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Inclusive Transformation of the European Materials Sector

Report for the EUKI 2018 Project "Climate Friendly Materials Platform: supporting transition in Central and Southern Europe" – MAY 2019

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Since the end of 2016, the Climate Friendly Materials Platform (CFMP) has been bringing together policy makers, industry representatives, practitioners in industrial decarbonisation, and applied researchers in order to develop a shared understanding of tangible policy options and eventually common policy action at the national and EU levels to work toward the overall goal of successfully decarbonizing the basic materials sector. Jointly led by Climate Strategies and DIW Berlin, the CFMP project is delivered by a multidisciplinary, international team of researchers from a number of institutions, representing various fields (EU law and institutions, climate policy and economics, energy markets, and infrastructure policy and economics). The present report is based on analysis and workshops focusing on the transition in Central and Southern Europe funded by EUKI 2018 and implemented by DIW Berlin together with WiseEuropa, REKK and IIT Comillas Pontifical University.

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Introduction

Production of basic materials (cement, iron and steel, paper and board, aluminium, as well as chemicals and petrochemicals) accounts for around 16% of European GHG emissions (DIW calculations based on EEA (2012) and EEA (2016)[1]).

For some time this number was regarded to be sufficiently low to be out of the primary focus of policy makers – which was largely dedicated to improving the power sector and generally increasing energy efficiency. However, the Paris Climate Agreements' commitment to reaching ***net carbon neutrality*** by mid-century implies that a comprehensive industrial policy strategy is required that also tackles CO_2 emissions from the basic material production.

This is reflected in the reform of the EU ETS Directive approved in 2018 for the 2020-2030 period. The discussion remains focused on how to secure sufficient free allowance allocation to ensure that sectors like steel are protected against investment- and carbon leakage. Furthermore, it also raised awareness within the senior management of the major material producers that business as usual investment plans are not compatible with the long-term emission reduction objectives formulated in the Paris Climate Agreement, both at the European level and in many Member States.

This has led the management of international companies to question whether to pursue major (re-) investments in carbon intensive production processes of basic materials during times when financing is being withdrawn from coal plants and when there are large scale write-offs on existing power stations in the power sector. Apart from concerns of carbon leakage, there are risks of changing demand patterns for carbon intensive materials and competition from new investments in climate friendly production processes.

To overcome this inertia, the European Commission was asked by the heads of Member States to outline a 2050 long-term vision for Europe. The document was presented in November 2018 (European Commission, 2018). The Commission, as well as several Member States, hosted workshops with all basic materials sectors to inform stakeholders about scenarios in which carbon neutrality can be achieved by mid-century and demonstrate the portfolio of existing and proven technologies.

Obviously, such a vision cannot be used in our complex market-based economies to prescribe specific technology development and choices – particularly in an environment with large-scale uncertainty and asymmetric information about costs and performance of such technologies. However, it can help to engage private actors in a dialogue about urgent decisions – and to identify the need of public policy to address knowledge spillovers and learning-by-doing externalities, financing constraints, and policy risks.

The EUKI Climate Friendly Materials European Roundtable aimed at engaging national stakeholders from Hungary, Poland, and Spain in this European discussion – focusing on the following elements.

1. *What is the nature of 2050 roadmaps – which elements will be part of a transformation pathway for a basic material sector?*
2. *What is the status and outlook of national material industries?*
3. *What is the status of national policies, what are lessons learned so far, what are the challenges ahead and what are the remaining gaps?*
4. *What policy toolbox can be used to close the gaps and what solutions can allow private actors in market based economies to pursue investments that follow the 2050 roadmaps?*
5. *How can European policies be inclusive e.g. support national developments? What is the value added of European cooperation?*

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[1] *About 1/3 of these emissions are indirect emissions from producing electricity for basic material producers.*

1

Which elements will be part of a low-carbon transition pathway for the basic material sector?

Transformation of the basic materials sector that is compatible with the 2050 emission reduction targets can be achieved by pursuing and combining a number of mitigation options:[2]

1 Share, repair and reuse

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

2 Material efficiency

a. Efficient design of products.

Improved product design can achieve the same services with less, but better tailored, higher value materials. For example, lightweight design (e.g. of steel beams used for construction and of aluminium alloys used for car bodies) can reduce the need for steel and aluminium by 25 to 30% (Carruth et al. 2011). Higher quality products with longer lifetimes can further reduce material demand.

b. Efficient manufacturing.

This can reduce the loss of material during production processes and improve material reuse. For example, an improvement in material efficiency could reduce emissions and material costs in automobile manufacturing by 56% to 70% (Horton and Allwood 2017).

3 More and purer recycling

Recycling rates still vary across applications and material types. For example, 80-90% of end-of-life steel is collected for recycling, while in the case of plastics, only 18% is recovered (Material Economics Report 2018). Improvements depend on product design, suitable dismantling and separate collection of material to allow materials to be recycled for the same purposes, rather than down-cycled to lower material quality. For steel, a major concern is contamination, for example with copper and other elements, which reduces the quality of recycled steel. In the case of oil-based plastic products, certain types of polymers are suitable for mechanical recycling - to be used for the same function or to be re-made into the same material (mainly packaging plastics).

4 Low-carbon production processes

While, in the short-term, incremental efficiency improvements of conventional production processes may deliver small emission reductions, conventional processes need to be replaced with "breakthrough" technologies (Table 1). The introduction of production processes based on renewable energy (electrolysis or directly solar-derived hydrogen) or supported by carbon capture and sequestration or use can avoid or absorb most of carbon emissions linked to primary production of materials (Philibert/IEA 2017, Bataille et al. 2018).

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[2] *This section is based on Neuhoff et al. (2018).*

5 Material substitution

Substitution of materials with alternatives characterised by lower life-cycle emissions can allow further emissions savings. For example, wood-based construction components can have much lower CO_2 intensity than steel and concrete (Materials Economics Report 2018) and clinker substitutes are already being developed (IEA 2018).

TABLE 1

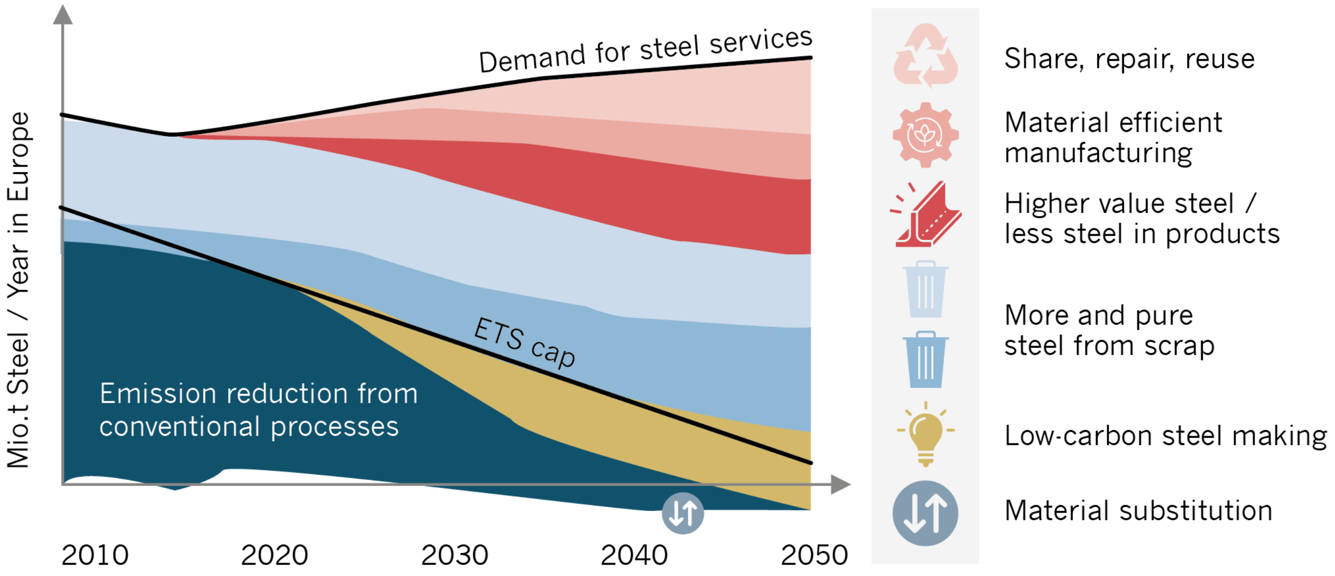
Summary and categorization of policy instruments for reducing emissions from materials production.

