



# How coordinated sectoral responses to environmental policy increase the availability of product life cycle data

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## Abstract

**Purpose** Environmental Product Declarations (EPDs) and Product Carbon Footprints (PCFs) have a significant potential for contributing to consumption-based approaches to climate change. This paper provides an important building block towards a theoretical model of the factors accounting for variations in the availability of life cycle data across countries. It does so by positing a mechanism linking industry associations' institutional role within environmental policy processes to the availability of product life data and by empirically validating it.

**Methods** Interviews, qualitative document analysis, web scraping, quantitative text analysis, set-theoretical causal reasoning, and process tracing.

**Results and discussion** Environmental policies that stipulate industry-government deliberations and assign a coordinating or mediating role to industry peak associations can stimulate the exchange of environmental information among industrial sectors. The policy instruments of determination of 'best available techniques' (BAT) towards standard setting, negotiated collective agreements and carbon pricing all contribute towards the institutionalisation of organised information exchange within industry. This lowers transaction costs for the monitoring, reporting and verification of sectoral environmental data and can thus be conducive to the creation of sectoral life cycle assessment data, with positive knock-on effects on the availability of firm- and product-specific LCA labels.

**Conclusions** Industry associations' institutional role within environmental policy processes can partially explain cross-national variations in the availability of product life cycle inventories.

**Keywords** EPD · PCF · LCA · IPPC · Climate policy · Emissions trading system · Negotiated agreements · EU ETS · Life cycle inventory · LCI

## 1 Introduction

As Environmental Product Declarations (EPDs) and Product Carbon Footprints (PCFs) can inform consumption-based approaches to climate change (Jordan and Bleischwitz 2020), it is crucial to inquire into the factors driving the development and diffusion of these eco-labels.

EPDs comprise certified life cycle assessments (LCA) of the environmental impacts associated with the production of a good. PCFs comprise partial LCAs, solely focussing on

global warming potential (see, e.g. Ormond and Goodman 2015; Van der Ven et al. 2017).

An important area for EPDs is the construction sector, which consumes vast quantities of the most important materials in terms of GHG emissions, in particular steel and cement (IRP 2020, p. 13). In early 2017, globally, there were nearly 6000 EPDs for construction products and 3600 of them verified following the European norm 15,804 (Anderson 2017).

German EPDs by far outnumber US EPDs in the construction sector (Anderson 2017). What accounts for this difference and what have been the drivers of EPD diffusion? There are distinct yet complementary ways to explain such variation. One option is to focus on specific cases and subject them to a comprehensive structured comparison taking into account the various potential factors, but short of a rigorous theoretical model of the diverse factors accounting for variations in the availability

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of life cycle data across countries such an approach runs the danger of being impressionistic and merely idiographic. This article contributes towards the construction of such a rigorous model by focusing on one factor: the extent to which the political environment provides incentives for an intra-sectoral exchange on the environmental impacts of production. The comparison between Germany/the EU and the USA provides empirical support for the proposed mechanism, offering a partial explanation for the differences between Germany/the EU and the USA.

Various potential factors account for the variability of EPD diffusion across countries: one can distinguish between informational push factors (conducive to information supply) and informational pull factors (stimulating informational demand). Informational pull factors have emerged in the form of incentives for EPD use by green building certification schemes (Cole and Jose Valdebenito 2013; Kaplow 2014; Passer et al. 2015) and the Buy Clean California Act, which, from July 2021, mandates the state to only procure a range of building materials below a threshold level of embodied carbon, demonstrable via EPDs (LegiScan 2017; US Green Building Council Los Angeles 2019).

Informational push factors are crucial: when the UNEP/SETAC Life Cycle Initiative consulted with experts on the question: “What is limiting more implementation of [life cycle] approaches in your country or industry?” The number 1 answer was “data” (United Nations Environment Programme and Society of Environmental Toxicology and Chemistry 2012, p. 51). Informational push factors in the form of more stringent environmental monitoring requirements and the greater diffusion of environmental management systems have contributed to Europe’s greater availability of life cycle data at the company level, as these elements drive *individual* companies to gather environmental data (see AUTHOR, under review). This article goes beyond the level of individual companies and instead focuses on how formalised coordination between government and industry peak organisations is conducive to the institutionalisation of intra-sectoral information exchange. This informational push factor for *sectoral* EPDs has knock-on effects on the availability of company-specific EPDs.

