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Åhman, Max; Nilsson, Lars J

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PO Box 117
221 00 Lund
+46 46-222 00 00

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Chapter 5: Decarbonising industry in the EU - climate, trade and industrial policy strategies

Max Åhman and Lars J. Nilsson¹

Environmental and Energy Systems Studies, Lund University

Introduction

Decarbonising society poses both threats and opportunities for the manufacturing industry. For the industry that manufactures end-user products, decarbonisation presents a potential to innovate higher added value clean-tech products and to expand into new ‘green’ markets. For the energy intensive industry (EII), that produces mainly basic materials such as steel, cement, aluminium and basic plastics, the opportunities are less obvious and the challenges greater.

The EU objective to reduce GHG emissions by 80 to 95 per cent by 2050 relative to 1990 includes a suggested industry sector ambition of 83 to 87 per cent reduction (European Commission, 2011a). To reach such near zero emissions in the EII entails major technological shifts that are still relatively unexplored. It appears much more difficult for the EII than for other sectors, not least from an economic and policy perspective (Nilsson et al., 2011; Åhman et al., 2012).

Technical options for decarbonising energy supply, buildings and transport are better understood or developed, and these sectors and their markets are much less exposed to international competition than industry. Industry operates in markets where ownership and value chain structures are increasingly global and integrated across continents, and competition is increasing from emerging economies (European Commission, 2013a).

Parts of the manufacturing industry, for example, consumer electronics, develop products with life-cycles of two to three years and sometimes even less, with corresponding retooling. In contrast, investment cycles of 20 to 40 years are not uncommon in the energy and capital-intensive industries and technical life times for equipment may extend beyond that (Lempert et al., 2002). Thus, investment decisions and strategic development efforts made today partly determine the options and room for manoeuvre for industrial emission reductions by 2050.

Industry in Europe is increasingly recognising the need for a low-carbon transition. Sector roadmaps have begun to explore the challenges therein. But there is still considerable uncertainty concerning how goals can be reached and a transition governed. The long-term risk of carbon leakage in an EU decarbonisation scenario, and the capital intensity and other characteristics of the EII, force policymakers to consider two

contested and difficult issue areas: trade barriers through import tariffs or carbon border taxes and targeted industrial development policies.

In this chapter we analyse the challenges for decarbonising industry, with a focus on the capital and energy intensive basic materials industry. The next section provides a brief overview of the industrial sector, its energy use and emissions. The following section reviews the technology options and potential implications for the overall energy system of decarbonising industry. Next, we describe and analyse the current policy landscape of energy, climate, trade and industrial policy. We then assess the functional overlap, political will, societal interest and current institutional set-up, which provides the basis for finally discussing what is needed for an integrated policy strategy.

1. Manufacturing and the energy intensive industry

Industry is an important part of the climate problem because of its emissions. It is also an important part of the solution since it will produce the low-carbon technologies that are needed to decarbonise in all sectors. The manufacturing industry in the EU accounts for more than 16 per cent of GDP; consists of more than two million enterprises; and employs more than 30 million people (European Commission, 2013a).

Manufacturing begins with materials that are transformed in diverse, complex and geographically dispersed value chains until reaching an end-use market and thereafter the end-of-life market (waste/recycling). The industrial sector is, to various degrees, integrated across the value chains from primary materials to end-use products. It includes light industries, such as specialised manufacturers of high-tech products with high value added and relatively low emissions such as pharmaceuticals and electronics. It also includes the EII, including producers of basic materials with high energy and carbon emissions intensity, such as steel and cement. The definition of the EII varies, but according to the EU definitions used in the energy tax directive (2003/96/EC), this sector accounted for about 2.1 per cent of GDP and employed directly 3.7 million people in 2004 (Bergman et al., 2007).

When analysing the prospects for decarbonising industry it is necessary to distinguish between the EII that produces basic materials and the lighter manufacturing industry. The opportunities and challenges in a low-carbon transition differ substantially between them.

For down-stream light manufacturing that finishes or assembles intermediate and final products, the main challenge in a low-carbon transition is the ability to innovate new products and adapt to a new and future 'green' demand (for example, for energy efficiency, electric mobility and resource efficiency). Moving towards a decarbonised EU in 2050 will create market demand for new climate-friendly products associated with low-carbon energy sources, their supporting systems and infrastructure, smart grids, passive housing, electrification of transport, and energy storage technologies. A low-carbon transition will thus provide many opportunities for innovative firms to develop and expand into new markets. This sector can more easily pass through potential cost increases from carbon neutral energy supply since energy is typically a small share of production costs.

Down-stream manufacturing requires high quality basic materials from the up-stream and energy intensive part of the value chain that produces materials such as cement, steel, aluminium, organic chemicals (such as ethylene for making polyethylene) and nitrogen fertiliser. In this sector, the challenges of decarbonisation

are greater since energy constitutes a considerable share of production costs and major changes in basic process technologies may be required. Petrochemicals need to be replaced with chemicals from other feedstock. When going beyond marginal emission reductions, there seems to be relatively few, if any, co-benefits from decarbonisation.