Technological option	Example of use
Carbon capture and storage or use (CCS and CSU)	CO_2 capture from fossil fuel combustion processes in industrial plants, from process streams in the production of steel, cement, hydrogen, and ammonium. Captured CO_2 may be used to produce chemicals, fuels, fertilisers, and other products.
Use of biomass and waste	Increased use of biomass and waste as fuel or feedstock in production processes across all industrial sectors.
Electrification of heating sources and synthetic gas production	Use of electrically-powered low-temperature heating systems in the paper and food sectors, and high-temperature systems in the production of glass (electric fusion), ceramics (electric furnaces), iron and steel (increased use of electric arc furnaces). Use of electrical power in power-to-gas solutions.
Industrial symbiosis, creating heavy industry clusters	Quantitative use in the chemical and pulp and paper industries, but also possible in other sectors. Co-location of production in clusters enables a more optimal use of materials and energy by employing waste from one process as feedstock in another.
Use of hydrogen	Hydrogen used as feedstock in the production of chemicals, coal replacement in the steelmaking process and energy source in fuel cells; hydrogen obtained through electrolysis may represent a zero-carbon energy source.
Use of high-temperature reactors (HTR)	Deployment as high-temperature industrial heat source, e.g. in the chemical sector, enables a significant reduction of CO_2 emissions.

Source: Blocka et al. (2019)

FIGURE 1

Illustration for steel sector of how a portfolio of mitigation options can enable decarbonization of the material sectors in line with the 2050 targets (no numerical simulation)



Source: DIW's illustration

Figure 1 illustrates, in relation to steel, how the portfolio of mitigation options listed above can align the materials sector with the objectives of the Paris Climate Agreement. Conventional steel-making will be phased out. As low-carbon production processes will compete with other sectors for renewable energy resources (BDI 2018), reducing demand for primary material production will be essential to remain within available resource potentials. Therefore, the level and quality of recycling will need to be increased, and it will be crucial to exploit the mitigation potential in the value chain.

2

What is the status and outlook of national material industries?

Hungary

The manufacturing sector contributed 24,310 million euros to the total gross value added of 113,896 million euros of the Hungarian economy in 2017 (21.3%). The largest contributors are the transport equipment and fabricated metal and machinery sectors, accounting for nearly 2/3 of manufacturing value added, followed by the food, chemicals and the non-metallic mineral sectors (Eurostat, 2017a).

Companies producing chemicals, wood, paper, basic metals, and non-metallic mineral products have the highest energy cost share of total costs, ranging between 4 to 9%, similar to European manufacturing companies. However, the most important contributors to the Hungarian gross value added and export revenues, i.e. the machinery and transport equipment producers, represent a smaller share of the energy consumption in the manufacturing sector (5 and 9%, respectively) (Eurostat, 2017b).

The manufacturing sector mainly relies on natural gas and electricity as energy sources: the shares of these fuels were 31 and 33%, respectively in 2017. The energy consumption of the industrial sector increased from 129 TJ in 2008 to 182 TJ in 2017 and has been rising continuously since 2009. The contribution of electricity, natural gas, and oil-based products expanded over this period, while the amount of heat remained constant (Eurostat, 2017b). A slight increase is observable in renewable energy use as well as in applying wastes as a fuel, although the share of these energy sources is marginal. The carbon intensity of electricity generation in Hungary is relatively low – in 2016 it reached 260 gCO_2/kWh compared to the EU level of 295.8 gCO_2/kWh according to the EEA (2016a), due to the high share of nuclear power in the electricity mix – contributing 49% to electricity production and 42% to final electricity consumption in 2017 according to Eurostat (Eurostat, 2017b). Renewable-based electricity accounted for 7.49% of final energy consumption in 2017 (Eurostat, 2017b). The share of industries contributing most to export revenues and value added is relatively low (14%) in the total energy consumption of the manufacturing industry (Eurostat, 2017b).

The greenhouse gas emissions of the Hungarian manufacturing industry amounted to 11.2 million tons CO_2eq in 2016, accounting for 21% of the total emissions,[3] of which 58% was attributable to emissions from industrial processes and product use (EEA, 2016b). Firms producing chemical and non-metallic mineral products contributed most to the industrial emissions (with 25 and 20%, respectively). The GHG emissions intensity of the Hungarian manufacturing industry has declined over the last decade. However, if we consider the energy-intensive sectors, we find that in the case of the coke and refinery as well as the chemical sectors, the expansion of production during economic recovery was accompanied by increasing emissions per value added. On the other hand, the emission intensities of coke and petroleum products and basic metals were lower in Hungary than in the EU (EEA, 2016b).

The industrial sector has recovered from historic decline following the 2008 crisis. Consequently, energy use by industrial sectors has quickly rebounded. There is a noteworthy significant change: the observed rise in industrial energy consumption is predominantly attributable to growth in electricity consumption. This is good news in the light of the decarbonization efforts: electrification is an efficient means of decarbonizing energy use by industry, provided that the electricity production increasingly relies on renewable sources of energy.

Based on the prognosis of the Hungarian government, the Hungarian GDP in 2030 is expected to exceed the value for 2015 by 76%. The main sectors of growth are in industry, the construction sector, and services, while added value from the agricultural sector will stagnate. The estimation reveals an industry share of 28.9% in 2030 compared to 27% in 2015 (HITM

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[3] *Excluding LULUCF and memo items.*

(2018).

The Hungarian industrial sector is deeply integrated into the European and global value chains. Within the EU, the share of foreign-controlled enterprises is the highest in Hungary, at a 51.4% share of value added by foreign-controlled firms in 2016 (Eurostat, 2017a). The major firms of the most energy intensive material industries are local subsidiaries of multinational companies, so in their case the implementation of new, environmental-friendly technologies is the result of a complex internal optimization process, including the analysis of the demand of the main buyers of materials.

Poland

The most significant material sectors in Poland - in terms of total output, employment, and production volumes compared to other European countries - are cement, iron and steel, paper and board, as well as basic chemicals (in particular, fertilizers). Coke is also included due to its crucial role in the steelmaking supply chain and its strong industrial base in comparison with the rest of the EU. In economic terms, among the material industries considered, the Polish manufacturing of coke oven products represents more than a half of the total EU value added generated in this sector. Manufacturing of cement as well as of fertilizers and nitrogen compounds also represent significant parts of the European industry (11 and 9%, respectively), while the Polish steel and paper industries contribute only 4% (Eurostat, 2017a). Taking into account that, in 2016, all Polish manufacturing accounted for 3.4% of manufacturing value added generated in the EU, the much higher share of Polish producers in the EU materials sector shows that Polish industry specializes in basic material production.

Poland's industrial emissions per capita are below emission levels observed in the most developed European countries (EEA, 2016). One of the main reasons for this is the lower industrialisation of the whole economy outside the EU ETS system - Polish industrial production per capita is around two times less than the EU average (Eurostat, 2017a).

Within the material sectors, the key difference between Poland and rest of the EU lies in the structure of energy carriers used. The role of coal in Poland is significantly higher in the production of chemicals, non-metallic minerals as well as paper and pulp production, where it is used as cost-competitive alternative energy source to natural gas. Thus, coal dependency is an important feature not only of the Polish power sector, but also of final energy use in material industries.

Gradual output growth has been recorded in material sectors in Poland in the last decade. This is mainly based on higher utilisation of already existing production capacities rather than major investments in new plants. Furthermore, materials' output volume has been dependent on general business cycles, but there was no long-term structural decline visible in the aftermath of the financial crisis that hit Europe in 2008 – Poland maintained economic growth throughout the recession. While industries such as steel and cement faced declines in production – respectively 33% and 12% between 2007 and 2009 - they had fully recovered by 2011-15, driven by inter alia public investments financed by EU funds as well as from private activity stemming from robust economic growth (JRC, 2015).

Before joining the EU in 2004, the Polish material industry had already gone through some restructuring and technological upgrading. As a result, the overall capacities decreased and process efficiency improved. In general, the material industry in the country has already undergone major modernisation since the mid-1990s. In some areas, such as the use of alternative fuels in cement production, Poland performs significantly above the EU average – the cement industry is the largest consumer of processed waste as a fuel (Ecofys/Cembureau, 2016).

Another feature of the Polish material industry is its high dependence on foreign direct investment– especially in steel and cement production. On one hand, this leads to an easier and quicker uptake of best practices in conventional technologies and operational excellence. On the other hand, it limits the potential of domestic initiatives focused on introducing breakthrough low-carbon technologies. Chemicals (basic chemicals, fertilisers) and petrochemicals as well as coke production are among the sectors with a significant role of state-controlled companies, which may be interested in exploring new technologies. While these companies are major players in the domestic market, they face more barriers (e.g. access to capital, know-how, ability to diversify risks) when compared to multinational corporate competitors.