In Germany, in the beginning, companies needed convincing to contribute their own data for the assembly of generic data sets. The Institut Bauen und Umwelt (IBU) then pursued sectoral EPDs, offering trade association members average EPDs for a product group, which gave an initial boost to the publication of EPDs. Via sectoral EPDs, generic data could often be substituted with average data.<sup>1</sup>

Sectoral EPDs are an important catalyst for company-specific EPDs. First, they spread out the cost for EPD creation

across companies and are thus more affordable than company-specific ones. Second, once sectoral EPDs are released company-specific EPDs proving superior performance vis-à-vis sectoral EPDs acquire stronger marketing value.<sup>2</sup>

When the pioneering British Building Research Establishment (BRE) published about a dozen LCAs for construction products in 1999, they were based on data from UK trade associations.<sup>3</sup> Ecoinvent, one of the two main life cycle inventory (LCI) database providers, obtains primary data mostly from working with industry associations, who have the resources to be competent partners in the creation of LCIs.<sup>4</sup> For the other main LCI database provider, GaBi, industry associations are also important data sources (PE International 2013). Improvements in these background databases ease the process of creating high-quality life cycle assessments for products further downstream.

Kareiva et al. (2015, p. 7378) suggest spillover effects from corporate environmental disclosures to product labelling. Yet, the literature fails to sufficiently discuss the link between sectoral and product level data. The following fills this gap by proposing a causal mechanism linking the institutional framework in which environmental policy-making occurs to the generation of sectoral data on the environmental impacts of products.

The next section details hypothesis and methods. The article analyses three different types of sectoral coordination: Section 3 first describes how the European Commission enticed a range of industry sectors to engage in the sharing of data on the environmental impacts of production. After the proposition of mechanisms whereby such information-sharing may foster the production of sectoral LCIs, a temporal correlation between these exchange processes and the creation or publication of LCA datasets is identified. Section 4 shows how sectoral initiatives seeking to influence climate policy have helped to generate important LCI data and methodologies. Section 5 presents evidence that negotiated collective agreements have lowered the transaction costs involved in producing sectoral LCIs. Section 6 analyses spillovers between the different types of sectoral coordination. Section 7 discusses the results and derives recommendations for research and policy-making.

## 2 Hypothesis and methods

Environmental policies differ in the extent to which they incentivise companies to share information on the environmental impact of production within sectoral organisations.

<sup>1</sup> Interview with senior IBU representative in September 2017.

<sup>2</sup> Interview with IBU, and with Jane Anderson in October 2017.

<sup>3</sup> Interview with Anderson.

<sup>4</sup> Interview with Ecoinvent representative in December 2017.

**Table 1** Different types of information-intensive sectoral coordination with the aim of influencing environmental regulatory outcomes

	Function	Example	Level
Sector-based approach	Unilateral sectoral action to pre-empt or influence regulation	Cement sustainability initiative	Transnational
Negotiated collective agreement	Agreement between government and sector instead of regulation	Declaration by German Industry on Global Warming Prevention	National
Sectoral consultation	Collective sectoral information provision as part of institutionalised stakeholder dialogue	EU IPPC and IED Directives	National or supranational

Information provision is an important part of lobbying and offers an opportunity for industry to shape the perception of what regulation is feasible and rational (Broscheid and Coen 2007). How exactly such information provision occurs has important implications for the availability of information on the environmental impacts of products along their lifecycle.

This paper adopts a transaction-theoretical framework (Hall and Taylor 1996, p. 943; Nee 1998, p. 1f.; North 1990, p. 362) to argue that policy-induced incentives for the intra-industry sharing of environmentally relevant information reduce transaction costs for the creation of sectoral EPDs and are therefore conducive to their adoption. I identify two pathways for the reduction of transaction costs: first, the shared information can be directly relevant for EPD creation, thereby reducing the need for further information exchanges. Second, a political institutional configuration rewarding trade associations' sectoral coordination and an active role in collating environmental information from member companies establishes or entrenches trusted channels of information-sharing, easing the gathering of data relevant for life cycle assessments.

Where increased sharing of information on the environmental impacts of *production* lowers transaction costs for information-sharing about the environmental lifecycle impacts of *products*, this can also be conceptualised as a spillover effect. A *spillover* occurs when improvements in activity *a* lower costs for or increase the productivity of activity *b* (Pierson 2000, p. 255).