Reducing emissions to near zero in this industry sector, through carbon capture and storage (CCS), or switching to non-fossil fuels and feedstocks, is likely to result in substantially higher production costs. Higher prices for metals and other basic materials are unlikely to be a problem for the economy. The EII accounts for only a small share of GDP and the cost-share of basic materials in finished products is generally small, indicating that cost increases can be absorbed. The problem is that, all else being equal, high production costs threaten international competitiveness and may lead to carbon leakage (that is, when production is relocated to countries with less costly climate policies).

The EII may seem unimportant from an economic and employment point of view (Neuhoff et al., 2014), but materials are essential to the economy and for reducing emissions in other sectors. The possibilities for substitution by less energy intensive materials are often limited and substitution through imports leads to carbon leakage. An argument forwarded by industry for maintaining production capacity of basic materials in Europe, in addition to employment and carbon leakage, is that the geographical proximity between different stages of the value chain is important for innovation in materials and product development. The importance of this link between low and high added value industries and innovation has some theoretical and scientific support (Boschma, 2005; Hansen & Winter, 2011).

1.1 Energy use and emissions in the EU industrial sector

Industry used 3,370 Terawatt-hours (TWh) of energy in 2010, equivalent to about 22 per cent of total final energy use in the EU. The major share of energy used is electricity (30 per cent) and natural gas (29 per cent), with smaller shares of renewables (7 per cent), oil products (11 per cent) and coal/coke (13 per cent). The energy use is concentrated in a limited number of EIIs that account for a major share of industrial energy use (about 70 per cent) and emissions (Lapillone et al., 2012). In addition to this, industry uses another 1,190 TWh of fossil fuels for ‘non-energy consumption’ – mainly naphtha, natural gas and other petroleum products as feedstock for producing, for example, plastics and nitrogen fertiliser.

Industry emissions directly account for about 20 per cent of total CO₂ emissions in the EU. Emissions from industry originate from the combustion of fossil fuels, emissions from the process itself, and indirect emissions from the use of electricity (usually reported as power sector emissions). Process emissions occur when producing cement (converting calcium carbonate to calcium oxide), iron (which involves carbon monoxide to reduce iron oxide to elemental iron), and aluminium (where electrolytic reduction of aluminium oxide consumes the carbon anodes). Combustion of fossil energy is the main source of CO₂ emissions, but more than 25 per cent are process emissions (see Figure 5.1).

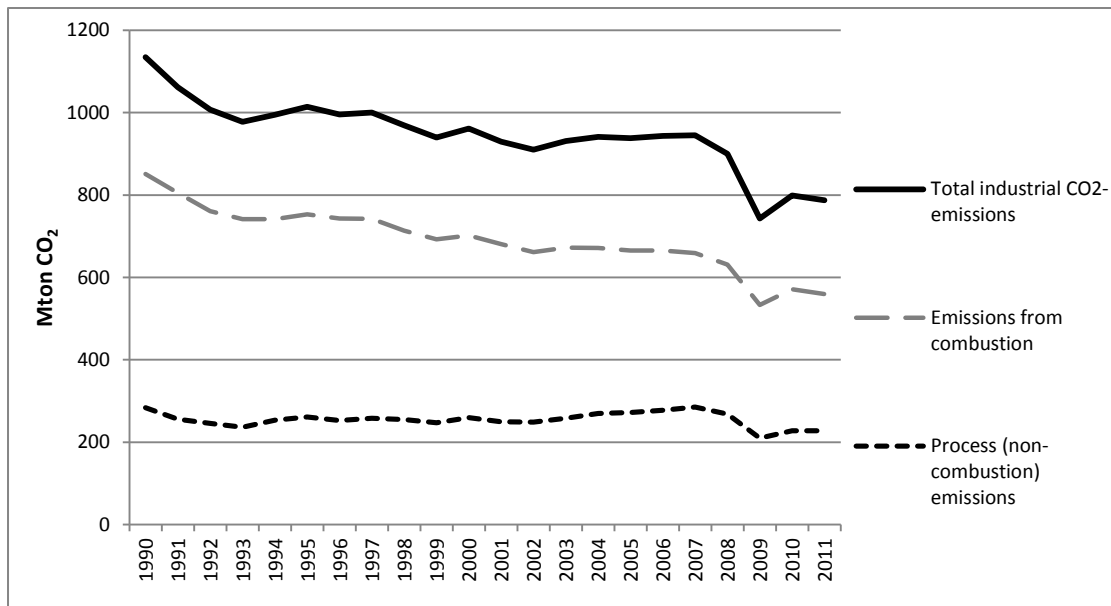


Figure 5.1: Industrial CO₂ emissions in the EU-28. Note: Not including indirect emissions from purchased electricity or other energy carriers. Source: Adapted from European Commission, 2013b.

Total CO₂ emissions from industry have declined since 1990 (Figure 5.1). The reductions are mainly attributed to increasing energy efficiency and fuel shifts (Lapillone et al., 2012). As shown in Figure 5.1, the process emissions that are directly linked to production volumes have not decreased much. There have been some changes in activity (that is the number of tonnes produced) and structure (the relative share of products) that have reduced process emissions but these changes have only had a limited impact on the overall trend (Lapillone et al., 2012).