Spain

In Spain, the industrial sector accounted for 23.5% of the total energy consumption in 2016 (IDAE, 2018). Economic activities related to the extraction, processing, and production of basic materials heavily rely on fossil fuel based energy carriers and account for more than 60% of the total energy consumption of the industrial sector. Processing of non-metallic minerals has the highest energy demand across all economic activities. Coal and petroleum products are used for the production of cement, chemicals, glass, ceramics, and derivatives of the aforementioned products. The share of renewable energy use, primarily the use of biomass in cement kilns, is low. Process based emissions make the mineral industry, especially in the cement industry, the biggest industrial carbon emitter. In the case of Spain, the mineral industry by itself accounted for almost 7% of the country's total CO_2 emissions in 2016 (EEA, 2016b).

The importance of the minerals sectors within the national energy and emission balance is one of the key features of Spain and is representative of other southern European countries like Italy and Greece. The steel and metal industry comes second and can be characterised by its high share of electricity use and, therefore, comparably low direct emissions. As of 2014, more than 70% (WSA, 2016) of domestically produced steel came from secondary steel production using electric arc furnaces. Due to the ongoing sector transformation, the share of secondary steel production has been growing over the last years. Furthermore, Spain is the third biggest aluminium producer in the European Union, an industry that primarily uses electricity for its production processes. Other relevant industries are the (petro)-chemical sector, the food industry, and the pulp and paper industry. The remaining industrial activities primarily use electricity and natural gas, which replaced other fossil fuels after the extension of the national gas network over the last 30 years.

The Spanish economy was heavily impacted in the aftermath of the global financial crisis of 2007-2008 and the previous burst of the housing bubble. Hence, national demand for basic materials, like cement, collapsed and resulted in the subsequent reduction of total industrial greenhouse gas emissions. Within the 10-year framework between 2005 and 2017, industrial CO_2 emissions fell by 42% (MITECO, 2018). While these figures permitted Spain to comply with European CO_2 reduction targets in the short-run, this development imposes challenges for the industrial sector in the long-run. The least financially and energetically competitive plants closed, while new investments in the remaining infrastructure remained low. There is a significant untapped potential for energy efficiency measures, given that the energy intensity of all branches of the basic material sector has been rising since 2010.

Since 2012, the Spanish industry experienced a partial recovery with the value of total industrial production in 2017 remaining about 15% lower than in 2008 (CCOO Industria, 2017). Specifically, the basic material sector has not been able to regain previously achieved output. With regard to national emission levels, the key question is whether the Spanish material sector will increase its production over the next decades, stagnate or deindustrialise further.

3

What is the status of national policies, what are lessons learned so far, challenges ahead and remaining gaps?

Hungary

Among the measures implemented in order to achieve the Hungarian energy efficiency policy targets, there are two dedicated to support energy efficiency improvements in the industrial sectors:

- mandatory employment of energy auditors prescribed for large companies,
- tax advantages for corporate energy investments.

Companies with a yearly electricity consumption over 400,000 kWh or gas consumption over 100,000m^3 should employ an energy officer. The officer should prepare regular reports on the company's energy consumption and suggest options for energy saving measures.[4]

In addition, companies can make use of corporate tax reimbursements by implementing energy efficiency projects. Companies can reduce the corporate tax with the amount of the energy efficiency investments. The cap of the subsidy is 30% of the total investment value and a maximum of 15 million euros.[5]

Despite the current measures, Hungary lags behind its intermediate energy efficiency goals, as the alternative policy measures applied by Hungary have not delivered the expected outcomes (HITM, 2018). Therefore, the current policy will require an overhaul. It is not yet decided how the tasks and burdens will be shared among the different energy consumer sectors. While the EU experienced an overall reduction in final industrial energy consumption and industrial energy efficiency between 2005 and 2017, Hungarian industry increased its energy consumption by 25% percent and increased its energy intensity by 24%.[6]

The Hungarian Government worked out and published its preliminary estimate on the sectoral contributions to the energy efficiency targets expected under Article 7(a) and 7(b) of the Energy Efficiency Directive.[7] The expected targets were published by the Government in the draft version of the National Energy and Climate Plan, as summarized below.

Targets and objectives on GHG emissions and removals:

- in industry, Hungary aims to limit the increase of emissions to 11.37 million tCO$_2$e, notwithstanding an increase in production
- this cap is broken down to energy and process emissions as follows: 5.05 mtCO$_2$e of energy emissions and 6.32 mtCO$_2$e of process emissions.
- According to the projections, industrial non-energy emissions are expected to exceed the 2015 level by 33% in 2030. Fluorinated GHG emissions are expected to significantly decrease by 2030 as a result of EU common policy actions (prohibitions and quota scheme).

As a result of additional measures, GHG emissions of end consumers can be 5.9 mtCO$_2$e lower than than those under the WEM (with existing measures) scenario. This translates to a 13% drop in end-consumers' GHG emissions by 2030 compared to 2005. However, in the industrial sectors, there are fewer additional measures. The government plans to implement an energy efficiency obligation scheme through a pilot project in 2019 and is also considering the introduction of cost compensation measures for indirect carbon emissions in Hungary for competitiveness reasons. The government is currently working on collecting technological innovation project plans from stakeholders that will be supported using the Modernization Fund and the Article 10c mechanism established by the EU ETS Directive (EU/2018/410).[8]

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[4] *Act 2015 LVII. on energy efficiency*

[5] *According to Act LXXXI of 1996 on Corporate Tax and Act LXXVII of 2015 on Energy Efficiency*

[6] *Computed as final energy consumption over gross value added (GVA) of the industrial sector. Source European Commission (2019): COM(2019) 224 final, https://ec.europa.eu/commission/sites/beta-political/files/report-2018-assessment-progress-energy-efficiency-targets-april2019_en.pdf*

[7] *Directive 2012/27/EU*

[8] *Technical workshops on EU ETS funding mechanisms for modernising energy sector, presentation of Botos Barbara, Hungarian Ministry of Information and Technology in the Budapest workshop, January 21, 2019, https://ec.europa.eu/clima/events/technical-work-*

Poland

There are significant regulation gaps present in the Polish material sectors regarding future decarbonisation. Key problems include the lack of implemented circular economy principles as well as no regulatory support for green investments and process innovation. Furthermore, the industry faces an additional constraint: low-carbon electricity production in Poland is currently low and is increasing slowly, which limits potential decarbonisation of the materials sector through the introduction of electrification and/or power-to-gas technologies in the short- and mid-term perspective.

At the beginning of 2018, the Polish government published its Roadmap of Transformation towards a Circular Economy. The government identified three areas of focus in the industrial production sector: reduction of industrial waste, extended producer's responsibility (EPR), and life cycle assessment of the environmental impacts. Within the roadmap, appropriate institutions are encouraged to analyse the potential to increase the use of industrial by-products and waste and offer legislative changes in this regard. However, the document does not consider connections between the circular economy and ensuring long-term deep decarbonisation of the materials sector through demand-side measures. Moreover, the link between industrial options considered in the strategic documents (e.g. HTR reactors applied in industry) and concrete policy steps remains weak. There is a significant gap between the short-term policy focus on incremental improvements and ensuring compliance with current European climate targets with the more fundamental shifts needed to secure the long-term transition towards meeting material needs of the Polish economy in a sustainable manner.

So far, the national debate on the decarbonisation of material industries in Poland has been dominated by short-term perspectives, focused on the EU carbon leakage protection, mitigating energy price increases for consumers, and, from the technological side, improving efficiency of conventional production techniques.

The main concerns are stemming from high dependence on coal energy generation as well as slow implementation of policy instruments on the domestic level. However, issues related to meeting long-term GHG emission reduction requirements are omitted. In addition, there are no national incentives for innovations in low-emission processes or demand-side changes that would allow curbing the use of basic materials in the economy as a whole.

Long-term deep low-carbon industry transformation, including the basic materials sector, is not mentioned in the National Energy and Climate Plan (NECP) for 2021-2030. In addition to the NECP, the government also published the long-term perspective of the energy generation policy through 2040 (PEP2040), which does not include any provisions for introducing low-emission production technologies. Furthermore, the documents do not address the need to ensure that Polish industry gains access to the considerable amounts of zero-emission, affordable electricity that is necessary for various low-carbon alternatives to current production processes.

Some important lessons may be drawn from past Polish experiences of attempts to support innovative low-carbon technologies. Although developing CCS technologies for the power sector was considered an important strategic option for the Polish energy transition in the early 2010s, it was not backed with the introduction of concrete domestic policy instruments. In turn, this led to the inability of domestic companies to tap into the EU-wide sources of funding in this area. The available EU funding must be complemented with domestic policy measures if the same problem is to be prevented in the case of industrial innovations in 2020s.