This paper presents evidence for the hypothesis that *a political environment setting incentives for an intra-sectoral exchange on the environmental impacts of production is conducive to the creation of sectoral life cycle data sets.*

Differences in policies are not isolated instances but embedded in differences across configurations of different policies, constituting distinct policy environments. US businesses often adopt a more adversarial attitude towards government than their Western European counterparts, who are embedded in a more corporatist cooperative culture (on the cross-national variation of such relations in environmental policy see Kollman and Prakash 2001). US trade associations tend to service their members rather than coordinate them, whereas in Western Europe, the

cooperative culture between business and government requires business to coordinate their action to fully exploit the bargaining potential that dialogue and agreements offer (Delmas and Terlaak 2002, p. 13f).

Table 1 shows three different types of information-intensive sectoral coordination aimed at influencing environmental regulatory outcomes: sector-based approaches, negotiated collective agreements and formalised sectoral consultations.

Instead of seeking to directly pass environmental legislation, some governments first choose to negotiate voluntary agreements with industry peak organisations to improve the performance of specific sectors. A failure to comply voluntarily with such *negotiated collective agreements* (NCAs) may result in the passing of legislation. *Sector-based approaches* grow out of unilateral sectoral action to pre-empt or influence regulation. Formal *sectoral consultations* institutionalise the provision of information from industry peak organisations to regulators.

Sector-based approaches and negotiated collective agreements are located in the pre-legislative sphere but the institutional capacity they create has ramifications for the formal embedding of *sectoral consultations* in regulatory procedures. These types of sectoral coordination can—individually or cumulatively—lead to increased sectoral information-sharing on environmentally relevant information and thereby reduce transaction costs for life cycle assessments.

The distinct ways in how these different types of sectoral coordination relate to governmental activity affect their level of operation. Sector-based approaches are not directly related to a governmental interlocutor and can therefore be transnationally organised. In contrast, NCAs require a government whose potential for passing legislation endows it with the required bargaining power for negotiating an agreement. Formalised sectoral consultation requires a national or supranational regulatory entity.<sup>5</sup> While these sectoral coordination types may

<sup>5</sup> Potentially, any of these sectoral coordination types could also be located at the subnational level but that would be a separate discussion, going beyond the empirical material at hand.

operate at distinct levels, the coordination established at one level can lower transaction costs at another level.

The next sections look at each of these sectoral coordination types in turn, providing evidence from empirical cases.

This paper combines semi-structured interviews, qualitative document analysis, quantitative text analysis in the form of dictionary methods and topic modelling (Welbers et al. 2017; Roberts et al. 2018), set-theoretical causal reasoning (Schneider and Wagemann 2012, pp. 56–75) and process tracing (Vennesson 2008; Collier 2011). It first establishes a systematic pattern of temporal overlap between sectoral information exchange in the context of the elaboration of best available technique reference (BREF) documents for the IPPC process and the release of sectoral life cycle information. It then offers different mechanisms for explaining this correlation. It focuses on the cases of the cement and steel sectors to trace processes leading from actual or anticipated policies and negotiated agreements, over sectoral information exchange to the release of sectoral LCIs and EPDs.

### 3 Sectoral consultations

In the EU, industrial sectors play a pivotal role in deliberations on integrated standards for *multiple* environmental media, such as water and air, in the form of BATs. In contrast, in the USA, environmental regulations tend to focus on only one environmental medium at a time and those media-specific standards are rarely coordinated across a sector (Fernandez 2005, p. 555; U. S. Environmental Protection Agency 2008, pp. xi, 140). Sectoral consultations can be seen as instrumental for achieving integrated multi-media approaches (Fiorino 1996; Erling 2001).

In 2010 about 50,000 industrial installations came under Directive 96/61 concerning integrated pollution prevention and control (IPPC Directive), stipulating emission limits based on BATs (Krämer 2016, p. 179). A Bureau of the Commission's Joint Research Centre produces BAT Reference Documents (BREFs), describing for each specific process the BAT. These are based on an exchange of information in a forum constituted by the Commission, Member States, environmental organisations and, crucially, industry sectors. By the end of 2010, this process had produced 35 BREFs, also for sectors covered by the EU emissions trading system (ETS), such as iron and steel, cement and lime, pulp and paper and glass (Krämer 2016, p. 176f.).

