Energy Policy 120 (2018) 533–549

Contents lists available at ScienceDirect

Energy Policy

journal homepage: www.elsevier.com/locate/enpol

Leveraging material efficiency as an energy and climate instrument for heavy industries in the EU

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ARTICLE INFO

Keywords:
Material efficiency
Energy and climate policies
Multiple stream framework
New institutionalism
Rational choice institutionalism
Resource efficiency

ABSTRACT

Material efficiency is indispensable to reaching agreed targets for industry's energy and carbon emissions. Yet, in the EU, the energy- and emissions-saving potentials of this strategy continue to be framed as secondary outcomes of resource-related policies. Understanding why material efficiency has been overlooked as an energy/climate solution is a prerequisite for proposing ways of changing its framing, but existing studies have failed to do so. This paper fills this gap by triangulating interviews, policy documents and three policy theories: namely, historical and rational choice institutionalism, and multiple streams framework. Factors discouraging material efficiency as an energy and climate strategy include: difficulties in reframing the prevailing rationale to pursue it; the inadequacy of monitored indicators; the lack of high-level political buy-in from DG Energy and Clima; the ETS policy lock-in; uncoordinated policy management across Directorates; the lack of a designated industry lobby. Policy solutions are proposed. Before 2030, these are limited to minor amendments, e.g. guidance on embodied energy calculations or industry standards. Post-2030, more radical interventions are possible, such as introducing new fiscal drivers, re-designing the ETS emissions cap or benchmarks for allowances. This evidence suggests that the transition to a low-carbon industry will require Member State- and industry-level action.

1. Material efficiency: A tool to reduce energy use in heavy industries

In 2016, industry was responsible for over a quarter of the European Union's (EU) total final energy use (Eurostat, 2018), and just under half of this was consumed in energy-intensive industries. Improving energy efficiency (EE) in these industries is therefore key to reduce carbon dioxide (CO_2) emissions and energy demand (EC, 2016b) in the region. Yet potential gains from EE have proved to be limited compared to the scale of CO_2 emissions reduction targets (Allwood et al., 2010; Fischedick et al., 2014).

There is a growing body of academic literature which contends that reducing the use of energy-intensive materials through material efficiency (ME)[1] – using less materials to provide the same service – could be a complementary strategy to address the emissions gap. Allwood et al. (2011) propose nine strategies to improve ME: light-weighting, re-using, re-manufacturing, recycling, diverting scrap, extending product lives, using products more intensely, improving process yields, and substituting materials. Several studies have quantified the technical potential for improvement of some of these strategies in energy-intensive sectors, e.g. steel (Allwood and Cullen, 2012; Rachel et al., 2013; Pauliuk and Müller, 2014), aluminium (Cullen and Allwood, 2013), paper (Griffin et al., 2018; Ewijk and Stegemann, 2017), cement (Kajaste and Hurme, 2016) and chemicals (Griffin et al., 2017). Overall, Cooper et al. (2017) estimate that 6–11% of the energy used to support economic activity, both globally and in the EU, can be saved by improving ME. In steelmaking, Cullen et al. (2012) reveal that over a quarter of the global liquid steel produced is lost in casting (74 Mt), forming (99 Mt) and fabrication (186 Mt).

ME also has proponents outside of academia, with interest from the International Energy Agency (IEA, 2015), Intergovernmental Panel on Climate Change (Fischedick et al., 2014) and United Nations

Abbreviation: BREF, Best Practice Reference document; CE, Circular Economy; DG, Directorate General; EC, European Commission; EE, Energy Efficiency; EEA, European Environment Agency; EED, Energy Efficiency Directive; ETS, Emissions Trading Scheme; EU, European Union; GhG, Greenhouse Gas; HI, Historical Institutionalism; IED, Industrial Emissions Directive; JRC, Joint Research Center; LCA, Life-cycle Assessment; ME, Material Efficiency; MSF, Multiple Streams Framework; RCI, Rational Choice Institutionalism; RE, Resource Efficiency

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[1] The terms ME and resource efficiency (RE) are often used interchangeably. Here, the term ME denotes the strategies identified by Allwood et al. (2011), as well as industrial symbiosis – the recovery of by-products.

https://doi.org/10.1016/j.enpol.2018.05.055
Received 20 February 2018; Received in revised form 22 May 2018; Accepted 24 May 2018
0301-4215/

Environmental Programme (Etkins and Hughes, 2017). All three signal it is an under-explored CO_2 mitigation strategy which merits further policy attention.

In the European Commission (EC), policies that support ME belong within the environmental policy remit (EC, 2011a) – in the Directorate General (DG) for Environment – rather than energy and climate. These environmental policies aim to guarantee resource availability, reduce price volatility and drive economic growth (EEA, 2010, 2016; EC, 2011b), framing impacts on energy use and emissions as potential secondary outcomes. Industrial policies aimed at reducing energy and emissions, however, have yet to leverage ME as a tool to achieve the region's binding energy and emissions targets. In fact, Skelton et al. (2017) and Neuhoff et al. (2016) have showed that the Emissions Trading Scheme (ETS) – the EU's main climate policy – provides inadequate incentives for material efficiency.

This paper sets out to answer two research questions:

1. *Why is material efficiency not part of the EU's energy and climate policy remit?*
2. *How could it become a policy option to help reduce energy and emissions?*

2. Review

Answering these questions requires: an understanding of the current EU energy, climate and resource policies (Section 2.1); an assessment of existing studies that investigate the prominence, or otherwise, of ME in these policy areas (Section 2.2); and a review of frameworks that examine the agenda-setting process (Section 2.3). Together, these three strands of literature inform the research approach to this study (Section 2.4).

