Need for more practical approach to innovation. Carbon price is not enough for innovation.
- Border carbon adjustments were also mentioned. The discussion on BCA is important
 emissions embedded in imports coming to the EU;
- Industrial innovation is argued to be the big challenge of the European industry. The innovation gap between Europe, US and China si widening. We really need to become aware that this will be a big challenge.
- There are many indications EU ETS also offers many options for strengthening industrial innovation in Europe. The need of a fundamental reform of a EU ETS taking innovation into consideration was mentioned.
- Link carbon pricing and industrial competitiveness. It was mentioned that the EC has corrected some of the shortcomings of the EU ETS.
- Regarding flow of revenues that that can be generated from sale of allowances need to be invested wisely in low-carbon technologies;
- Regarding the 2030 debate on climate and energy package, it was mentioned that a stronger carbon price would play a role in innovation. Technologies are available both on short and long term. We need to get them on the market. The ETS auction revenues can be used for this purpose. The EU ETS thus could really work for the market.
- International offsets and innovation products: what are main reasons for not trying of developing a system where buy credits for using innovative products? It is a tool out

- of the box issue to be further investigated; there are time constraints on this approach;
- Regarding industrial innovation industrial clusters, it was mentioned that some sectors in some regions, in some clusters are more exposed to international competition. Imports of leakage from abroad, but there is also elements of exports. Industrial clusters from Europe are exported in countries outside EU. It was argued that it's the clustering of industries which makes industry competitive: forming industrial clusters that create synergies an element to investments in innovative technologies;
- Carbon price is there to drive breakthrough technologies: how much money/ sector, how much European intervention, does it take place in EU; currently now doing research on technologies. Sometimes this innovation occurs abroad. The carbon price is not too high to use revenues for innovative projects.

9.6 Annex 6 – List of interviews and questionnaires

Interview 1 – think tank, the role of financial instruments in industrial innovation

1. How can financial instruments enhance the predictability for investments in low-carbon technologies towards 2030?

Predictability is a big word.

Regarding the investment for technological innovation, much more is needed than what is done today. Also financial crisis came into play. There are two issues: one, how to increase investment in technologies? Second, how to do this when access to finance becomes more complex? After financial crisis, even if there has been improvement, there is still uncertainty, investors are risk averse.

What do financial instruments do? They are not a solution to eliminate uncertainty. They reduce risks. First thing is that they reduce the cost of capital. The EU through financial instruments offers a cushion, it protects up to 20% of the investment. Other investors are interested. It means these projects are fitting priorities.

Regarding the instruments for deploying technologies at industrial scale, there has been an increase in the number of projects. They are trying to put in many areas where returns are far into futures, very risky, lots of banks do not do that.

These EU financial instruments need to be understood. Financial Instruments are very important. They can generate a lot of money, are a very useful instrument.

2. What type of financial instruments would address companies needs for industrial innovation in the scaling-up of demonstration projects at industrial scale?

Steel companies can get a loan through the RSFF, if a company wants to test a new technology that would reduce emissions. If we talk about large investments in the steel company, then financial instruments would not play a role. They can go to other banks.

3. Do you think it would be politically feasible for member states to redirect some of the state aid compensatory measures that are currently offered for electricity costs for industries together with EU-ETS auctioning revenues into 'co-financing public resources' for financial instruments - not for this programming period but for post-2020?

From efficiency point of view, compensatory measures could have been given to innovate and increase efficiency and reduce energy costs. It can be done. Money could be invested; give companies money to reach the level of efficiency; this is an investment. Obligations can be attached to compensatory measures. It's easier said than done.

However, the money remains in the member states to finance their needs. That is more feasible to be implemented. See the example, the Marguerite fund. You could create a European fund, but not run by the EU, which could be dedicated to industries which are at risk to invest in energy efficiency. Compensation is not an income for industries, but companies are not particularly keen on this (fund). The companies will be affected (if no compensatory measures for electricity prices), but it would be much more efficiently than the current system.

Is this a financial instrument? If the EU budget is also there, it is a financial instrument. It could guarantee loans. It changes the nature of financing.

The fund can support companies, there is a lot of flexibility in terms of product: grants, loans. The fund needs to be created. But from the EU point of view cannot be considered a financial instrument.

Create a fund for high-energy consuming industries.

These companies can ask when want to do energy efficiency in companies; it depends on their location; if in a poor region, they can access different instruments.

4. Do you think these instruments have a sufficient visibility among private actors – be it industries/ private banks? How can their visibility be improved?