There is a striking temporal coincidence between the timing of the elaboration of BREFs and either the publication of major LCIs by industry, or the foundation of an organisation instrumental in releasing such data. Figure 1 compares the schedule of the elaboration of initial BREFs,<sup>6</sup>

and select revisions, with the publication of European LCIs from related industries for the period from 1996 to 2014.<sup>7</sup> The timelines stretch from kick-off meetings (including a de facto precursor event) to BREF acceptance. In nearly all sectors, there were temporal overlaps between the BREF elaboration schedule and the creation of LCIs.<sup>8</sup> In the case of the cement sector, the overlap is not with the creation of sectoral LCIs but with the founding of the Cement Sustainability Initiative (CSI), which eventually gathered data used in EPDs.

The simultaneous rise of the lifecycle perspective and the emphasis on a type of pollution prevention and control that were both seen as expressions of an *integrated* way to approach environmental problems (cf. OECD 1996) can explain the broad, mid-term, overlap. Yet, the more narrow, short-term, overlap does provide important evidence linking the two phenomena. These temporal overlaps could be interpreted as a correlation. In this logic, the absence of information on a European ceramics LCI could be seen as a missing value and the remaining events would be perfectly correlated. Alternatively, one could be of the opinion that the absence of co-occurrence slightly diminishes the strength of the correlation. However, ten cases, one of which seems to be incomplete, are an extremely small population for a correlational study.

Instead of adopting a correlational perspective, one could also apply set-theoretical causal reasoning, which works well with a mid-sized N (Schneider and Wagemann 2012). For this, it is useful to represent the events in Fig. 1 in their relation as sub- and supersets in a Venn diagram (see Fig. 2).

Figure 2 shows that X is a superset of Y, i.e., events immediately relevant for LCI availability always co-occur with related BREF processes. The causal interpretation of this figure now rests on the assumption that one set of events conditions the other set of events: either X conditions the outcome Y, or Y conditions the outcome X. If the hypothesis advanced here is correct, X conditions Y. However, we can see that there are Xs without corresponding Ys. Therefore, X is not *sufficient* to bring Y about. Yet, for every instance of Y, there is a corresponding X. Therefore, X can be seen as a *necessary* but not by itself *sufficient* condition for a corresponding Y:  $X \leftarrow Y$  (Y implies/is a subset of X).

However—one may object—perhaps the causal relation is the reverse: Y conditions X. Whenever there is a Y, there is also an X. But there are also Xs without corresponding Ys. Therefore, Y could be seen as sufficient but not necessary to

<sup>6</sup> Based on Schoenberger (2009, p. 1529).

<sup>7</sup> Large volume organic and inorganic chemicals (as solids) and organic fine chemicals and specialty chemicals were excluded from the list, as these are rather broad categories. So was everything not belonging to the rubric of basic materials.

<sup>8</sup> See SI for details on overlap between IPPC process and LCI releases.