There is a significant lack of understanding of the long-term consequences of maintaining emission-intensive production methods. Product benchmarks for direct emission intensity, which are set for the EU as a whole, do not differentiate between the installations using various fuels. Thus, even the most efficient installations using coal-based heat and electricity significantly exceed product benchmarks based on the emission data from gas-fuelled industrial plants. The recent rapid increase of the emission allowances prices put this issue high on the domestic policy agenda. In 2018, the government has intensified work on the legislation that will allow using part of the EU ETS revenues to provide protection for energy-intensive industries.

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Spain

In the past, Spanish governments have implemented multiple policies to reduce emissions and promote more efficient use of energy. National policies, though, fell short of promoting and encouraging far-reaching changes within the material sector. On the contrary, the main goal of both the national and regional governments has been to actively try to reduce the energy bill of the basic materials sector by means of public aid and tax exemptions, although with limited success. For example, electro-intensive sectors have not been compensated for their indirect emissions as allowed by the EU (although this is expected to change in 2019). The focus on energy cost reduction as a key element of the industrial energy policy is also reflected in the report about the agenda to strengthen the industrial sector in Spain, published by the Ministry of Industry in 2014 (MINETUR, 2014).

A recently published draft of a new royal decree aims to clarify the status of the energy intensive industries. In this draft, the current government introduces various measures that reduce regulated fees and cost components of the electricity price for large energy intensive industries. However, measures, reductions, and policies, only cover the next 3 to 4 years and only provide short-run fixes without providing a long-term vision. Until very recently, the long-term reduction of energy- and emission- intensities of the Spanish basic material sector was not the focus of national policy makers.

Energy policy for the energy intensive industry was principally driven by the concern that high energy prices could jeopardize industrial competitiveness (given that electricity and gas prices are higher in Spain than in other major EU countries), rather than the need to improve energy efficiency. This flaw in the national energy policy was pointed out by the independent expert commission for the energy transition appointed by the previous government.[9]

In the case of Spain, the future energy policy for the basic material sector will be determined by the new law of climate change and energy transition (MITECO, 2019), currently being drafted by the national government, as well as the National Energy and Climate Plan, the draft of which is already public. The National Energy and Climate Plan sets very ambitious decarbonization targets for the Spanish economy, although not that demanding for industry. Most of the emissions reductions are concentrated in the electricity sector and in transport, therefore allowing some breathing space for industry.

The policy measures proposed for industry include subsidies to incorporate renewable energy in industrial processes as well as energy-efficiency studies and investments for industry. Some more measures for accompanying the decarbonization of industry are proposed in the National Strategy for a Just Energy Transition: sectoral agreements, a strategic agreement for the car industry, and a Statute for Electrointensive Consumers (the draft of which is already published, basically consisting of eliminating a minor part of the electricity charges for these consumers, in return for their compromise in applying energy-efficiency measures).

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[9] *Comisión de Expertos sobre Escenarios de Transición Energética*

4

What policy toolbox can be used to close the gaps and allow private actors to pursue investments in line with the 2050 roadmaps?

From previous sections, it emerges that efforts to support the uptake of low-carbon production processes at both the national and European level have been dominated by other concerns, like carbon leakage.

Policy makers have been operating with incomplete perspectives over a possible package of policies and incentives that could drive the low-carbon transformation of national materials sectors.

In this section, we investigate how policy instruments can create sufficient incentives for private actors to pursue transformative investments along the lines of the 2050 vision.

Based on the previous conversations in national round tables – the discussion focused on three policy options that seem to have the potential to make a significant contribution to the transformation process: carbon-pricing schemes that include robust carbon leakage protection, standards, and contracts for differences.

1 Extending EU ETS to combine carbon leakage protection with full carbon price pass through

All attempts to price carbon have raised the same concern about tradability of materials in the highly competitive international environment: different timings and levels of carbon pricing across different regions in the world imply incremental costs for sectors characterized by high trade intensity, relocation of material production, and carbon leakage rather than emission reduction.

To prevent this, the EU-ETS allocates allowances for free to the materials sectors (at a benchmark level per ton of materials produced). However, this mutes carbon price pass through in the value chain, with the result that incentives for deep emissions reduction are dampened.

Two main approaches have been discussed to overcome this shortcoming.

First, Border Tax Adjustments (BTA) adjust the carbon price at the border, charging imports (on the basis of the weight of material in the product) and reimbursing exports, to protect against carbon leakage to regions without comparable carbon pricing and auctioning levels. Combined with substitution of free allocation with full auctioning of permits, in principle it would allow achieving full carbon pass through while restoring incentives to achieve emission reductions (Cosbey et al., 2019).

One issue with BTA is that there is no process for ex-ante approval and, thus, uncertainty about ex-post legal challenges by other countries remains. Further, a financial reimbursement of carbon costs of exports requires careful monitoring, triggering significant administrative effort to avoid fraud.

The second approach is Inclusion of Consumption (IoC) of carbon intensive materials in the EU ETS. With IoC, consumption charges on basic materials are levied on sales to final consumers based on the weight of carbon-intensive materials in product. This could re-instate the carbon price signal in the value chain that is currently muted due to the free allowance allocation in upstream EU ETS, therefore restoring incentives (Neuhoff et al 2016).

Consumption charges are on the good side of trade law. To qualify as a consumption charge, IoC may not differentiate based on production location or process, but must be based on a benchmark of carbon intensity (emission per ton of material produced).

In order to implement consumption charge, the upstream emission trading system needs to be adjusted. Allowance allocation must be output-based; e.g. proportional to current or recent production volumes (tons of material) and the benchmark level (emissions/ton of material). Thus, carbon cost pass through from the upstream system is muted and a double charging of consumers is avoided. IoC, if applied only to a subset of carbon intensive materials, can create competition distortions between different types of materials. Hence, materials that are in direct price competition in significant markets need to be jointly covered. Furthermore, it must be ensured that the overall policy regime is based on life-cycle assessment.

For both approaches, it is crucial that effective monitoring and certification systems are put in place, as the ex-post stage can be a weak point in the system.

2 The role of low-emission and circularity standardization

Standardization can have an important role in leveling the playing field between conventional production processes and low-carbon processes, effectively accelerating the phase-out of the former and enabling the phase-in of the latter. In addition, it can be central in laying the basis for a circular economy.

Emission performance standards specify emission intensity caps i.e. for material production processes, the maximum amount of CO_2e per ton of material produced. In principle, they could be formulated sufficiently stringently so as to preclude production with carbon intensive production processes within Europe once clean production processes are sufficiently established.[10]

However, in such a situation, international producers may continue to produce with conventional production processes and sell on the European market. This points to the value of a consumption based standard as an alternative or complement.

Product certification of clean production processes of major basic materials and end products containing such materials sold on the European market can either be voluntary or mandatory under the EU regulatory framework.

Circularity requirements for goods sold in European markets, which ensure that products are more durable (e.g., via minimum lifetime of components), can be repaired (e.g., components can be easily replaced), and materials contained within products can be easily recycled while avoiding down-cycling (e.g., products can be easily disassembled, or mandating less varieties to facilitate sorting, standards for high quality demolition).

If used as basis for regulatory requirements, existing norms, such as European Standards (EN), can be a powerful tool to ensure minimum environmental quality. Such a level of binding standardization can oblige producers, which are importing goods into the European single market, to comply with required minimum standards.

As suppliers already need to be certified according to multiple European and industry specific standards, certifying them for low-emission and circularity standards would imply a small additional administrative effort. However, it might be challenging to verify whether imports and non-European production sites comply with European Standards.

Importantly, legally binding norms and standards for production processes and product design can define minimum requirements for the recyclability of all goods on the European single market. As such, they are crucial for enabling a circular economy. Some measures could be implemented using legislation that is already in place, but insufficiently exploited until now. For example, the EU Eco-Design Directive (2009/125/EC), currently mandating minimum efficiency standards, could be extended with additional circularity regulation for different product groups. Moreover, standards could be adopted to a larger extent in green public procurement.[11]

Some concerns regarding the design, implementation and governance of further standardization remain and need to be accounted for.

First, it is complicated to compare the performance of different materials production processes (for example in the case of steel or chemicals). An approach towards setting just benchmarks is necessary.

Second, there might be an issue of governance reliability given that most industrial standards are developed by certifying authorities in very close cooperation with industrial players. There is a risk that changes and modifications to different types of standards (e.g., footprint vs performance standards) are led and dominated by large industrial players. The governance system in place needs to ensure that standardization is robust to such conflict of interest issues.