Yes. The ones that are channelled through national banks are sufficiently visible. The visibility of what they are is not clear. For innovation there is very high level of use so no problem in terms of visibility.

5. What do you think we lack more: the interest of private investors (including lack of capacity and knowledge in private banks on energy efficiency aspects), public cofinance or clear long-term based public rules?

First, private investment is a very big issue. Second, regulatory reform is important. It is not about public money so much, really about attracting capital. Regulatory framework is the biggest problem.

Interview 2 – think tank representative, political feasibility of several policy options for addressing competitiveness and carbon leakage in the European energy-intensive industries – focus on the European steel sector

1. Do you think the EU ETS is an instrument for inducing technological innovation?

There is no clear answer. There is on the one hand, a YES dimension. It has not really induced technological innovation, but it induced organizational innovation which led to technological innovation. The EU ETS has not driven technological innovation, but discovered technological innovation for those who need to implement this.

Regarding the NO answer, the period of observation is not sufficient to really get solid empirical evidence that technological innovation was induced by the EU ETS. Innovation was driven by the EU ETS in its pricing function. The role of the EU ETS in technological innovation was clear related to spending the revenues of the auction in programs such as NER300. There is a difference between more radical innovation (where revenues from auction can be used) and incremental innovation (where the pricing factor of EU ETS and discovery of innovation play a role).

2. Do you think there should be a differentiation of the EU ETS according to sectors characteristics (e.g. different benchmarking according to sectors, different EU ETS for industry and power)?

This is a stupid idea. There is differentiation in the EU ETS. The architecture of the EU ETS: there is an overarching pricing, which is uniform, it makes no difference. The difference is made at the compensation side. It gives more flexibility. If China, Australia and US really go for serious ETS, the all issue of leakage, we would have to see it in a different way. It is much easier to do the restructure of compensation side than restructure the EU ETS. The compensation side needs to be addressed to deal with differences.

3. How do you find free allocation as a measure of protecting sectors at risk of carbon leakage? How can it be improved to induce more innovation?

Many many different ways were discussed. If in the context of flat rate solutions: if we want to have a mechanism that applies for all sectors, then you end in the world of free allocation. If there would be more differentiated way on leakage (there are two different dimensions: operational and investment leakage – need to be addressed in different ways). I am much in

favour of monetary compensation than free allocation. In each regime of carbon leakage there will be at least some sectors where free allocation as compensation measure plays a role. It doesn't stop nor induce innovation. It is simply a measure in a world of different carbon prices. The list is too broad, the criteria are too broad.

The question is: do we want to stay with free allocation, as way of dealing with carbon leakage? How to narrow the sectors which could get free allocation? Trade intensity as standalone is a nonsense criterion. The combination of trade and carbon costs is a pragmatic approach and carbon costs as stand alone. Removing trade intensity as sole criterion would be a huge success. The question is how to bring criteria which would allow going for further differentiation like price elasticity. We need to leave behind the binary world. There is need of more differentiation. There is yet no final pinion on what is good and bad, but there are some proposals in the debate which have the potential to get it forward, but very detailed discussion is needed.

4. What kind of incentives would European energy-intensive industries (steel sector in particular) need to invest in technological innovation (both in terms of energy efficiency and added-value products)?

We need to differentiate investment leakage (relocate new investments) and operation leakage (relocate production). The margins for different sectors are different. The cement sector the only one which is sensitive to operation leakage. The contribution margin in the other sectors is so high. We should decrease the level of free allocation to steel sector and deliver monetary incentives and subsidies for new investments if steel companies want to remain in Europe if they deliver certain emissions efficiency standards. This would drive innovation and address the problem of investment leakage which is more serious and not addressed by free allocation. A combination of subsidies and free allocation is the way to address investment leakage, so-called tailor-made compensation measures. We need to develop differentiated approaches for different sectors, again we can use benchmarking to trigger high efficient investments.

5. What is your opinion for introducing potentially border carbon adjustments measures by the EU, what would be the implications?

Economists love but in real world it would not work. The inclusion of the EU aviation is a BCA measure. It failed. It is not an option, at least not for open economies like Europe. The experiment with the aviation crashed so dramatically because of the same reasons put forward for BCA measures. Nobody has been able to present a practical proposal on technical aspects of the BCA such as how it should be designed for primary products, commodities.

6. How do you see the feasibility of using auction revenues and direct compensations for electricity costs and redirect these resources in financing schemes for innovation for

European energy-intensive industries – focus on steel sector? What would be the impact in terms of distributional effects?