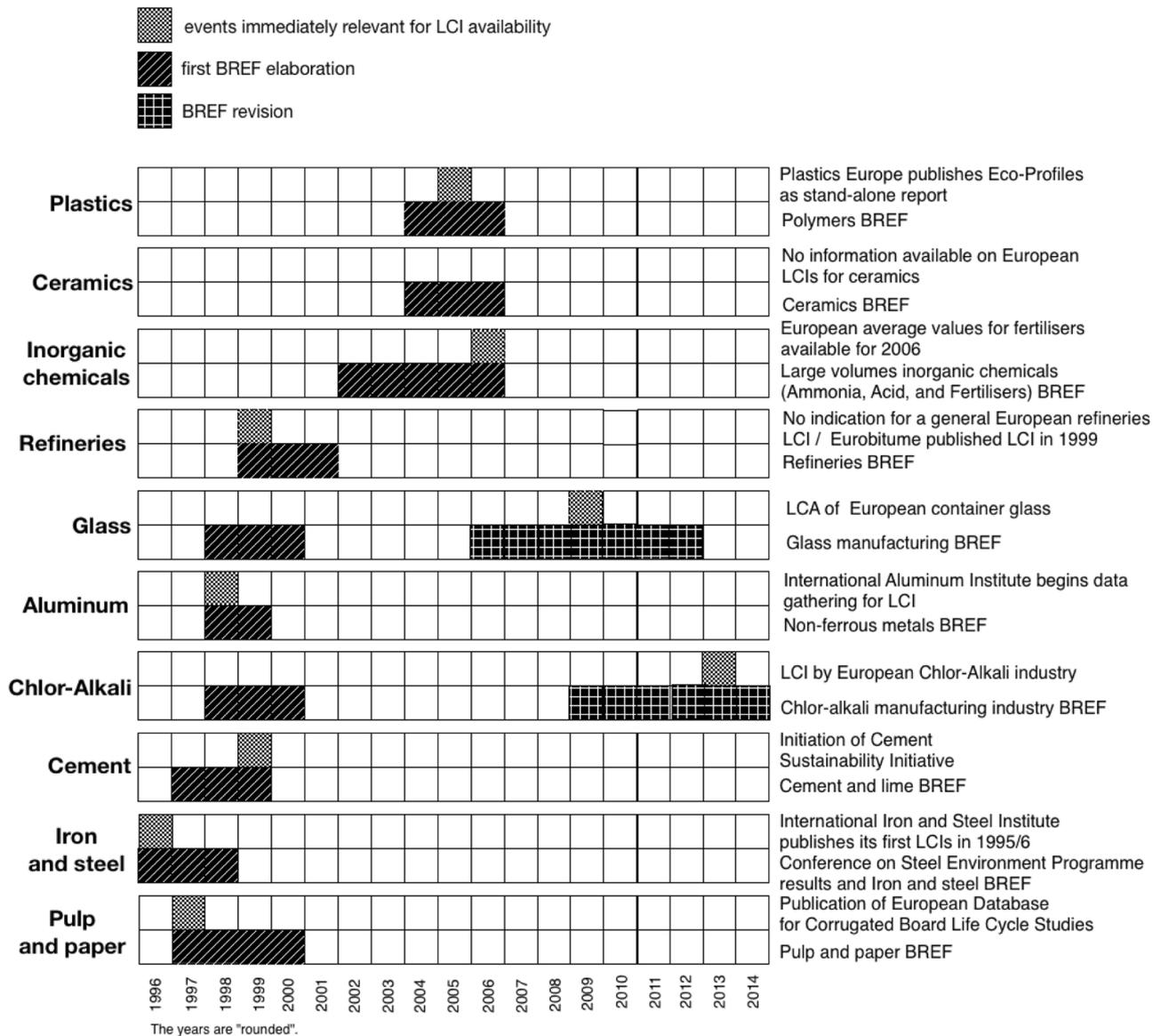


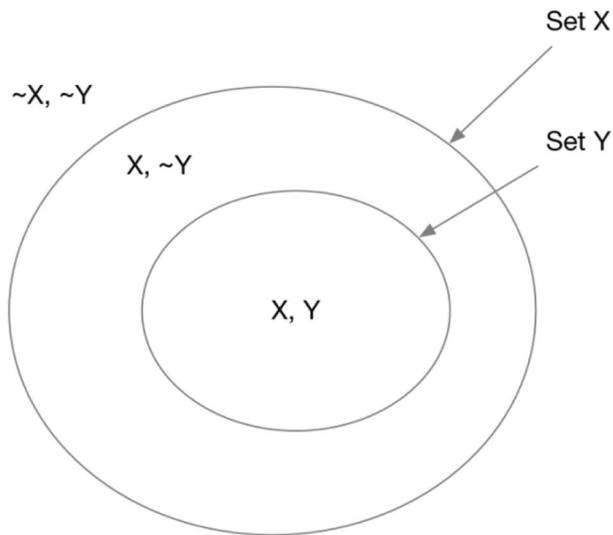
Fig. 1 Schedule of the elaboration of BREFs and European LCI publications

bring X about: Y->X. Yet, from a theoretical perspective, it seems much less probable that the scheduling of regulatory processes is in large part driven by the readiness of industry sector to produce LCIs, rather than that regulatory processes providing incentives for intra-sectoral information sharing improve the conditions for the creation of sectoral LCIs.

This should certainly not be interpreted as BREF processes actually being strictly causally necessary for the release of sectoral LCIs in a kind of law-like relationship. While Fig. 1 is the result of an extensive literature search, future research may still unearth additional sectoral LCIs that undermine this strict regularity and turn the ‘crisp’ set into a ‘fuzzy’ set. Still, the regularity of the association constitutes important preliminary evidence for causal

mechanisms linking the two phenomena, even if there may be potentially unidentified mediating mechanisms.