Third, by setting narrowly defined technical requirements and restricting possible applications (e.g., the use of certain biomass residues as alternative

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[10] Emission performance criteria have already been implemented by the Industrial Emissions Directive (2010/75/EU). This regulation, though, only covers processes for which the EU published BREF (Best Available Technique Reference) documents, which are not yet published for all target sectors or are with revisions that are up to 17 years old (in case of Industrial Cooling Systems dating 12.2001). Furthermore, this directive grants national authorities the freedom to diverge from emission levels defined as BAT.

[11] The current EU public procurement regulation (Directives 2014/24/EU and Directives 2014/25/EU) provides a regulatory framework for considering environmental quality in the awarding of public contracts, including via technical requirements. However, it neither mandates the use of GPP nor sets binding targets. Therefore, EU Member States are free to determine the extent to which they implement and use GPP.

feedstock in the fertilizer industry), some standards hinder the shift to new materials and the exploration of innovative products, product designs (e.g., in building construction), and sustainable solutions. Standardization needs to foster innovation by setting the right performance oriented incentives (e.g., based on lifecycle GHG emissions, toxic substance content, ease of recyclability).

Furthermore, it should be considered that certifying all actors in the supply chain can be a highly complex endeavor. The basic material sector, like the cement industry, has a supply chain with a highly reduced complexity compared to, for example, the car industry. Car manufactures have well- established sector specific standardization requirements and impose compliance certification, even on small and medium-sized suppliers. This suggests that additional standardization requirements may be challenging, but not impossible, for the basic material sector.

An important question is the appropriate timing for the phase-in of standards and corresponding legislation to make them legally binding. This includes key decisions about the design of such standardization, as whether these should be, for example, defined based on quantities marketed (large quantities first), for individual sectors, or by labelling in an early phase.

Experiences from existing product and process standards in the EU can help in designing the corresponding regulation to foster the standardization and certification of basic materials. Current legislation to ensure that imported biofuels meet sustainability criteria by certifying local production processes (RED/RED II) could be extended. For this hybrid governance approach, the EU recognizes standards and certifications developed by private initiatives to assess and certify compliance of a particular biofuels. EU institutions accredit and monitor the certification processes of these private initiatives to ensure that the certified biofuel complies with EU legislation (Stattman et al. 2018).

3 The role of Contracts for Differences

Creating incentives for investment in breakthrough low-carbon material production processes requires two things. First, to ensure sufficient and stable revenue streams from investments in low-carbon technology. Second, to ensure cost-competitive supply of large volumes of low-carbon electricity. Contracts for differences have potential to address both needs.

Project-based carbon contracts for differences (CCfDs) are contracts between a company developing a low-carbon project and a national government. These are implemented as a contract for differences on the yearly average auction price of emission allowances (EUAs) with emissions benchmark as a baseline. The difference between the EUA price and an agreed strike price per ton of emission reduction is paid, thus effectively ensuring a guaranteed carbon price for the project. If the market carbon price exceeds the strike price, the project owner is liable for paying the difference to the government (Richstein 2017).

CCfD can help to cover the incremental cost of low carbon innovation, especially the operating cost, so that commercialization becomes a viable economic option. This way, it can ensure sufficient revenue streams to incentivize investments in low-carbon technologies. Therefore, they might in principle be superior to more standard innovation funding, which has seen pilot projects abandoned despite funding due to the lack of commercialization perspectives.

These kind of contracts could work stand-alone in the case of technologies close to the market, as they stabilize the cash flow and limit price volatility. For break-through technologies, they would need to be complemented with traditional innovation funding in order to bring technologies to higher Technology Readiness Levels (TRLs) and to bridge valleys of death.

Further, CCfD can allow national governments to create lead markets for low-carbon innovation processes and materials, as well as to recuperate costs as carbon prices rise. In addition, they signal the long-term carbon policy ambition of governments and anticipate long-term carbon-price expectations, thereby addressing regulatory uncertainty and risk during the transition process (Chiappinelli and Neuhoff 2018).

Several issues were discussed during the workshop, including (i) potential competition between Member States and conflicts of interest in the definition of the strike price; (ii) how to ensure a competitive strike price in case of limited participation in tenders and for CCfDs; and (iii) what should be the emission-reduction benchmark level when EU-ETS free allocation is removed. An option that comprehensively addresses these issues is the allocation process itself. Firstly, based on competition (through auctions) for innovation funding and CCfD signed with national government, it would include a common strike price, using current benchmarks.

Insofar as national governments take regulatory risk in CCfD, a question emerges on how to compare the performance of these contracts with other industry contracting formats adopted in project financing, e.g. Public Private Partnerships in big construction projects.

Another concern possibly relevant for the design of CCfD is that if they are designed at the EU level, projects may end up being concentrated in few geographical areas (e.g. CCS deployment will require infrastructure, which will be where natural resources are). Therefore different strike prices for different regions or other suitable instruments (e.g., preferential loans by EIB etc.) may be required to address such differences.

Contracts for differences for Renewables (CfDs) are contracts where renewable energy operators are remunerated at an agreed upon strike price whenever the wholesale electricity price is lower than the strike price, while the operators must pay back the difference when market values lie above the strike price. Therefore, CfDs hedge investors against power price uncertainty, enabling lower financing costs and competition between small and large actors. A public counterparty resolves policy risks and overcomes constraints that limit, in many instances, private long-term contracting arrangements with final electricity users as well as avoiding downgrading of intermediaries if they retain the long-term price risk. All this implies a reduction of renewable energy cost (almost 30% reduction per MWh delivered, see May et al 2018).

Therefore, CfDs for renewables have the potential to ensure cost-competitive supply of large volumes of low-carbon electricity required to decarbonize European industry. An example of a successful experience in this case is the UK, where CfDs are awarded by a government-backed entity.

While the three policy instruments discussed in this section seem to have good potential to transform the basic materials sectors, open questions, as highlighted, should be addressed and other remaining issues should be considered in the design. Thus, further and deeper analysis is needed to strengthen the case for such a policy package.

How can European policies be inclusive? What is the value added of European cooperation?

5

1 What opportunities exist for all EU countries to be included in the transition process and benefit from innovation and investment in climate friendly options?

The participants of the Hungarian national roundtable argued that the intensity of support in industrial energy efficiency programs should reward combined energy efficiency measures that result in multiple benefits, thus encouraging higher energy savings.

In the case of Poland, its existing expertise in the area of decarbonizing conventional carbon-based technologies (developed, inter alia, through its past attempts to introduce “clean coal” technologies in the power sector) may be applicable to CCS-based industrial decarbonisation options. There are several incentives to redirect the focus from the power sector to industry: a lack of tangible progress and operational cost competitiveness of CCS technologies in the power sector, a well-developed domestic coke industry that is interested in introducing “clean coke” solutions to ensure sustainability of its business model in the long run, growing interest in the hydrogen economy (with supplies coming from the industrial sector, which can be decarbonized by applying CCS), as well as the relatively well-developed cement industry that faces a process emissions problem. Nevertheless, it may be challenging for Poland to develop CCS industrial solutions alone, especially if the rest of the EU chooses alternative technology pathways.

Another opportunity for Poland is to develop industrial symbiosis solutions on the regional level. Silesia – the largest remaining hard coal mining region in the EU – is also one of the major clusters of large industrial power plants in the EU (Strane Innovation 2016).

2 What is the role of multinational (foreign) ownership of companies – which is particularly prominent in central and eastern European countries?

The internationalization of material sector firms is both an opportunity and a threat from a host country perspective. The innovation potential of these companies significantly outreaches the playing field of local competitors. Despite this fact, without a credible incentive from a European level policy framework, multinational companies tend to optimize their investments and technologies based on short-term financial gains rather than environmental aspects. Plants at lower company levels can rely heavily on corporate resources with respect to technical/technological expertise, financing energy-efficiency measures. Company-wide synergies are also exploited in most cases, while energy-saving opportunities are identified at both the corporate and the plant levels.

Past experience in Poland shows that multinationals are ready to, and do invest in, modernization and organizational innovations (often based on best available technologies and practices, e.g. achieving very high share of alternative fuels usage by cement plants in Poland) in industrial power plants. These decisions are driven by business cases (increased process efficiency) and the need to comply with the EU environmental regulations. In this context, the investment cycle provides an opportunity to leapfrog technologically, as was the case in the past with the modernization of technologies used in CEE before the economic transition and the EU accession.