It is the way to go forward. You can strengthen this: provision in the broad range of compensation measures. The model for indirect compensation should be based on benchmarking – up to certain levels according to technical level. It is a push side. The benchmarking side is to be used to compensate for indirect emissions costs. Benchmarking is an important element plus additional spending such as the revenues from auctions.

The problem is that compensation addresses a real time problem. Innovation addresses future solutions. There is a gap between the two. There needs to be a bridge gap between the two. This is the main factor for balancing this.

Interview 3 – think tank representative, political feasibility of several policy options for addressing competitiveness and carbon leakage in the European energy-intensive industries

1. Do you think the EU ETS is an instrument for inducing technological innovation?

Studies have found that it has produced some degree of innovation. The question is what drives innovation: price signal, the long-term target? If it is the price signal, it is not clear that the current price is able to trigger lot of innovation. If it is the long-term target: there will be scarcity in the market then of course the EU ETS might be an instrument for inducing technological innovation. It is debatable if the EU ETS is a driver of innovation until now also because of the price experience. It is also a question if the EU ETS is the right instrument to achieve and induce technological innovation.

2. What aspects/elements of the EU ETS would you redesign to induce more innovation in the short/medium-time the European energy-intensive industries?

Innovators react on the price signal, and knowing there will be a long-term sufficient price signal that would make innovation profitable. Instruments to make it clear to market participants what is the price signal on the long-term, price corridors that would increase over time that give a clear signal about the price they will face in the future. This is likely to stabilize expectations of market participants. Companies invest if the long-term expectations are stabilized. Long term targets need to be credible to invest upfront lot of money to trigger innovation. The market and long term targets need to be credible in the eyes of market participants.

The price is not really seen as politically feasible. The market stability reserve: is it able to stabilize expectations in long term and to increase the credibility of the EU ETS in the long-term? I have doubts about this. More research is needed to assess the impact of the market stability reserve. There is little research on impact of market stability reserve on impact and market. It is at early stage.

3. Do you think there should be a differentiation of the EU ETS according to sectors characteristics (e.g. different benchmarking according to sectors, different EU ETS for industry and power)?

The cap remains the same as there is only one market. Different benchmarks open the door to lobbying, not good. Per se, this option should still be researched. It is obvious for some sectors because of technological paths different. Approaches to compensation may differ according to sector needs.

4. How do you find free allocation as a measure of protecting sectors at risk of carbon leakage? How can it be improved to innovation?

The more compensation you give the lower the incentive to innovate. Market price should drive the innovation. Free allocation has a value on the market. As long as they can abate less than the CO2 price they have the incentive to innovate. In theory it should drive innovation even in sectors that get free allocation.

In practice, it may make the urgency to develop innovation less prominent in the company as the company knows they would get the free allocations. Free allocation reduces the incentive to see the need of innovation as being urgent. This is just a hypothesis.

5. What kind of obstacles do you see for introducing potentially border carbon adjustments measures?

I am not an expert on this topic.

6. How do you see the political feasibility of using auction revenues and direct compensations for electricity costs in financing schemes for innovation for energy-intensive industries?

Not a bad idea to finance innovation through fund mechanisms but would the market not be able to deliver innovation without the subsidies for innovation?

You can have an innovation market failure. You subsidise the companies to compensate for high costs.

But subsidising a company if market is functioning anyway then is it not a waste of money? It is important to assess if the money is really needed for the innovation to take place.

If there are breakthrough technologies available, but if innovation is not taking place, subsidies may be a solution but it is important to understand what the drivers are and subsidies may not be the best response.

Interview 4 - academia representative, technological innovation in European energyintensive industries with focus on the steel sector

1. Do you think energy-intensive industries can improve their competitiveness through technological innovation?

Innovation is poorly understood. Decisions taken in companies are complex. They are different from company to company. Regarding carbon price, who will take it into account in the structural decisions in the company? In which of the decision-making process of a company is it taken into account?

Carbon price is only one of the decision factors.

2. What kind of incentives do European energy-intensive industries (steel sector in particular), would need to invest in technological innovation (both in terms of energy efficiency and added-value products)?

For the steel sector, there is no carbon price. Why? Steel companies need to have predictable energy prices. They need a clear technology pathway. Does Europe need steel in the future? Investment decisions are taken for many years in the future. By 2050, steel companies want to know what it going to happen. Policies are vague. The EU ETS is not working. Steel companies want a clear framework until 2050.