Long-term forecasts for basic materials show relatively stable production levels to 2040 and beyond (IEA, 2013). New production capacity will mainly be added in developing countries where demand for basic materials is growing due to industrialisation. Demand for some materials, for example, cement and steel, appeared to level out in China in 2013, but production is expected to continue to increase in India (IEA, 2013).

2. Towards decarbonisation of industry

In 2011, the European Commission published a ‘Roadmap for moving to a competitive low-carbon economy in 2050’ (European Commission, 2011a) combined with an ‘Energy Roadmap 2050’ with a focus on the energy sector (European Commission, 2011b; see also Chapter 1). Since mitigation options and challenges are specific for each industry sector, the European Commission expressed the need to develop roadmaps in cooperation with the industrial sectors concerned. Since then, and encouraged by DG Enterprise, industry associations in the EU have developed their own roadmaps to present their views on the technical opportunities and challenges as well as the policy implications. So far the paper industries (CEPI, 2011), chemical industry (CEFIC, 2013), steel association (Eurofer, 2013), glass association (Glass for Europe, 2013), cement association (CEMBUREAU, 2013), and the aluminium association (EAA, 2012) have published their own roadmaps for 2050.

In the short to medium term, the main mitigation options are to improve energy efficiency and to shift to less carbon intensive fuels, for example, from coal to natural gas and from natural gas to biofuels. In the IPCC Fifth Assessment Report, it is estimated that energy intensity in industry can be reduced by up to 25 per cent through wide-scale deployment of best available technologies (IPCC, 2014). We estimate that the short- to medium-term mitigation potentials range from 10 to 30 per cent for EII. This estimate is based on Åhman et al. (2012), the IPCC report (2014), and the industrial roadmaps listed above. It includes energy efficiency and fuel shifts that require adoption of best available technologies, often with co-benefits, but no fundamental changes to existing core processes.

The Commission and the industrial roadmaps are less detailed on the long-term technical options and provide only rough sketches of the development post-2030. A common argument from industry is that emission reductions beyond 50 per cent require development of ‘breakthrough technologies’, including solutions that are neither technically mature today nor cost-competitive without a high price on CO₂ emissions. CCS is put forward as a key back-stop² technology in both the European Commission’s and the industry’s roadmaps, despite uncertainty concerning the feasibility of CCS (see below). Compared to the Commission’s roadmaps, the industrial roadmaps recognise and provide more examples of the non-CCS options (such as electrification and new materials), and most of these involve major shifts in core process technologies.

2.1 Long-term technology options

The performance, costs and other characteristics of low-carbon technologies are important for understanding the prospects for a new institutional set-up. In addition to CCS, the potential energy carriers and energy sources to replace fossil fuels in the EII are limited to bioenergy and electricity from renewables or nuclear energy. For decarbonising the EII, attention must also be given to the process emissions and the potential end-of-life emissions from products that contain carbon of fossil origin, such as petroleum based plastics.

For the EII, three broad technical strategies for decarbonising the production processes can be identified:

- *Biomass as fuel or feedstock:* Biofuels can replace fossil fuels in most processes and be used as feedstock for producing bio-based chemicals and materials, such as polymers. Biomass is readily available in the pulp and paper industry and has already replaced much oil use. If used in cement production, emissions can be reduced by about 50 per cent but the process emissions from calcium carbonate conversion remain. In principle, bio-coke can replace coal-based coke for reducing iron oxide to pig iron. But biomass and land is a limited resource and there are competing uses (for food, feed, fibre, chemicals, and so on) and conflicts with other environmental objectives such as biodiversity and recreation. Bioenergy accounts for about 50 exajoules, or ten per cent of current global primary energy use. The potential 2050 deployment levels have been estimated at 100 to 300 exajoules (IPCC, 2011) so the contribution compared to future global energy demand is limited.
- *Carbon Capture and Storage:* CCS for industrial application can reduce a large share of industrial emissions including process emissions. But applying CCS to industrial facilities, especially existing ones, is more complicated than applying CCS in the power sector. An industrial plant typically has several different

source emissions with differing concentrations and the physical space for post-process capture CO₂-scrubbers may be limited. Currently proposed technologies do not capture all the CO₂ in the flue gases and they increase the consumption of heat and electricity. To capture more than about 80 per cent of all emissions from an industrial plant with CCS will require deeper integration into the core production processes. However, there are also some 'low hanging fruits' in terms of relatively pure CO₂-streams in some industrial processes. Many issues remain concerning CCS, including technical challenges, costs, large-scale infrastructure needs, legal aspects and lack of public acceptance (see Chapters 1 and 3).