2.1. *The EU's energy, climate and resource-related policies*

The EC has a breadth of policy tools at hand to incentivise and enforce the reduction of energy and material use (the combination of which we denote as 'resources') in heavy industries. Currently, four main policy areas can influence this: (1) the Energy Union; (2) DG Energy (EC, 2006, 2011b, 2014d); (3) DG Environment (EC, 2011a, 2014c); and (4) DG Clima.[2] Fig. 1 uses the policy pyramid approach (Reinaud and Goldberg, 2011) to characterise the EU policy landscape shaping resource use in industry. Policies are divided into three groups: effort-defining policies; supporting measures that encourage the delivery of these efforts; implementation tools that help operationalise these.[3] See Table A1 for more details.

Starting at the top of the pyramid, there are three effort-defining policies for heavy industries, all motivated by the need to reduce energy and emissions: the 2020 climate and energy package; the 2030 climate and energy framework (EC, 2008a, 2014a); the Energy Union. These impose two economy-wide targets for 2020 and 2030; one on emissions (20% and 40% reduction) and one on energy use (20% and 27% reduction).

The ETS is the main supporting measure for these effort-defining policies (EC, 2009a). Other regulatory mechanisms that provide tangible support include the: (1) Eco-design directive, which targets energy-consuming devices; (2) Energy Efficiency Directive (EED), which enforces energy auditing in large enterprises (Article 8); (3) IED, which defines best available techniques for installation permits (EC, 2009b); (4) the Raw Materials Initiative, which aims to improve the market for secondary materials (EC, 2008c); (5) waste legislation, which is now under the Circular Economy (CE) package (EC, 2015b). The remaining supporting measures mainly provide the foundations from which longer-term progress can be initiated: roadmaps, monitoring frameworks and research funding, e.g. Horizon 2020.

At the bottom of the pyramid, a number of implementation instruments are available, which enable engagement with the wider policy community. For example: training programmes, stakeholder platforms, regulation guidelines, impact assessments and public consultations.

Visualising the coverage of the most relevant ME measures across existing EU policies – portrayed in Fig. 2 – reveals that only a subset of these are currently covered by DG Environment, with little support offered for measures such as light-weighting or yield improvements. Policies targeted at industrial energy use primarily focus on heating, cooling, recovering waste heat, and fuel switching. The EU's flagship climate policy, the ETS, provides weak incentives to introduce any ME strategies (Skelton et al., 2017; Aidt et al., 2017; Neuhoff et al., 2016), and IED's guidelines on best practice do not explicitly cover ME and target non-CO_2 emissions.[4]

2.2. *Analyses of EU-level material efficiency policies*

Section 2.1 shows that ME cuts across multiple Directorates and policy objectives, and the literature examining ME-related policies is similarly diverse. The reviewed studies, summarised in Table 1, can be grouped into four categories, those which investigate: (1) the suitability of ME indicators; (2) the barriers to ME; (3) the analysis of policy agendas; (4) options for and impacts of policy interventions. From these, the most relevant papers are highlighted with asterisks (*) in Table 1.

Mehlhart et al. (2016) investigated the, as yet, under-explored energy-saving potential of ME as an option to achieve energy targets. The report identifies barriers only for a subset of ME measures in different sectors, including heavy industry, and proposes remedial interventions. Similarly, Scott et al. (2017) analyse ways in which EU product policies could be extended to include aspects on material and product use; they propose modifying these to include embodied emissions – currently unaddressed by the ETS. Yet, Mehlhart et al. (2016), do not consider the complete policy landscape shown in Fig. 1, and Scott et al. (2017) provide no empirical evidence. Neither study investigates the lack of attention given to ME in energy/climate policies, but rather take this as their starting point.

Two studies examine the economic rationale for policies that incentivise ME in industry. Neuhoff et al. (2016) and Skelton et al. (2017) specifically analysed the potential role of the ETS in stimulating ME. Neuhoff et al. (2016) propose the inclusion of a consumption charge, and Skelton et al. (2017) suggest the removal of distortive taxes and the implementation of carbon leakage exemptions that "*are independent of embodied carbon*". Despite valuable analyses, they, again, fail to reference the broader policy landscape, and provide limited insight into the political and behavioural aspects taking part.

Cooper-Searle et al. (2017) use the Multiple Streams Framework (MSF) from Kingdon (1984) to investigate why ME is not a bigger part of the UK climate policy agenda. The authors go beyond quantitative economic analyses, and provide meaningful insights into the aspects influencing policymakers' decisions. Yet, restricted to the UK's automotive sector, it provides limited insight into the agenda-setting process for climate strategies at EU-level.

The EU is committed to reduce energy use by 20% before 2020 and by at least 27% before 2030. The successful adoption of ME in heavy industries is key in achieving these. None of the studies in the literature

[2] Aside from these, DG Growth and other Commission-wide initiatives can occasionally indirectly impact industrial energy and material use (as shown in Fig. 1 and 2).

[3] We exclude two policies (Circle Economy, 2017): Extended Producer Responsibility (EPR) and Green Public Procurement (GPP). The former, although effective in areas such as batteries, electric vehicles and packaging, is not particularly relevant to heavy industries. Similarly, GPP only has an indirect impact.

[4] They only cover the production facility, limiting the extent to which they can regulate upstream environmental impacts and outgoing material streams – where gaps for ME improvements lie (EPA, 2016).