What are potential mechanisms linking the IPPC with the availability of LCIs? First, the deliberation on BATs is multi-criteria in nature, making it structurally similar to LCA. Several authors suggest the use of LCA for the determination of BATs (Barton et al. 2002; Dellise et al. 2020). In a guidance on the determination of BATs (known as *ECM REF*), the European Commission (2006, pp. i, 7, 77) suggests a ‘truncated’ version of LCA to resolve more complex cases involving cross-media trade-offs. However, Brinkmann (2019) notes that “[i]n practice, the *ECM REF* is very rarely used to determine BAT, as there is usually a broad agreement within the [Technical Working Groups



X = Relevant BREF process  
Y = Events immediately relevant for LCI availability

**Fig. 2** Venn diagram of co-occurrences between BREF processes and events immediately relevant for LCA availability

(TWGs)].” Yet, the ECM REF may not be the only way in which LCA could help to determine BATs. A number of BREF-related documents affirm the applicability of LCA for the determination of BATs (see Table 2 in the SI). While not necessarily decisive for the ultimate outcome, at least in some of these cases, TWGs are likely to have taken LCA results into account when determining BATs.<sup>9</sup> Such a potential recourse to LCA in BAT determination makes it beneficial for interested parties to cultivate capacity in this area.

Second, structural similarity translates into overlapping data needs. For specific production stages, LCIs require the same data needed for the determination of BATs, resulting in important synergies.<sup>10</sup> Major methodological reports underlying the Ecoinvent database extensively reference the IPPC process, which collates data otherwise scattered among companies or national trade associations, making it available for sectoral LCIs. They also extensively reference U.S. Environmental Protection Agency (EPA) data (see Table 3 in the SI), in particular its *Compilation of Air Pollutant Emissions Factors* (AP-42), some of which are also, at least partly, based on the results of studies to support new source performance

<sup>9</sup> Correspondence with European IPPC Bureau representative in April 2020.

<sup>10</sup> As a stainless steel industry representative put it: “In the case for process regulation, [IPPC] requires rigorous data focused on the production route ...; the demand to demonstrate emission reductions, energy efficiency, and benchmarks for the industry on a common basis rely on clear and transparent methodology that life cycle inventory exercise has at its foundation.” (Price 2003).

standards [for examples, see, e.g. U.S. Environmental Protection Agency 1995; U.S. Environmental Protection Agency n.d.; U.S. Environmental Protection Agency 2008).

Third, as the BREF elaboration process provides incentives for coordination within sectors to improve their strategic position in their exchange of information with the Commission, it stimulates information exchange more generally. Whereas in the EU, the process determining BATs directly involves industry in TWGs, in the USA, the EPA is solely in charge of national level BAT determination and has, at least formally, a more arms-length relation to industry (OECD 2018, p. 137ff.).

Crucially, the TWGs convene industry and offer incentives for trade associations to work towards a consensual constructive position. In response to the IPPC Directive, major EU industrial associations formed the IPPC Alliance<sup>11</sup> (IPPC Alliance 2008; Jacob et al. 2009), which meets about every 3 months, especially to prepare for the forum of representatives from Member States, industry and environmental non-governmental organisations charged with overseeing the BAT information exchange process, and for the forum composed of member states adopting decisions on BAT conclusions (Orgalime). National governments consult with their domestic industry, too, (VDZ 2008, p. 45; Umweltbundesamt 2015), whose associations may also gather data from their members to conduct their own studies to influence the BAT process (see, e.g. VDZ 2008, p. 26). The convening of industry experts and the exchange of information on the environmental impacts of industrial production across companies strengthens or reinforces social networks and institutional structures conducive to the collation of sectoral LCIs.

Ecoinvent, the LCI database dominant in the academic environment, is heavily populated with European data. In 2012, Ecoinvent covered more than 3000 genuine unit processes whereas the closest US equivalent, the US Life Cycle Inventory (US LCI) database, only covered 432. The US LCI Database appears to have less coverage on soil emissions and resource consumption than Ecoinvent but performs better in terms of air emissions (Suh et al. 2016, p. 1293). Suh et al. (p. 1296) suspect the first to “likely.. be the result of an inconsistent or incomplete definition of the system boundaries required by US LCI”. However, the better coverage of soil emissions and resource consumption in Ecoinvent could alternatively be explained with the IPPC’s multimedia approach and the data generated through the BREF process. The BREF development is based on a

<sup>11</sup> Later renamed into IED Alliance (Cembureau 2011), referring to the EU Industrial Emissions Directive recasting the original IPPC Directive.

very intensive survey of industrial installations, which also includes consumption data.<sup>12</sup> Even if there had been better alternative data sources on soil emissions and resource consumption, the BREF process would have served as a backstop making such data available. When Ecoinvent could already extensively draw on data from the IPPC BREFs, the National Renewable Energy Laboratory's (2003, pp. 19ff.) US LCI Database Project report only listed research institutes and industry associations as its most promising database sources. However, they were also planning to draw on EPA air emission databases (*ibid.*, p. 16), which may account for the US LCI Database's better performance in terms of air emissions.