3. Which policy/ regulatory areas need to be improved to offer industry actors (steel sector in particular) more predictability for investments in technological innovation?

Long-term energy price is important.

Commitment from European policy-makers that energy price has a certain level. All policies assessed what is the effect on the energy price.

4. How do you see the feasibility of using auction revenues and direct compensations for electricity costs and redirect these resources in financing schemes for innovation for energy-intensive industries – focus on steel sector? What would be the impact in terms of distributional effects?

Industry would accept more than European / member state level to invest in innovation.

5. The steel sector's production and technological paths is also being affected by what is happening in other sectors. Do you think the steel industry could play an important role in the promotion of innovative products in other sectors through taking its own path in innovative products?

There is dependence on steel in other sectors in the low-carbon transition. The sector is searching for new products. Steel companies are dependent on energy and climate polices. If the framework is not clear, they need to find their new ways.

Investment decisions need to be made fast, but it is completely unclear how Europe will move ahead. Clear statements are needed, statement like: 'Europe needs steel'.

6. How do you find free allocation as a measure of protecting sectors at risk of carbon leakage? How can it be improved to induce more innovation?

There aren't so many alternatives.

Border carbon adjustment measures could be an option.

Interview 5 – academia think tank, political feasibility of several policy instruments for technological innovation in the European energy-intensive industries

1. Do you think the EU ETS is an instrument for inducing technological innovation?

The main purpose of the EU ETS is to reveal the carbon price, but not any price. It should reveal a price that allows the best credibility of long term reduction for carbon players. Reduction in the short term as well. Participants need to be aware of and confident in the future scarcity of allowances, so that it induces technological innovation.

We used to have the short term incentive. If the credibility of the EU ETS had not been destabilized as is the case since 2009, it probably would have induced technological innovation. Now there is absence of incentive even in the short term, and there is less chance that long term incentive is perceived as credible enough.

The credibility of the policy is really at the core of the price. If there is no political credibility there is no scarcity of allowances and hence there is no price on carbon. Political credibility of the emission reduction target together with the implementation tools need to be maintained over time so that the constraint is credible. If there is no certainty that the EU ETS is there in 10 years, if there is no credibility in the future policy framework, this affects the price credibility.

2. What aspects/elements of the EU ETS would you redesign to induce more innovation in the short/medium-time the European energy-intensive industries?

The question is how you govern the system to ensure it is taken seriously in consideration. The level of the anticipated future price is very important. The EU ETS is not able to do that at the moment.

There is a governance taboo linked with current EU's more general problems such as taking decisions in general in all policy fields. It is not the proper policy environment for politicians to feel confident enough to strengthen the credibility and policy willingness to ensure the robustness of the emission target constraint over time. The coordination between different objectives of the EU was not properly ensured between 2008-2012. As such market participants realized there was no need for a carbon price in the short term, and that threatened the credibility of the longer term constraint. The RES deployment, energy efficiency and the access to international offsets influenced the carbon credibility.

There are other things that happened in the meanwhile. The energy intensive industries look at wide range indicators in their investment decisions such as labor, capital, energy and carbon costs. If the governance of the EU ETS is not strong enough, the industries will neglect

the CO2 price compared to other parameters. In the current setting, labour, capital and energy costs are the main decision parameters of companies.

It is not sure that we learned all lessons from past, from the two first phases of the EU ETS, for example, concerning the coordination of the ETS with RES support policies. There are no binding targets on RES in the proposal for a 2030 climate and energy package. This doesn't give real visibility on the policy package that will achieve this emission reduction and renewable deployment. There are various approaches in different countries. Also problems occur because of lack of coordination and harmonization among countries. The energy market is one of the priorities of the EU. There may be some ways to better implement coherent policies between member states. The UK has a unilateral carbon policy. This depresses the carbon price signal for the rest of the EU. The EU ETS should be corrected over time as new policy interactions manifest.

Energy intensive industries feel scared by the carbon costs. Political credibility of targets and the coordination between the tools to achieve these targets will affect the carbon price because allowances have no reality, it is just a paper from politics. It is less physical and tangible than commodities. In the current framework, it is less powerful to influence decisions. As a lobbyist you know you can have a greater influence. The carbon price is in the end the credibility of the political target for reduction and the coordination of tool for achieving it. In the oil industry, although politics can have a strong influence, there is a certain physical amount in the ground, but when we are to consider the supply of carbon emissions, this is based purely on political decisions. It is based on directives, decisions, regulations, reports and studies from experts. There are benchmarks, caps, offsets that can be discussed. In the end, these are variable parameters. It is a question of credibility of political decisions. This is less robust because it is dependent on a vote and all the legislative process. The carbon price as such is more vulnerable to political pressure from lobbyists.