- *Electrification:* Electrifying the process completely, or using hydrogen, is a radical solution that could rid the industry of fossil fuel related emissions. A number of electro-thermal processes for industrial heating in different temperature ranges are possible (using, for example, microwaves, infrared radiation or plasma). Hydrogen from electrolysis can be used for reducing iron oxide or replacing hydrogen from natural gas in fertiliser production. Through co-electrolysis of water and carbon dioxide, or by reacting hydrogen with carbon dioxide, a synthesis gas (mainly CO and H₂) can be produced from which a range of hydrocarbons and platform chemicals can be produced. Such 'power-to-gas', 'electro-fuels' or 'electro-plastics' processes are technically possible but relatively expensive. Industrial emission reductions from electrification rest on the assumption that electric power supplies are fully decarbonised (see Chapter 3).

In addition to these three basic options, conventional cement may, in principle, be replaced by alternative cements (for instance, by magnesium based cement) or other building materials – eliminating the process emissions from calcination. For aluminium, research is ongoing, and has been for a long time for purely economic reasons, to develop inert anodes that would not cause process related CO₂ emissions from the depletion of the anodes, but the prospects for a breakthrough are uncertain.

On the issue of functional overlap we make the observation that CCS has no co-benefits in the EII since it is less expensive to release CO₂ to the atmosphere than to capture and transport it to final storage. Electrification and hydrogen may offer some process advantages but these are largely unexplored and they are likely to be trivial compared to the increase in energy cost relative to continued use of unabated fossil fuels. The bio-based industry is a more complex and interesting case. Decarbonisation of transport will reduce demand for petroleum-based fuels and support the development of bio-refineries. At the same time, weak demand for some paper products is prompting the forest industry to look for new markets. Petroleum-based chemicals and materials will also be replaced eventually.

2.2 Co-evolution and interdependence with the energy system

The EII transforms and processes huge flows of materials that contain carbon (coal, oil, natural gas, and biomass) for energy use as well as for use as raw material and feedstock. Changes in the use of energy and feedstock will have considerable implications for the rest of the energy system depending on which routes to decarbonisation are chosen. Historically, the EII has co-evolved with the economy as a whole and with the development of energy systems. The European coal-steel nexus, the merger of the chemicals and petro-industry after World War I, or the early uses of hydroelectricity to power new industries are some examples (Kaijser & Kander, 2013; Bennett & Pearson, 2009). For example, petroleum refineries in their present

form are set to decrease production as an effect of climate policy. This will have implications for the chemical sector that relies on refinery by-products (for example, naphtha) as feedstock.

Sustainability concerns are already pushing the introduction of bio-based chemicals and fuels. Emerging bio-economy solutions for producing biofuels, chemicals and electricity could induce a stronger integration of sectors such as agriculture, forestry and chemicals but also increased competition for biomass. It is an open question whether the petrochemical, forestry, or some other industry will be the champion of the future bio-based economy.

Electrification of processes or a shift to hydrogen for instance, in steel and industrial heating, could lead to very large increases in total electricity demand. Such technology shifts will have profound energy system implications. Electrifying EU primary steel production alone would require an additional 380 TWh of electricity per year, equivalent to about 13 per cent of present total EU electricity demand. The total use of fossil fuels for 'non-energy consumption' which, as noted, amounts to 1190 TWh in energy terms needs eventually to be replaced.

3. The policy framework for governing industrial emissions

The climate policy debate has mainly been concerned with marginal emission reductions and costs and benefits in the near term (such as, the Kyoto Protocol or 2020 targets). The need to develop integrated policy strategies for a low-carbon transition in industry is a relatively new issue that has emerged as a result of the 2050 objective. Here, we describe and analyse the framework, as of 2014, for governing an industrial low-carbon transition. The key policy domains in this include climate and energy, trade, and industrial policy.

3.1 Climate and energy policy

Industrial GHG emissions are mainly regulated via the EU Emissions Trading Scheme (ETS) that puts a cap on emissions within the EU. The Industrial Emissions Directive, IED (2010/75/EU) is a complementing regulation which is the basis for granting and updating industrial permits at the national level. The Industrial Emissions Directive takes an integrated approach (that is, the whole environmental performance of the plant), based on best available techniques, and allows flexibility to avoid subjecting plants to disproportionately high costs. In principle, the Industrial Emissions Directive could be used for regulating emissions at a lower total cost to industry (Johansson, 2006), but in practice the ETS is the main instrument for emission reductions in heavy industry.

The ETS includes all major industrial GHG-emitting facilities including heat and power production. Installations included in the EU ETS under the emission cap will, by definition, collectively reach the targeted reductions. If the EU is to meet its ambitions of 80 to 95 per cent reduction by 2050, the reduction rate of 1.74 per cent per year until 2020 needs to be increased. Discussions concerning new targets for 2030 that are aligned with the 2050 target are ongoing as of 2014, including an increase of the reduction rate to 2.2 per cent per year (European Commission, 2014a).

Under a tight and long-term emission cap, the real issue is not if the targets will be met, but how and at what cost. For industry, different outcomes are plausible and strongly dependent on complementary policies and other societal goals. Reducing emissions can be achieved by reducing output (and importing

from abroad thus causing carbon leakage), by technical measures (often costly as discussed above), and through reductions in consumer demand for basic materials. The costs and future directions for mitigating GHG emissions in the industrial sector are also strongly influenced by energy policy at the EU and national levels.