A credible EU-level policy framework that provides sustainable price signals to invest in low-carbon technologies is crucial for incentivizing international companies to transform, especially during the mass deployment of these solutions within the EU market. Another option is to put in place discriminatory, regionally-sensitive EU policies e.g. for Innovation

R&D for local producers, to give these countries preferential treatment that enables them to become an early mover in the transformation.

3 How to avoid delaying investments in climate friendly technologies and practices, and extending the life time of old assets such that, once they are ultimately closed, markets are captured by others?

The energy and emissions intensity depend on the specific product structure of the industries in the various countries. Economic cycles strongly affect the levels of industrial emission in the short term. For example, looking at trends in the most energy-intensive Hungarian manufacturing sectors, it is obvious that the dynamic expansion of production during economic recovery following the 2008 crisis was accompanied by increasing emissions per value added in some sectors, especially in the coke and refinery sector and the chemical sector. This fact highlights the contradictory aspects of short-term economic growth and emissions.

The challenge remains during the pilot phase and early scale-up of the low-carbon industrial technologies. Past examples (in particular Polish experiences with supporting coal + CCS projects within the NER300 programme) show that relying solely on EU funding to achieve early deployment and associated learning-by-doing effects is not enough. Domestic policy solutions, including additional investment or operational support, are needed to leverage available European-level funding. This may be a major obstacle for CEE and Southern member states. They often face greater fiscal constraints and are less experienced not just in deploying complex R&D support from different sources, but also other instruments (e.g. green public procurement). Another obstacle is limited participation in EU innovation funding (especially Framework Programmes), notably among the institutions in the CEE region. National Energy and Climate Plans and Long-Term Scenarios introduced by the Energy Union Governance regulation provide a useful framework for strategic thinking about the sectoral and overarching actions, as well as cross-border cooperation on the infrastructure and R&D activities. Thus, these documents should explicitly address the material industries challenge, both when it comes to decarbonisation of industrial processes as well as the integration of low-carbon transition with circular economy development measures.

4 How to ensure public acceptance of the transformation e.g., by timely including distributional impacts in the debate, which is currently biased towards trade-issues?

This may involve options to make bearing the incremental cost progressive, e.g. per-head reimbursement of consumption charges, which are easy to understand and communicate. Further, demand-side perspectives and circular economy development should be linked with discussion on low-carbon industrial process deployment from the start, in order to ensure that the transition in the materials sector is introduced in a cost-efficient manner and the benefits can be widely shared.

Public acceptance is likely fundamental if decision makers are to dedicate attention to the climate implications of material choices. Equally, national policy makers have a large impact on public acceptance. Hence, it is equally important to raise awareness among national policymakers regarding the scale of required changes and implications for the materials sectors.

Public acceptance and awareness of policy makers is essential for future policy design to guide a successful transition process, and this may benefit from capacity building regarding specific policy mixes and policy instrument designs, including the networking between different EU Member States (e.g. twinning arrangements).

Conclusion

The transformation of the basic materials sector in line with the 2050 emission reduction target presents both a challenge and an opportunity.

On one hand, the capital-intensive investments that are needed to meet the targets will not be made unless there are sufficient incentives set by the policy framework, which is currently unclear and dominated by other concerns (e.g. carbon leakage protection). Creating a robust policy package might be challenging. On the other hand, transition processes with large (re)investments is an inherent opportunity to attract resources to and create job opportunities in various countries.

Inclusive transformation can enable all EU countries to take part in the transition process and benefit from innovation and investment in climate friendly options. It requires a shared vision of feasible development pathways and will benefit from financial/policy incentives on the EU level. Thus, it can protect local economies, as well as Europe, from lock-in risks associated with carbon intensive processes and practices.

Discussion in the project roundtables focused on three policy instruments that were considered to have the potential to make a significant contribution to the transformation process: carbon pricing robust to carbon leakage, standards, and contracts for differences. Further analysis on these instruments is needed to strengthen the case for the policy package, including a deeper understanding of the distributional impact of transformation incremental costs.

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Annex

Statistical data on materials industries in Hungary, Poland and Spain

Hungary

TABLE 1: Material sectors in Hungary compared to the EU (2015).

	Production *in 2015, Mt*	CAGR *2005-2015*	Share in EU production in 2015
Steel	*1.7*	*-1.5%*	*1.0%*
Basic chemicals	*1.9*	*14.3%*	*2.1%*
Cement	*2.4*	*-3.3%*	*1.4%*
Paper	*0.8*	*3.0%*	*0.8%*

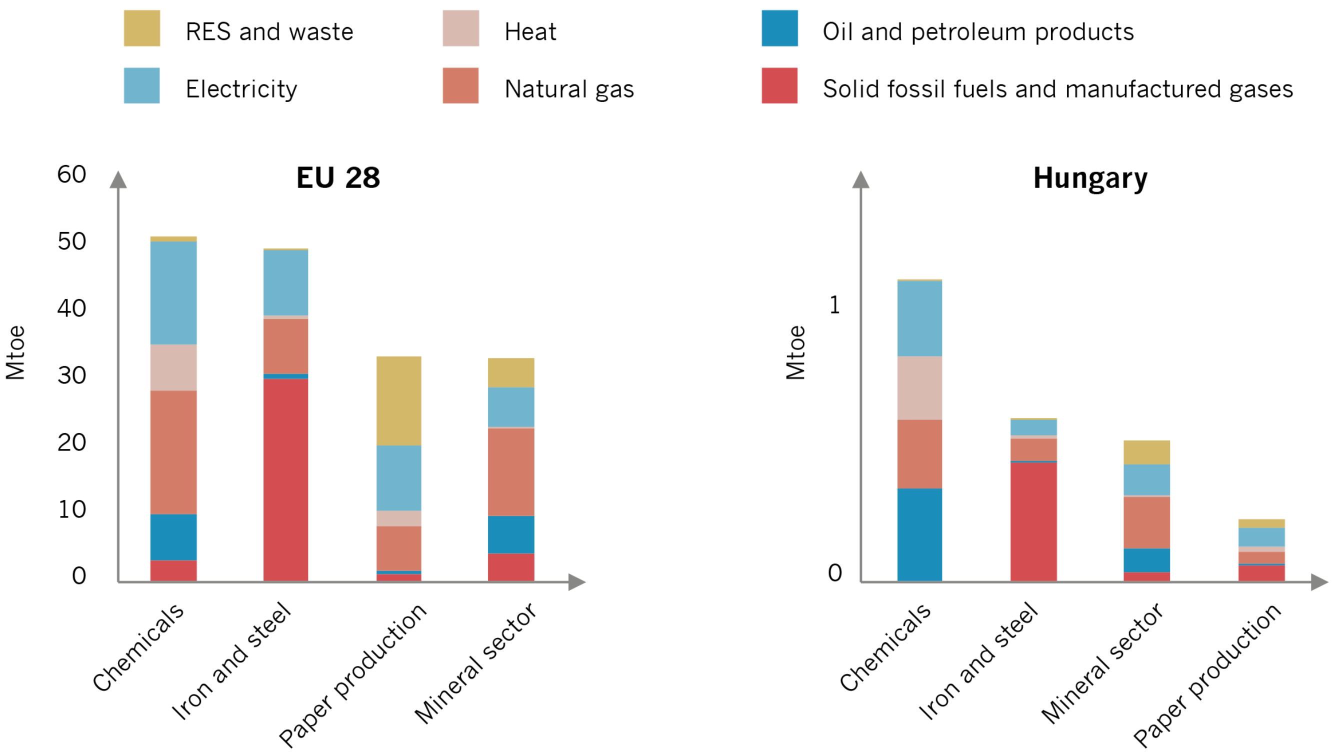
Source: JRC-IDEES-2015 (ISI, CHI, NMM, PPA)

TABLE 2: Economic indicators for material sectors in Hungary (2016).