It is a real question if we want to have a price of carbon in order to develop new technologies and use the advance of RDI and export the innovation through value-added products produced in the EU. The business of innovation is there. Can we shift to low carbon technologies and become suppliers for the rest of the world? There is a need of other commitments from other parts of the world so that a global demand for such technologies and services arise.

3. Do you think there should be a differentiation of the EU ETS according to sectors characteristics (e.g. different benchmarking according to sectors, different EU ETS for industry and power)?

The EU ETS was created for mixing different participants so that the global cost is minimized. If you split the market in two, etc, then in theory it will be less efficient than one market. It cannot reduce emissions at least cost. There are sectoral differences, but also size differences. There are small industries and also small energy plants. There are many ways of splitting the market. But this is not a good idea as it would mean going back and not forward. On the contrary, economists encourage the extension of the scope of the EU ETS.

4. How do you find free allocation as a measure of protecting sectors at risk of carbon leakage? How can it be improved?

In theory you don't threaten the emission reduction incentive when you give free allocation. There is a difference between the carbon price on the market and installations' own emissions reduction costs. Allowances for free don't change the carbon price. Free allocation is just a compensation measure. It does not change the reduction incentive. The reduction incentive comes from the cap. Free allocation changes the total cost of compliance. But decisions to reduce emissions depend only on installations' own reduction costs. There is an opportunity cost linked to the carbon price when firms are able to reduce emissions: reducing emissions means buying less allowances or keeping allowances that would have been used instead. In any case installations have an incentive to reduce emissions given a certain CO2 price on the market. It gives same incentive whether allowances are given off free or auctioned. It is up to member states to decide what share of the total allowance value they want to have through auctions, and what share they give to industries in the form of free allocation.

There is a discussion in Europe, that free allocation to be dynamically linked to growth. But the problem is if the production rises you give more allowances than the cap. It can be seen as environmentally dangerous. We don't have to be absolute definitive with industry. We don't want industry to leave but also need to give them a strong signal and an incentive to evolve in a world where they can evolve their business in a context of carbon price.

Benchmark gives incentive to go to BAT. This is a good way. All industries will resist to measures for less free allocation. But companies should look at their own carbon reduction costs. Companies' decisions should depend on carbon reduction costs and not on free allocation. Free allocation should not be understood as a specific target for each installation, like their own objectives. It should not work like this. Final emissions should depend on the comparison between the carbon price on the market and their own reduction costs; but not on an amount of allowances received. Free allocation is a compensation that can come only on top of that principle.

Industry can be compensated, but rules need to be clear. And information should be made more transparent, for example with a European observatory of low-carbon technologies, monitoring and reporting to the market what the progress of industry is in terms of abatement linked with carbon incentive and not with other things. But people so far just complain about energy costs. They don't look at the carbon price but at the energy cost side.

5. What kind of incentives do energy-intensive industries need to introduce technological innovation?

Incentives don't come always from price incentives. Business strategies are important. The market is changing. Companies should adapt to market changes.

Industries are maybe a bit stuck in the past. They don't see the future of their business. There is a business outside Europe, especially in developing countries. They should account for

development of countries and innovate. The mistake is to look to the past rather than look at the future. There are many incentives.

The patents policy can also foster innovation, RDI spending, update plans regularly for next 10 -20 years, creating a product that has a new demand. The need will develop as well outside EU. But we in the EU should be the first to create our own product.

6. What kind of obstacles do you see for introducing potentially border adjustments measures?

Technically, it is complicated to measure the carbon content of products: how much carbon, where and how it is produced.

Carbon price generating policies outside of Europe are better. BCA would generate complex issues. BCA are not constructive measures. They do not really incentivize other countries to go into climate friendly business, at least not in a friendly and open way. WTO and UN should work on the comparability and coordination/harmonization of climate policies across Parties which could solve or temper a lot of potential problems if carbon prices generating policies spread outside of Europe.

The second problem is how does it merge with WTO rules?

7. How do you see the political feasibility of using auction revenues and direct compensations for electricity costs in financing schemes for innovation for European energy-intensive industries?