The primary objective of the ETS is to reduce GHG emissions. However, a secondary objective is also, as a price-based mechanism, to promote improvements and thus innovation and adoption of new technologies. The price signal given by the ETS is important for providing economic incentives to mitigation measures but mainly through incremental technical changes. There is relatively broad consensus (see for example IPCC, 2014) that a carbon price alone is insufficient to support and induce the long-term technological shifts that are required. It needs to be complemented with policy instruments targeting technology development, demonstration, and up-scaling (Hanemann, 2010).

In 2008, the EU launched the climate and energy package in an effort to integrate these two policy fields, expressed through the 20/20/20 targets (Chapter 1). From the perspective of industry, the effect of the ‘energy component’ of the package (including specific targets for energy efficiency and renewable energy) has been to reduce the mitigation costs by reducing the price of emission permits within the ETS. So far, the EII is largely exempt from the costs of support schemes for renewable energy sources (RES) and can usually benefit from energy efficiency policies (Ericsson et al., 2011; Stenqvist, 2014; see also Chapter 3). For decarbonisation, even stronger climate and energy policy integration will be needed, with serious consideration of long-term climate objectives (Dupont & Oberthür, 2012).

3.2 Trade and industrial competitiveness

Trade policy must be coordinated with climate policy as long as there are no international climate policy agreements that provide a level playing field for industry (for example, in terms of universal carbon prices) (Helm et al., 2012). Progress on this issue is not likely in the near future since Article 3 of the United Nations Framework Convention on Climate Change lays down ‘common but differentiated responsibilities’ as an important principle. With differing national ambitions, industries that operate in global markets have to develop strategies spanning across countries with different requirements on emission reductions.

So far, the EU strategy to avoid carbon leakage has been to shelter the EII from policy-driven direct or indirect cost increases. The EII receives mainly free allocation of emission permits under the ETS and compensation for electricity price increases is allowed under the ETS Directive (2009/29/EC). Currently, 96 per cent of industrial GHG emissions within the EU ETS are on the ‘carbon leakage list’.³ Furthermore, the EII receives preferential tax treatment with lower energy taxes. Industry, as noted, is also often exempt from the burden of RES support schemes. Nevertheless, European industry is facing considerably higher energy prices than important competitors in countries such as the United States and China (IEA, 2013). The strategy to shield industry from the costs seems to have worked so far since there is no real evidence of carbon leakage from Europe in the first periods of trading up to 2012 (Bolsher et al., 2013). Special provisions will most likely remain in place to protect EII from additional costs that may disadvantage them in international markets (Neuhoff et al., 2014). However, future and more stringent climate policy will exacerbate the disadvantages, and the current compensation measures will be insufficient, as the carbon budget of the ETS gets tighter.

Energy price differences among countries and regions also arise due to differences in access to natural resources. The US unconventional gas boom, which led to much lower gas prices than in Europe, and reduced CO₂ emissions from US power production, is a case in point. Countries and regions endowed with RES may enjoy similar cost advantages and become home to low-emission energy-intensive manufacturing in the future.

Basic materials are traded internationally to varying degrees and they can be more or less sensitive to production cost increases. For example, cement and clinker, which is bulky and expensive to transport, is mostly produced and used locally and regionally. The annual export of cement from the EU in 2010-2012 was 11 to 17 Megatonnes (Mt), whereas the import was 3 to 6 Mt. The resulting average net export of about 10 Mt is relatively small compared to the annual EU production of about 200 Mt (EU Market Access Data Base). The annual export of paper 2010-2012 was 19 to 20 Mt and the import was 5 to 6 Mt. The resulting net export of about 15 Mt contrasts with a total production of about 90 Mt (CEPI Key Stats, 2012). In addition to transport costs, production may be more or less tied to local raw materials (such as minerals or pulp wood), supporting infrastructure and human resources, and integrated and complex value chains – factors that make relocation difficult.

Although markets for many materials are relatively regional due to transport costs and other factors, this situation may change if ambitions to decarbonise the EII are followed through. In this scenario, solutions for maintaining production within the EU must be sought in the trade regime, including neighbourhood policy, and through industrial development policy. Border taxes may become inevitable unless various support schemes can be designed to compensate for climate policy related cost increases. Several of Europe's competitors subsidise capital and energy for the basic industry (Haley & Haley, 2013). Where non-EU countries give unfair support to their industries through tariff and non-tariff barriers, subsidies and export incentives, the EU can challenge such practices under the WTO. Where leakage is most likely to occur to neighbouring countries, like cement production in the MENA region, bilateral agreements through neighbourhood policy may be sufficient.

The relatively high mitigation costs for decarbonised basic materials production needs to be handled in the evolving global climate regime, and/or through border tax adjustments and compensation schemes within the EU to avoid carbon leakage. It must be noted that there is also the possibility of positive carbon leakage, in that production moves to 'low-carbon energy islands' with an abundance of RES. Iceland and the Nordic countries, with good wind resources and large hydropower or geothermal capacities, may be cases in point, as may be Brazil, with large hydropower, solar, wind and bioenergy resources.