## 4 Sector-based approaches

Carbon pricing initiatives provide varying incentives for companies to come together to share relevant information.<sup>13</sup> In the EU ETS sectoral organisations have a more prominent role than in the Californian cap-and-trade system. Regulated installations are only required to provide benchmarking data from EU ETS phase IV (2021–2030) onwards. For prior phases, sectoral organisations—as intermediaries between policymakers and companies—have voluntarily organised the collection of benchmarking data. For the Commission, this was less burdensome than interacting with individual companies, offered greater technical capacity and helped to secure industry buy-in.<sup>14</sup> In contrast, California had first drawn on emission data from its mandatory GHG reporting regulation to derive benchmarks and then obliged those market participants who wished to become eligible for free allocation of emission permits to disclose their benchmarking data to the authorities (Partnership for Market Readiness 2017, p. 55f.).

What are the links between sectoral organisation of carbon data collection and the availability of data for sectoral LCIs and, eventually, EPDs? Consider the following structural similarities between sectoral data collection, emission trading schemes and EPDs:

- Bottom-up data collection to obtain sectoral averages and need for
- standards for monitoring and reporting,
- third party verification,
- maintenance of confidentiality, and

- the need to avoid accusations of anti-competitive behaviour (see, e.g. Stigson et al. 2008, p. 27; US Federal Trade Commission 2014).

These similarities reduce transaction costs for the adoption of any further such measure or initiative once one of them is in place.

In the following, case studies of the steel and cement sectors demonstrate the causal links between sectoral initiatives and the creation of sectoral LCIs.

### 4.1 Cement

1997 saw the kick-off meeting for the elaboration of the IPPC BREF for cement and lime (Schoenberger 2009, p. 1529). While the IPPC did not regulate carbon emissions directly, there was leeway to interpret the IPCC so as to justify such emission limits, too. Furthermore, energy efficiency was a criterium for determining BAT, linking it to carbon emissions (Smith and Sorrell 2001). For the cement industry, waste as a fuel was another important aspect of the IPPC BAT-finding process (Cembureau 1999, p. 47).

Mainly to develop industry-wide standards reducing the risks of using waste as a fuel, in 1999 the cement giant Holcim<sup>15</sup> initiated the founding of the Cement Sustainability Initiative (CSI), under the auspices of the World Business Council on Sustainable Development (WBCSD). By the year 2000, CSI had united about ten global cement companies, who jointly identified waste as a fuel and carbon emissions as among the top three long-term strategic challenges to the cement sector.<sup>16</sup>

According to the former Head of Climate Change at Holcim, Bruno Vanderborght, the European Commission's third EU ETS trading period (2013–2020) reduction target was too ambitious for the cement industry, who criticised it as technically unfeasible. Industry agreed to manage the regulatory risk by being forthcoming with GHG data, and in 2007, they published the first report based on their Getting the Numbers Right (GNR) database (Cement Sustainability Initiative 2016, p. 6).<sup>17</sup> The European cement association Cembureau shepherded European data collection for GNR, including non-CSI members (Cement Sustainability Initiative 2009, p. 5). Eventually, the GNR's methodologically streamlined coverage of emissions was sufficiently extensive for the consultants working on a "Methodology for the free allocation of emission allowances in the EU ETS post 2012" to base their proposed cement benchmark on it (Fraunhofer

<sup>12</sup> Interview with European IPPC Bureau representative in April 2020.

<sup>13</sup> With the introduction of emissions trading, the IPPC directive was amended to exclude installations already covered by the EU ETS from its carbon-related BAT requirements (Krämer 2007, p. 178).

<sup>14</sup> Interview with EU ETS expert from the European Commission's Directorate-General for Climate Action in August 2016.

<sup>15</sup> Then called Holderbank and now merged into the world's largest cement manufacturer: LafargeHolcim.

<sup>16</sup> Interview with Bruno Vanderborght, August 2017.

<sup>17</sup> See also interview with Vanderborght.