Politicians decide how to share the revenues from carbon. Money can take the form of free allocations and money can be used for direct or indirect compensations. A MS has to decide how many allowances for free and how to distribute revenues from auction. Economic theory says that an optimal setting is to auction all allowances and use to revenues to reach a "second dividend" in the form of reduction of other taxes (more distorsive). The first incentive is through carbon price and second incentive comes from tax rebate incentives. This is not the way MS see things for the moment in the current framework. You have to adapt and give allocation free to those who want them or have to offer finance schemes to others. There are various actors, various needs. It is a decision at MS level to which players to give and how money to be distributed. The money collected from auctions does not disappear, and it has to be used for something. Either spent on specific targets, for reducing deficits, or lower other more distortive taxes, e.g. taxes on labour or capital. One important point is that it should comply with State Aid rules if used to transfer wealth to specific industries. Now that grandfathering is replaced by benchmarking, there is less political influence on free allocation. There is less power from MS to influence free allocation. But on the other side, MS get revenues from auctions and they can now choose how to spend this money: it is the same question, but in a different way.

Direct compensation for electricity costs has to be transparent. Some body at EU level should monitor and report about this in order to know what the use of the revenues in the MS is. If this impacts electricity prices, there can be distortions of competition. It is a source of tension between Member States. There should be more transparency.

Interview 6 – legal expert on EU state aid rules for environment and energy

1. What do you think will be the impact of the Guidelines on environmental and energy aid for 2014-2020 on the competitiveness of European energy-intensive industries?

I think that for the European energy-intensive industries, the guidelines are positive. There are many exemptions for the industry, for example member states are allowed to grant exemptions to industries for cost for supporting renewable energy. In Germany, regarding the feed-in tariff, there is a calculation of the cost at central level and then carried forward to consumers. The energy-industries have been exempted and until now this has not been allowed under the state aid rules. In the new guidelines, this is explicitly allowed for energy-intensive industries, also for the CLL sectors. The EC said that in countries where there have been exemptions, the guidelines are applied retrospectively. The energy-intensive industries don't have these costs anymore. This increases the competitiveness on the international stage.

There are also exemptions for environmental taxes – that have a negative tax base – aiming to change the behavior for more environmentally friendly. Under the guidelines, member states are allowed to grant exemptions. The argumentation is: this tax might increase the burden on the CLL sectors. This might be too high burden. Member States need to be allowed to give exemptions, again the energy-intensive industries become more competitive.

Regarding the competition law argument, in principle state aid is not allowed. It creates barriers to competition as it disturbs competition. It is only allowed if a common objective wants to be achieved, the environmental objective. Even if state aid is allowed it has to be designed in such a way not to distort competition. The measure has a limited impact on competition. It should be adequate to the objective to be achieved but cannot go further than this. In previous guidelines, this obligation was much vaguer, while in the existing guidelines this is much more stressed – that the obligation imposes no harm than necessary on competition. The current guidelines look more to competition aspects.

The argument on exemption on environmental taxes that some exemptions are necessary to impose environmental taxes, there are some authors who argue that the amount of competitiveness gained is not as significant as some others would think.

The problem with the guidelines is not on energy-intensive industries but more the problem is that the guidelines do not enough support sectors that need to be developed in order to support the structure of the future energy market. The guidelines could have been more

supportive on demand response on energy-intensive industries, on RES (the argument is that they should be more competitive.)

On the general aims of the guidelines it is questionable if it achieves the aims, but positive on the energy-intensive industries.

Regarding internal competition distortion, the guidelines are not a harmonized instrument, this is not the aim. The harmonization argument, this has been mostly discussed about the RES.

It will not lead to a more harmonized energy price in the EU. We are far away from an internal energy market.

2. What do you think will be the impact of the Guidelines on environmental and energy aid for 2014-2020 on the environmental effectiveness of the EU policies – mainly in relation with achieving the long-term 90% GHG reduction by 2050?

There are so many exemptions for the polluting industries, this is very worry. The energy-intensive and high carbon industries can receive so many exemptions. This is not understandable if you look at the EU goal by putting the burden of the costs in on those who are less polluting. In Germany, more and more consumers are complaining about higher energy prices. Households and smaller SMES don't get the exemptions. The big ones get the exemptions, this does not have sense.

It really again depends on how the EC will interpret the guidelines. You feel that they are going in the right directions, - like for capacity mechanisms – but one cannot predict how it will be applied. There are not clear-cut criteria. There are lots of criteria which can be argued in both ways. Either DG Competition works with DG Energy on policies, then the guidelines are positive, that also promote good and sustainable energy policy. If member states are driving – then this is the worrying incentive – such as invest in industries that we don't need in future and create huge costs.