So far, introducing trade-related compensation schemes for higher carbon cost in the EU, such as carbon border tax adjustments, have not been high on the agenda for the European Commission. A similar idea was introduced with the inclusion of international aviation in the ETS. This initiative stirred international controversy and was forcefully resisted by both the US and China. European Commission actions in the trade arena linked to climate change have so far been limited to emerging technologies driven by climate policy, such as the conflict with China regarding unfair Chinese subsidies to solar photovoltaics (European Commission, 2014b).

Although there are many good reasons to avoid trade barriers, the conflict between imposing higher costs and maintaining free trade will continue to grow and will eventually force policy intervention. Some argue

that carbon tariffs on imported goods from countries with weak climate policies could induce them to join international climate and trade agreements, and to implement climate policies (Helm et al., 2012). Decarbonising industry will certainly put climate and trade policy to the test.

3.3 Industrial policy, innovation and technological development

Industrial policy has been around for a long time in Europe and elsewhere (Grabas & Nutzenadel, 2013). The concept is often associated with failed government attempts to rescue out-dated or ailing industries, or at ‘picking winners’ in terms of technologies or emerging companies. Although industrial policy has a mixed record, industrial policy of some sorts is inevitable. Priorities and trade-offs in infrastructure investments, research and development, education, environmental protection, tax systems, financing, labour laws and other factors that determine the framework conditions, or ‘playing field’ for industry need to be made. Within this broad definition of industrial policy, governments may choose to be passive or active but they cannot be neutral.

After the financial crisis in 2008, there was a renewed interest in industrial policy. In 2010, the European Commission tabled its ‘Integrated Industrial Policy for the Globalisation Era, Putting Competitiveness and Sustainability at Centre Stage’ (European Commission, 2010b), which ‘sets out a strategy that aims to boost growth and jobs by maintaining and supporting a strong, diversified and competitive industrial base in Europe offering well-paid jobs while becoming more resource efficient’.⁴ A distinction is often made between horizontal industrial policies that do not seek to promote any specific sector and vertical sector-specific policies. The EU industrial policy explicitly combines both by: ‘bringing together a horizontal basis and sectoral application [...] and the Commission will continue to apply a tailor made approach to all sectors’ (European Commission, 2010b, p. 4).

The EU integrated industrial policy has its roots in the Lisbon agenda (2000) – an attempt to make the EU the most competitive economy in the world – and it has co-evolved with broader objectives for sustainable development and concerns over reliable access to raw materials (European Commission, 2013d). It was followed in 2014 by a Communication that sets out the Commission’s key priorities for industrial policy, ‘For a European Industrial Renaissance’ (European Commission, 2014c). This contributed to the European Council debate on industrial policy in June 2014 and contains a number of proposals on information, energy and transport infrastructure, the internal market, competitiveness proofing and regulatory fitness checks, innovation, finance, SMEs, international trade, standardisation, and so on. EU industrial policy, including raw materials, rarely mentions the EII and focuses mainly on emerging and down-stream sectors such as space, information and communications technology, and rare-earth metals. The documentation of the high level groups for iron and steel, chemicals, and for raw materials does address the EII⁵ with a focus on the challenges of increasing competition, the need for favourable conditions for these industries in the EU, and action against unfair practices in other countries.

Innovation and support for technical change along the whole innovation chain (including research & development (R&D), demonstration, pilot test and market formation support/early deployment) is also a key policy area linked to decarbonising industry. The EU Framework Programmes for research have been replaced by a more holistic approach with the EU Horizon 2020 initiative. Horizon 2020 aims to integrate better the user side of research and support for market formation. The hope is that the EU can then more

effectively translate academic research into usable products and services innovations. A number of programmes are relevant to the EII, such as the ultra-low carbon dioxide project for steel,⁶ several efforts in the area of bio-economy, and the Strategic Energy Technology Plans for industry focusing on CCS and emerging down-stream technologies such as photovoltaics and wind, among others, but not yet for greening basic materials (see European Commission, 2013c). Financing mechanisms are also tied to some types of projects, for instance, via the European Investment Bank and the New Entrants Reserve programme (NER300). NER300 is an EU scheme to provide financial support to innovative renewable energy technology and CCS with the income from 300 million auctioned emission allowances under the ETS.

Current industrial R&D and innovation efforts both at the EU and member state level seem insufficient for the EII when considering the 2050 objective. One reason may be the conventional wisdom among innovation researchers that mature industries, usually engaged in incremental innovations, do not need public R&D support (Edquist & Chaminade, 2006). However, this ‘wisdom’ does not take into consideration the large-scale technology shifts needed to reach long-term climate objectives. Time scales, technology, political and economic risks are all well beyond previous experience when it comes to reducing GHG emissions to near zero by 2050. More long-term and sequential technology development and policy strategies are needed in order to develop the technologies for deep emission reductions beyond 2030. Present EU policy on technology development does not fully acknowledge the potential of non-CCS technologies for decarbonisation. It becomes captured by incumbent interests (for example, that of energy companies in CCS) and their short-term priorities, and misses the long-term 2050 perspective.