	Value added		Persons employed	
	million euro	*% in total manufacturing*	*Thousands of people*	*% in total manufacturing*
Manufacture of coke oven products	*16*	*0.1%*	*0.6*	*0.1%*
Manufacture of fertilizers and nitrogen compounds	*62*	*0.3%*	*1.0*	*0.1%*
Manufacture of cement	*44*	*0.2%*	*0.6*	*0.1%*
Manufacture of basic iron and steel and of ferro-alloys	*120*	*0.5%*	*4.3*	*0.6%*
Manufacture of paper and paperboard	*:*	*:*	*:*	*:*
Total	*242*	*1.1%*	*7*	*0.9%*

Sourc: Eurostat, 2017a

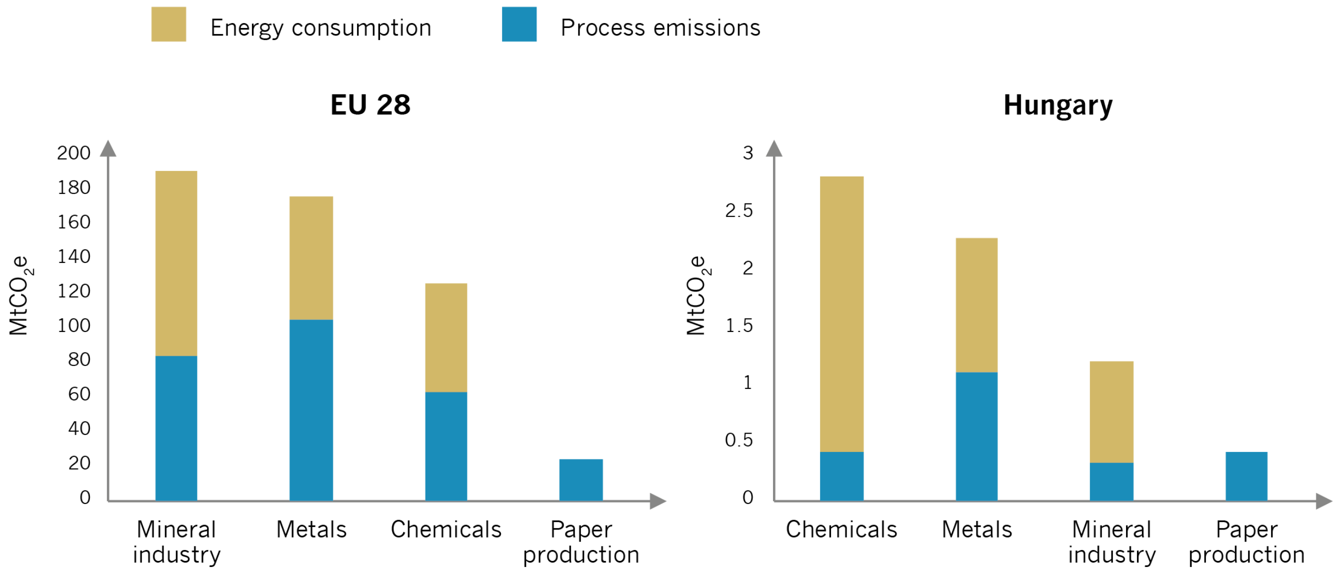
FIGURE 2



Source: Eurostat, 2017b

FIGURE 3

Total GHG emissions by material sectors in Hungary and EU 2016.



Source: EEA, 2016b

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12 When comparing energy consumption and energy efficiency across countries in steel production, the relative shares of primary production over total production should be taken into account.

Poland

TABLE 1: Material sectors in Poland compared to the EU (2015).			
	Production *in 2015, Mt*	**CAGR** *2005-2015*	**Share in EU production in 2015**
Steel	*9.2*	*1.0%*	*5.5%*
Basic chemicals	*4.0*	*2.3%*	*4.6%*
Cement	*15.9*	*2.3%*	*9.2%*
Paper	*4.4*	*4.9%*	*4.8%*

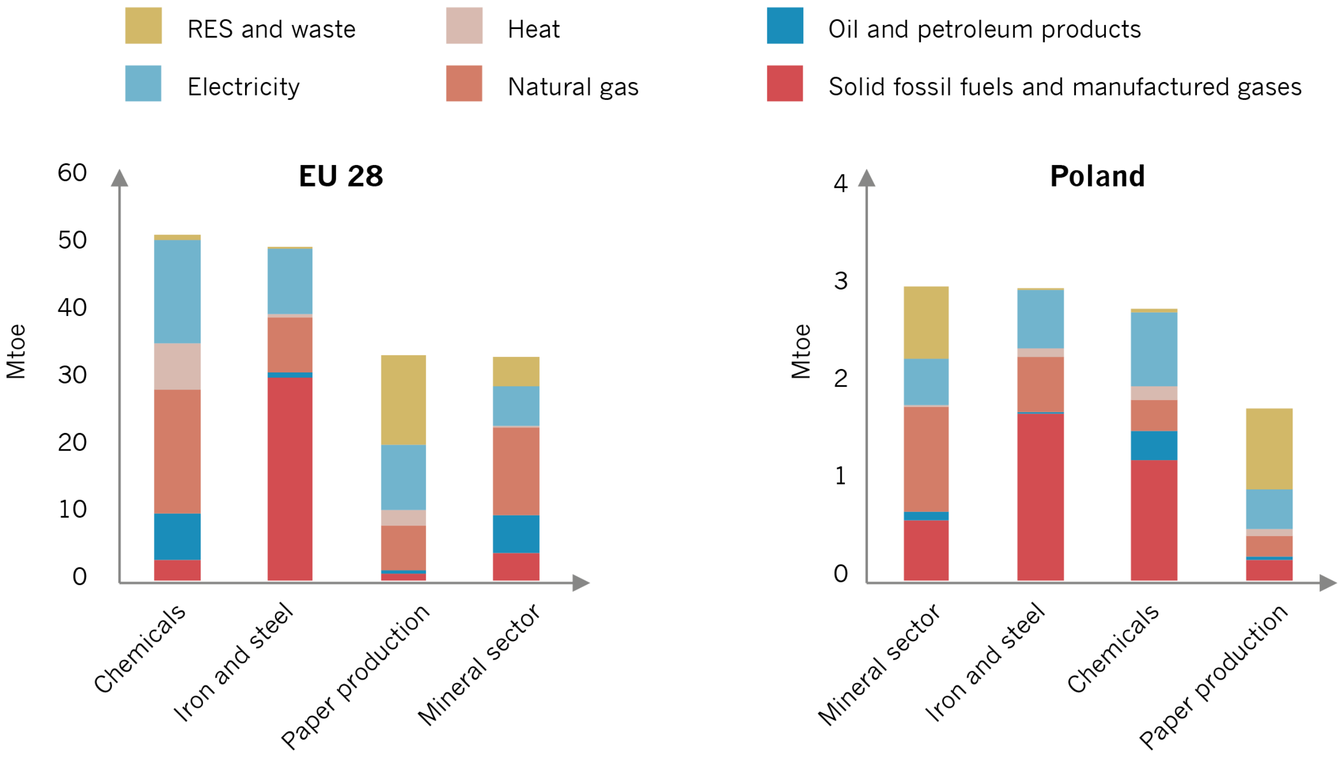
Source: JRC-IDEES-2015 (ISI, CHI, NMM, PPA)

TABLE 2: Economic indicators for material sectors in Poland (2016).				
	Value added		**Persons employed**	
	million euro	*% in total manufacturing*	*Thousands of people*	*% in total manufacturing*
Manufacture of coke oven products	*115*	*0.2%*	*3.7*	*0.1%*
Manufacture of fertilizers and nitrogen compounds	*513*	*0.8%*	*10,5*	*0.4%*
Manufacture of cement	*412*	*0.6%*	*5.0*	*0.2%*
Manufacture of basic iron and steel and of ferro-alloys	*1.018*	*1.6%*	*19.5*	*0.8%*
Manufacture of paper and paperboard	*683*	*1.1%*	*7.5*	*0.3%*
Total	*2.742*	*4.3%*	*46*	*1.8%*

Source: Eurostat 2017a

FIGURE 4

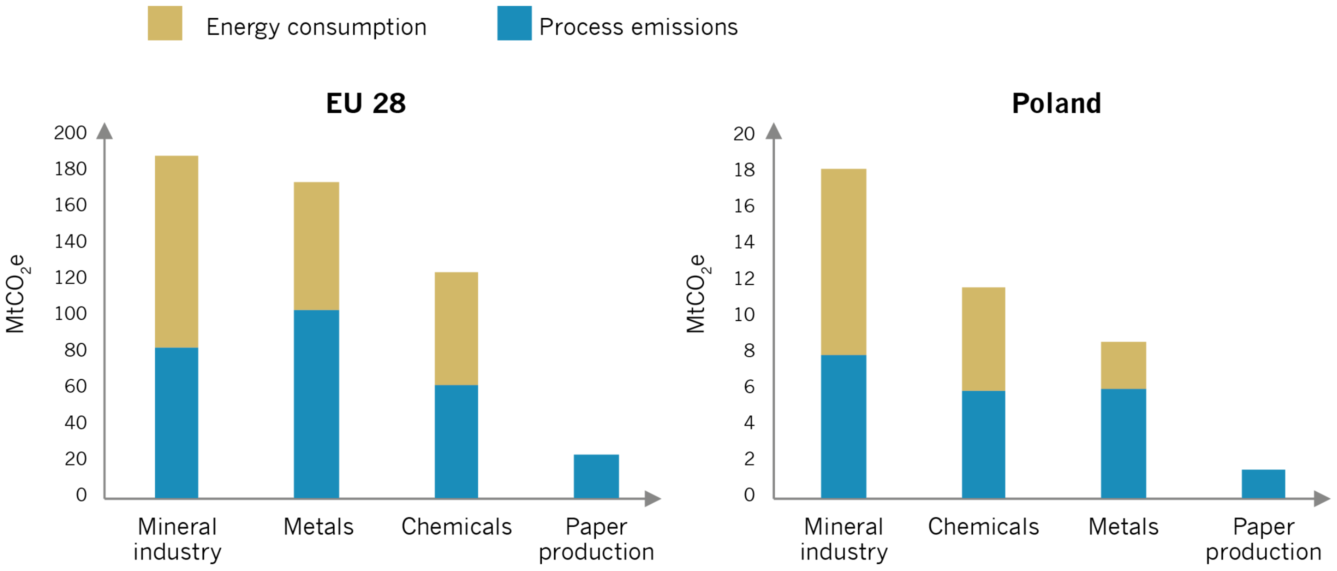
Energy consumption in material sectors in Poland and EU 2017