3. What kind of environmental and energy aid do you think it would induce more investments in technological innovation in the European energy-intensive industries?

It would be better if the energy-intensive industries to become energy efficient and make use of their demand response potential then it can also increase their competitiveness in the end. In the US, demand response is so huge, it has an impact on the wholesale energy market price. There are intermediary companies — utilities— which buy the possibility to switch on and off the machinery of a certain undertaking according to demand and response needs.

There should be given more incentives to invest in demand response or energy-efficiency than to give incentives to carry on with energy consumption as now, then energy-intensive industries in EU can become more competitive.

4. How do think the forms of aid granted by member states should be so as not to distort internal competition within the EU – with reference to the case of European energy-intensive industries?

At a certain moment we might go to a harmonized system but not yet the moment.

5. How do you find the political feasibility of redistributing direct financial compensations for electricity costs in funding schemes for innovation in European energy-intensive industries? Would there be any legal constraints to such an approach if this is done at Member State level?

The guidelines for environment and state aid say that the industry needs to do something in response: e.g. voluntary agreements for energy-efficiency or to do something for the environment.

From a legal point of view, if industry gets an exemption but also pays for an RDI fund, it always needs to be in the context of guidelines of state aid for environment and energy. Legally this is feasible. Politically is also feasible because the industry also benefits from the fund. Industry pays into a fund only if they benefit but this forces them to use the money in a beneficial way to also protect the environment.

Interview 7 – think tank policy expert on energy intensive industries and steel sector

1. What do you think is the link between energy prices in Europe and carbon leakage in the European steel sector? To which extent do you think energy prices represent an important factor for investment relocation of the European steel sector?

Energy prices represent a factor but this also depends on the size of the plant. For some companies it is an important factor, but there are also other important factors, like location, supply for raw materials. For some companies the supply of raw materials can be more expensive than the energy price factor.

It also depends on the conditions of the plant and product mix and margins.

For block steel industry, the energy price is important. For plants for high quality steel that have higher margins, energy price factor is less important. Production path is important in relation with energy prices.

2. What policy measures do you think should be implemented at EU level that would support the European steel sector to invest in breakthrough innovative technologies for energy and industrial processes efficiency?

Innovation support is important but it is already there to some extent.

Steel industry has to specialize more. They are in hard position to compete with steel from outside Europe, from countries and regions like: China, Indonesia, low-cost countries.

If the European steel sector wants to stay competitive, it needs to find new markets, other qualities of steel. There is high-knowledge in Europe, but the European steel sector is still looking at old days when they could make money from volumes (not all companies though).

The EU should help steel sector innovate. The focus should be on innovation. It should support deliver steel in new markets, find new markets of high-quality products, supporting in entering new markets. It should help steel industry refocus their activities.

There should be not only R&D support but also help implement and sell new technologies to customers;

3. What do you think are the challenges of the steel sector in going for a production route that would require less carbon intensive inputs?

Challenges are money needed to develop a new technology. It is very expensive. They need money to invest and develop these technologies.

The steel sector is under pressure, there is no money to invest. The steel sector (European) is rather conservative. It has improved but still why change?

There are some companies that are less conservative like Swedish companies. They are trying to find new routes, to invest in downstream activities. They work together with clients. Also the organizational model of the company: people talk to people around in Europe so that products are according to quality demands of clients. It is innovation.

You also need development in other sectors. CCS is still a technology to be proven. For example, in the power sector, if proved, then the steel can also implement this technology.

4. How do you find the political feasibility of using auction revenues and redistributing direct financial compensations for electricity costs in funding schemes for innovation in European energy-intensive industries?

Don't know, might be an option.

First, it is a good idea if try to use revenues to invest in innovation for making available new technologies in future. It is a good thing.

Regarding compensations for electricity cost, it is always a problem: not all member states do it. In steel industry some EAF are using this. There is huge difference in what they get in the steel industries. EAF would like to have state aid. They are more aiming at level playing field, making it equal for all Europe.

5. What aspects/elements of the EU ETS would you redesign to induce more innovation in the short/medium-time the European energy-intensive industries?

Over-allocation should be stopped. Now the steel industry has too many allowances, there is no incentive to do something about energy efficiency improvements.

Decrease the cap, less allowances for free.