4. Conditions for a policy-driven transition of the EII

The preceding analysis shows that the current combination of EU policies, overall, tends to preserve rather than create conditions for a low-carbon transformation of industry. Efforts to promote the bio-based economy may be an exception. As discussed above, the EII is generally sheltered from the effects of climate and energy policy and it is given various favourable exemptions to support competitiveness. Not much research, development and demonstration funding is going to the basic materials industry, and that which is does not appear to be directed at fundamental technology shifts in core processes.

The current situation can be understood partly through analysing the degree of functional overlap with other goals, or co-benefits, political will, and societal interest. These interlinked and overlapping factors can provide part of the explanation of the current institutional set-up. Against this background, we discuss the prospects for a new institutional set-up in the next section.

Functional overlap is very important for gaining support and acceptance for policy. Its popularity is evident in its many labels: co-benefits, ancillary benefits, synergies, policy hitchhiking and piggybacking. The basic idea, from a decarbonisation perspective, is that emission reductions generate other benefits and contribute to other environmental and societal goals such as air quality and job creation. Some measures with marginal emission reductions create clear synergies. For example, energy efficiency improvements, process or product changes, and increased materials efficiency can result in cost reductions, quality improvements and waste reduction.

Unfortunately, in the case of EII, functional overlaps hardly facilitate the zero-emissions target. Technology development for emission reductions may open up process advantages in some cases but it appears that decarbonisation mainly inflicts substantially higher production costs. The degree of co-benefits is uncertain since options and strategies are relatively unexplored, but decarbonising EII essentially means producing the same material or chemical compound in a more expensive way. CCS is a case in point: it brings no additional benefits, but a range of new worries. If future potential electricity and hydrogen use in industry can be flexible, it may be used to balance an electricity grid with more variable production. But we do not know to what extent future technologies and processes can handle variable power supply. The impact on jobs is very uncertain but likely to be small in this non-labour-intensive sector.

There is an overarching and relatively strong political will to decarbonise Europe, including industry. It is manifested through the ETS, which includes much of the basic industry, and in the 2020 and 2030 targets and the 2050 roadmaps. But the EU is far from united. Several member states have very ambitious long-term plans, such as the UK, Denmark and Germany, whereas others do not (see also Chapter 1). The policy implication of near zero emissions is a quite recent issue, perhaps first brought to wider attention through the low-carbon economy roadmap (European Commission, 2011a). Governments have always been concerned about the risks of costs increases to industry from energy and climate policy, and taken measures to mitigate or compensate such effects. But completely decarbonising industry makes such exemptions and compensation schemes much more difficult. We also note that there seems to be an emerging political will, a growing acceptance for, and change of narrative, when it comes to 'industrial policy' as indicated by the discourse on 're-industrialisation' and 'green economy' in recent years.

Societal interest and involvement is also an important precondition for policy and governance. This is clear and present in areas such as food and climate, cars and urban transport, or lighting (consider, for example, the success of Earth Hour). These are areas that come very close to people and their everyday life. Two examples are environmental labelling of paper and the promotion of biodegradable plastic bags made from biopolymers. Whereas consumers have an interest in cars, they generally have no relation to the basic materials that cars are made of. Thus, societal interest in the basic materials industry is low and likely to remain so. Societal interest may be mirrored through NGOs but industry oriented NGO initiatives such as the WWF Climate Savers do not target or attract the EII. A rare exception to the generally low interest is environmental NGO Bellona that has taken an active stance pro-CCS, including industrial CCS.

Another aspect of societal interest, and part of the institutional set-up, is the role of labour unions. Basic industry has been integral to the development of the industrial state and job creation is an important social aspect. Labour unions organising workers from the EII have typically held a strong political voice. Today, the divide in industry between the down-stream manufacturing industry that will most likely benefit from climate policy and the up-stream EII that faces a tough time is reflected in the various positions and attitudes towards climate policy in different labour unions. For example, IG Metal in Germany is quite progressive and sees opportunities in a transition whereas IG BCE (which stands for Bergbau, Chemie, Energie), which includes coal industry interests, is resisting change.

In summary, the current framework for governing emissions in industry rewards incremental improvements rather than prepares for the transition needed for decarbonisation. This is partly because near zero emissions by 2050 is a new idea. Protecting competitiveness and jobs is also an important and legitimate

explanation, and there are good reasons for keeping basic materials production in Europe. With carbon leakage, nothing is gained. Integration along value chains is an important source of innovation and in some cases it is in the EU that we find the feedstock (such as metal ores or wood, but also potentially clean energy for the processes). Maintaining production capacity for certain metals, fertilisers, and so forth, also has a supply security argument.

5. Towards a new institutional set-up

An important first step in a transition process is to develop some sort of shared vision, scenarios and clear direction for the longer-term development. Such visions are relatively well established in areas such as energy supply, smart grids, transport and buildings, although some of the details may be disputed. For basic industries this process has just started through the European Commission roadmap and subsequent industry subsector roadmaps.