Source: Eurostat 2017b

FIGURE 5

Total GHG emissions by material sectors in Poland and EU 2016.



Source: EEA, 2016

Spain

TABLE 1: Material sectors in Spain compared to the EU (2015).

	Production *in 2015, Mt*	**CAGR** *2005-2015*	**Share in EU production in 2015**
Steel	*14.8*	*-1.8%*	*8.9%*
Basic chemicals	*4.0*	*-3.1%*	*4.7%*
Cement	*14.7*	*-11.6%*	*8.5%*
Paper	*6.2*	*0.8%*	*6.7%*

Source: JRC-IDEES-2015 (ISI, CHI, NMM, PPA)

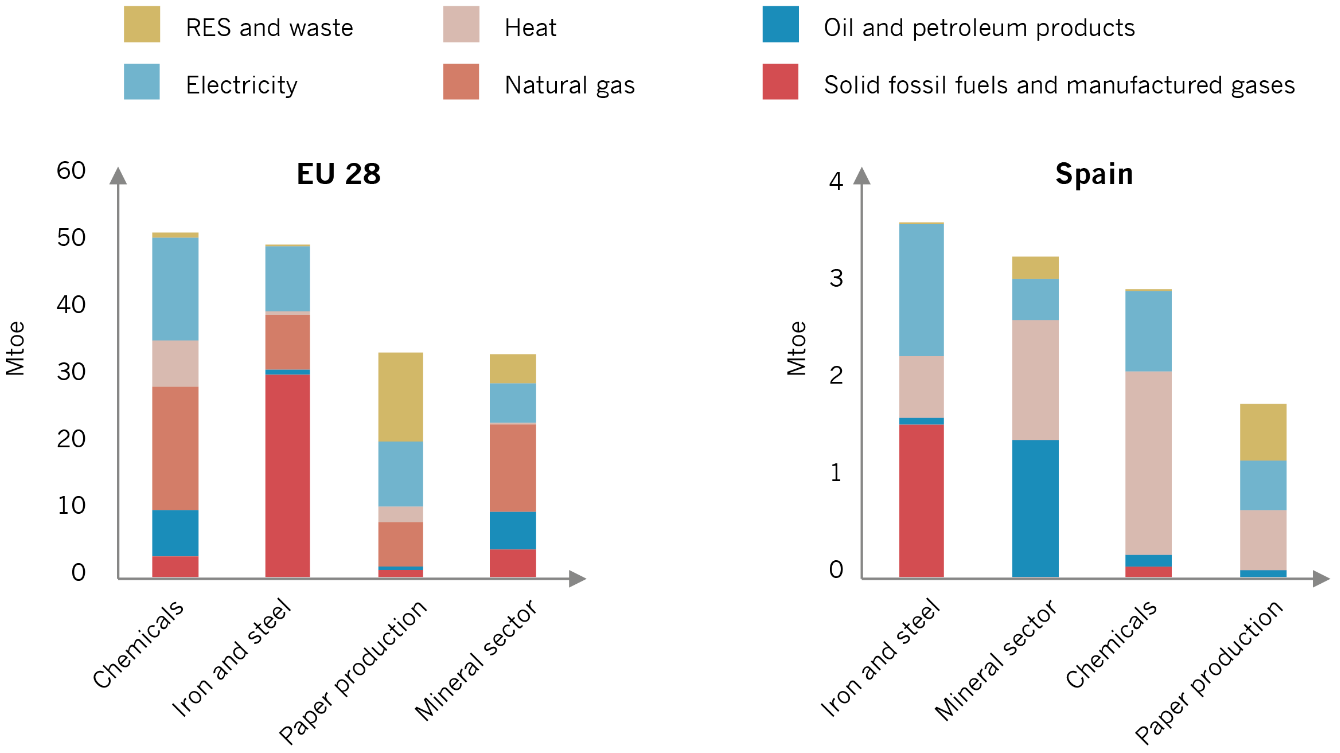
TABLE 2: Economic indicators for material sectors in Spain (2016).

	Value added		**Persons employed**	
	million euro	*% in total manufacturing*	*Thousands of people*	*% in total manufacturing*
Manufacture of coke oven products	*:*	*:*	*:*	*:*
Manufacture of fertilizers and nitrogen compounds	*321*	*0.3%*	*4.8*	*0.3%*
Manufacture of cement	*499*	*0.5%*	*4.8*	*0.3%*
Manufacture of basic iron and steel and of ferro-alloys	*1.678*	*1.6%*	*21.2*	*1.1%*
Manufacture of paper and paperboard	*964*	*0.9%*	*8.0*	*0.4%*
Total	*3.462*	*3.3%*	*39*	*2.1%*

Source: Eurostat 2017a

FIGURE 6

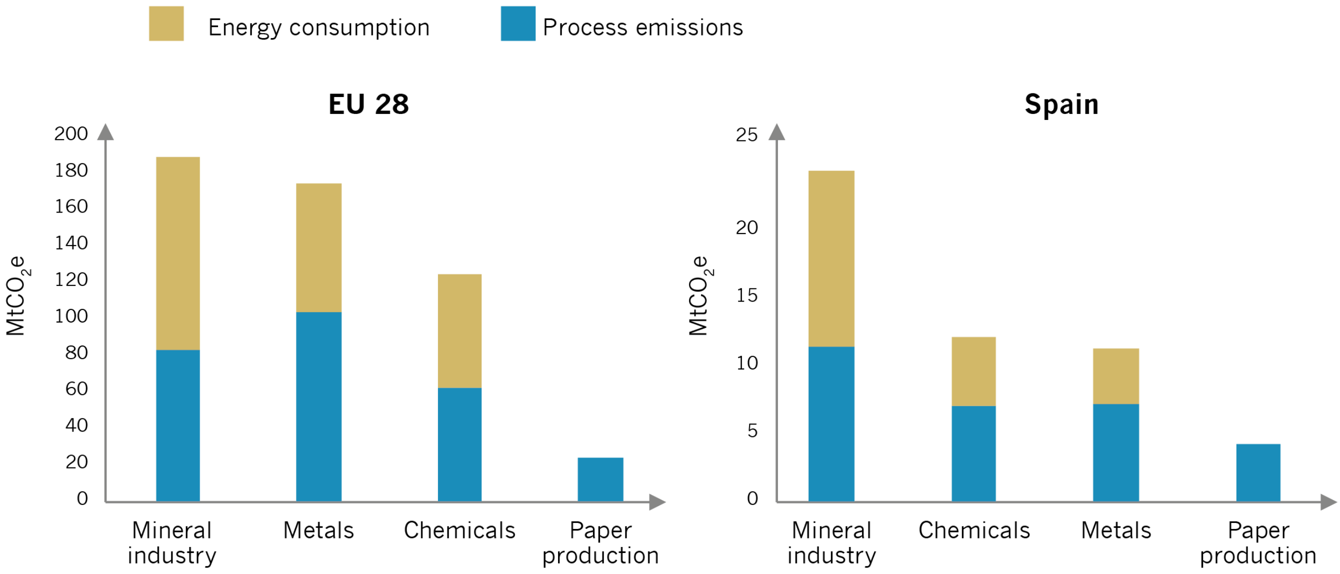
Energy consumption in material sectors in Spain and EU 2017



Source: Eurostat 2017b

FIGURE 7

Total GHG emissions by material sectors in Spain (right) and EU (left) 2016.



Source: EEA, 2016

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