Energy is a very important cost factor. They will do a lot to reduce energy use so that they can resist on the market. They need to invest a lot in energy efficiency. More factories will close down, only small parts will really invest in energy efficiency improvement. That is why European steel sector is really exposed to carbon leakage.

6. How do you find free allocation as a measure of protecting sectors at risk of carbon leakage? How can it be improved to induce more innovation?

The problem with the EU ETS is, it does not stimulate innovation. It will reduce emissions not now but in couple of years, in 5 to 10 years. The EU ETS and higher carbon price will only enforce existing technologies. EU ETS is not an instrument for innovation. There are other instruments for innovation.

7. What kind of other measures do you think could help improve the competitiveness of the European energy-intensive industries – with a focus on the steel sector- and avoid carbon leakage?

Now there are separate packages at EU level: climate, energy, innovation. What DG climate says is not always backed by DG Enterprise.

Energy security strategies represent a good direction. It ensures a certainty of supply of cheap energy in Europe.

Energy should be linked to the climate package, same goes with innovation, more integrated in what needs to be achieved on the climate field.

An industrial policy is lacking. There are some documents but should be more active in relation with energy and sustainability. There could be a discussion platform to see the reactions for the solutions, to involve many stakeholders, to make sure at least we talk about this.

It should be pushed harder: where energy intensive industries to be, how can help energy intensive industries achieve climate goals. Make sure that all is aimed for the same goal.

Questionnaire 1 steel sector representative

- 1. What do you think are the main factors that would drive investment leakage in the European steel sector?
- High energy prices in Europe, low prices in USA, Asia, ...
- Stringent ETS System in EU
 - 2. How this issue could be addressed by the EU in your opinion?

It is already addressed to the EU com., but there is no real reply. Some good reaction arising for the EU-Steel action plan, but this in predominantly address to the Member states; but from there you don't see only a few (smaller) actions.

3. What measures do you think should be implemented at EU level that would support the European steel sector to invest in breakthrough innovative technologies?

We need an (international) level playing field and real competitiveness in and around Europe. For breakthrough and innovative technologies we need some time (10 to 20 years) and some research fundings by the EU and MS-governments.

4. What factors are important in the steel sector to go for a production route that would reduce significantly the use of carbonaceous fuels inputs?

For the integrated steel production route there is no way out of carbon uses (use of coal, coke for the whole energy-supply in the integrated plant); share in Europe is about 70 %. The EAF-route runs only with scrape; share in Europe is about 30 %. But most of the steel scrap has produced before via the integrated route. So far there is no alternative in steel production. The news routes (DRI,) are so far not profitable/ feasible due to the missing competitiveness. There are so fare mostly small or pilot plants.

5. What do you think are the challenges for a high value-added steel production in the EU and how could they be overcome?

Competitiveness – competitiveness – competitiveness in and around Europe.

6. How do you see the feasibility of using auction revenues and redirecting financial compensations for electricity costs in financing schemes for innovation in the European steel sector as a measure of supporting competitiveness?

We need competitiveness in and around Europe – also for electricity and for climate issues. Due to the high energy prices in Europe there will be an investment and carbon leakage out of Europe.

7. What is your opinion for introducing potentially border carbon adjustments measures by the EU, what would be the implications for the European steel sector?

Border carbon adjustments along Europe borders will not increase any global competitiveness. This will led to new trade restrictions – also for the steel sector.

8. What is your opinion on a potential international sectoral technology based agreement in the steel sector?

We need competitiveness in and around Europe – so may be an international climate treaty could help to solve some of the problems. But the practical experience shows us, that "some countries" will help their own industrial sectors more than other.

9. Do you think it would lead to spillover emissions reductions technologies and best practices globally?

The best technologies (for production and emission reduction) will finally win the race. But so far there is no competitiveness in and around Europe. For new breakthrough technologies we need ten to twenty years more time for research and realisation of the new results.

Questionnaire 2: answer from a steel representative on implementation of the demandresponse measure in the steel sector

1. What do you think are the limitations of applying the demand-response measure in the steel industry?

Demand response is more related to reducing the electricity price than the consumption of energy. However there are technological limitations because the production cannot be easily stopped in the steelmaking. Its applicability depends on the type of products. It may be more easily implemented in the automotive industry, because it is easier to stop the production but in crude steelmaking the installation cannot be stopped when the installation works at its maximum capacity. It is not cost-effective.

As a steel company we are not interested in the type of source of energy in the energy system but in the energy price package. For sure, if renewable sources are to have a higher share in the electricity mix in the future, it is an interesting measure to take into consideration.