Overcoming the barriers to low-carbon technologies in basic industry and at the same time managing the risk of carbon leakage requires a comprehensive and systemic policy approach. It includes the development of new EU internal and external policy strategies that integrate industrial, technology development, trade, and climate policy. The need for such new policy strategies is articulated by the Confederation of European Paper Industries (CEPI, 2011, p. 3):

‘A new level of climate policies is needed: to achieve the reduction required while avoiding carbon leakage, policies need to be harmonised with global developments and industry investments cycles. The EU needs to complement the current carbon price and target-based policy approach with a multi-dimensional and industry specific climate change policy. The policy package should include a technology focus, be synchronized with industry investment cycles and global action, and include a raw material and product perspective.’

Research, development and demonstration and up-scaling for technology development and deployment require large investments. A major obstacle is lack of financing for up-scaling and moving breakthrough technologies beyond the demonstration-phase. Another is the lack of regulatory frameworks that reduce investment risks through creating a trustworthy future market environment, as feed-in-tariffs have provided for renewable electricity (see for example, Burnham et al., 2013). The risk of deploying new technologies and processes is thus not only technological but also political. Will climate policy persist and is there a trustworthy regulatory and market environment? The importance of this is illustrated by experiences from the NER300 scheme where a number of granted projects have been cancelled due to the lack of clear direction in future markets for renewable energy (such as biofuels for transport), or for carbon emissions and CCS. A similar scheme to the NER300 could be used for financing future technology demonstrations in the EII but it would only be one piece of an integrated policy package.

Policies and investment strategies in the capital intensive EII also need to consider the large sunk cost in existing facilities and the complexity of operations. Core industrial processes change only gradually over the years and the investment cycles in heavy industry are long. For many of these companies, 2050 is only one or two major investment decisions away. EII must aim at becoming ‘zero emissions ready’ by 2020 or 2030,

meaning that technologies have been developed and proven. Major investments in new core processes can be made thereafter, starting perhaps around 2030, provided that the broader institutional and market conditions make them economically viable.

Deployment through major investments is dependent on market conditions, which in turn are contingent on EU and international climate, energy and trade policies. It requires a coordinated response where climate policy and industrial policy is well integrated also into the EU response for maintaining open trade on a fair basis. This includes the use of bilateral agreements and various trade arrangements for easing the risk of unacceptable carbon leakage (some carbon leakage may be acceptable, and relocation of industry to regions with low-carbon energy supply may be welcomed).

The new global climate policy framework that is expected to emerge in 2015 may have implications for EU strategies for the EII. We do not want to speculate about the outcome of the international negotiations but it is clear that issues concerning carbon leakage and the EII must be dealt with if the EU wants to maintain its 2050 goals. Decarbonising and keeping industry in Europe can be seen as in line with sustainable development, since the alternatives are clearly unsustainable. EU investments made in developing low-carbon process technologies could later benefit other countries, analogous to the development of renewable energy technologies, and be seen as a major contribution international climate protection.

Conclusions

Decarbonisation provides opportunities for much of industry to innovate and adapt to new and 'green' market demands. For energy intensive industries, however, decarbonisation requires innovation and new investments in core process technologies that offer few co-benefits. There is not yet a shared vision and clear direction for a low-carbon transition in the energy intensive industries. There are gaps in key steps of the innovation chain, including insufficient R&D on basic options, such as electro-thermal technologies, lack of financing mechanisms (although NER300 may be further developed and expanded), and a need to create stable market conditions for green but more expensive basic materials. Although the ETS provides a basis for nudging industry towards lower emissions, it falls short of inducing the required longer-term technology shifts. It simply is not geared towards supporting a low-carbon transition in industry. Compared to other sectors, the EII faces greater economic, policy and governance challenges. The lack of co-benefits and societal interest, conflicts with free trade ideals, historical experience with industrial policy, and hesitance concerning the role of government in industrial restructuring are factors that impede the development of a new approach. We have discussed some of the key aspects of such an approach in this chapter. In essence, it requires the development of a new EU-internal policy that integrates innovation, industrial, and climate and energy policy for decarbonisation. It also requires an EU external policy that integrates international trade, foreign (for instance, neighbourhood policy and development cooperation), climate and energy policy.

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² Back-stop technology is often used to denote a technology to fall back on, with quite unlimited potential but relatively expensive, if other less costly options fail or have been exhausted. Although CCS is sometimes referred to as a back-stop technology, it should be noted that storage sites are not unlimited.

³ The carbon leakage list includes firms under the ETS that will receive free allocation of emission permits up to the benchmark.

⁴ See http://ec.europa.eu/enterprise/policies/industrial-competitiveness/industrial-policy/index_en.htm, date accessed 10 February 2014.

⁵ There are several high level groups between the European Commission and stakeholders, including one for steel, one for chemicals (concluded 2009), one on industrial policy and competitiveness, and a High Level Steering Group on innovation and raw materials. These groups are formed ad-hoc and serve as forums for information exchange between the Commission and industry.

⁶ ULCOS, Ultra-Low Carbon dioxide (CO₂) Steelmaking, is a joint EU-industry research programme. See www.ulcos.org, date accessed 14 October 2014.