Institute for Systems and Innovation Research et al. 2009, p. 11). Thus, the cement industry successfully leveraged GHG emission performance disclosure to influence the regulatory process.<sup>18</sup>

The cement sector's influencing of ETS benchmark-setting was accompanied by the dissemination of LCA discourse. In 2009, when the methodology for the free allocation of emission allowances in the EU ETS post 2012 was being elaborated, the WBCSD released lengthy cement-related reports, resulting in a spike in the prevalence of cement-related topics and keywords on their website. Figure 3 shows the results of the application of a topic model to the corpus of documents on the WBCSD (for methodological details, see the SI). Five of the topics are strongly associated with different terms related to cement and concrete. Based on these specific terms, the topics were labelled as Cement Sustainability Initiative, Cement and Concrete Mixes and LCA, Cement Industry Raw Material Extraction, Emissions and Waste as a Fuel and Cement Industry and/as Stakeholders.<sup>19</sup> The first graph shows the percentage of topic contributions to the corpus normalised by number of documents and the second graph normalised by document length. The first graph shows the peak of cement-related topic prevalence in 2007, when the GNR database was published, and the second graph has its peak in 2009, when the methodology for the free allocation of emission allowances in the EU ETS post 2012 was being elaborated.

Applying the dictionary method for quantitative text analysis shows the peak of the occurrence of LCA/EPD/PCF-related keywords<sup>20</sup> per 100 k words on the WBCSD website coinciding with the one indicated by the topic model, when the topic contribution to the corpus is adjusted by document length (see Fig. 4; for methodological details, see the SI). The spike in the prevalence of both LCA and cement discourse on the WBCSD website coincides in time with the elaboration of ETS benchmarks for the cement industry.

The informational infrastructure erected by the CSI in its coordination of the cement sector's pursuit of regulatory advantage went on to be further utilised for the creation of cement EPDs, thereby reducing transaction costs for the latter. In 2012, the CSI (2012, p. 25) was “developing a common methodology to quantify the environmental impacts of concrete, using [LCA] methodology”, in order to aid the publication of EPDs. In 2014, the international version

of the CSI EPD Tool was released, with its default values informed by GNR data (Cement Sustainability Initiative 2016, p. 10). In 2015, Cembureau (2015a; b) released two EPDs for European cements, also drawing on GNR data, “particularly related to the fuel mix, electricity consumption and emissions”.

## 4.2 Steel

The steel industry's coordinative role in the provision of benchmarking data for carbon pricing schemes helps to account for the fact that regionalised lifecycle datasets are available for Europe but not for the USA. A 2000/1 International Iron and Steel Institute study on an LCI for steel products did not yet provide any regionalised data on energy consumption (World Steel Association 2011, pp. 1, 80). Energy data is particularly sensitive.<sup>21</sup> Eventually, the European Confederation of Iron and Steel Industries (Eurofer) began to develop a life cycle footprint methodology for different steel products with the intention of providing the epistemic base for a global steel credit-and-baseline trading scheme (Stigson et al. 2008, p. 18). In 2009, a consulting consortium, contracted by the European Commission, published a report specifying a methodology for the free allocation of emission allowances in the EU ETS post 2012 for the iron and steel sector. It states that “in order to determine benchmark curves, Eurofer has started a data collection among its members” (Ecofys et al. 2009, p. 19), implying that prior to the preparations for EU ETS benchmarking, Eurofer did not have data of the same quality. In 2011, the World Steel Association<sup>22</sup> released its “[LCI] study for steel products”. Next to a global dataset, it now contained a regional dataset for Europe—and only for Europe—representing over 30% of its steel production (World Steel Association 2011, pp. 64, 11).

In contrast, no similar data was coming forward from the USA, where industry resistance had prevented the nationwide rollout of carbon pricing. In 2015, the LCA for an EPD on a specific US steel construction product used a non-US dataset for background data on steel (ClarkDietrich Building Systems 2015, p. 7). In 2018, the World Steel Association (2018, p. 6) could eventually provide various regionalised datasets for steel production, yet for the USA, it was still either not available or only of limited quality.

The stark difference between the availability of LCIs for steel between Europe and the USA can perhaps not solely be attributed to Eurofer's coordinative action to

<sup>18</sup> Prior to that Stigson—then President of the WBCSD—et al. (2008, p. 44) had already suggested using sectoral benchmarking initiatives for informing the distribution of free emissions permits.

<sup>19</sup> See the SI for the most prominent words associated with the topics.

<sup>20</sup> See SI for a list of keywords.

<sup>21</sup> Interview with European IPPC Bureau representative.

<sup>22</sup> Formerly the International Iron and Steel Institute (IISI).

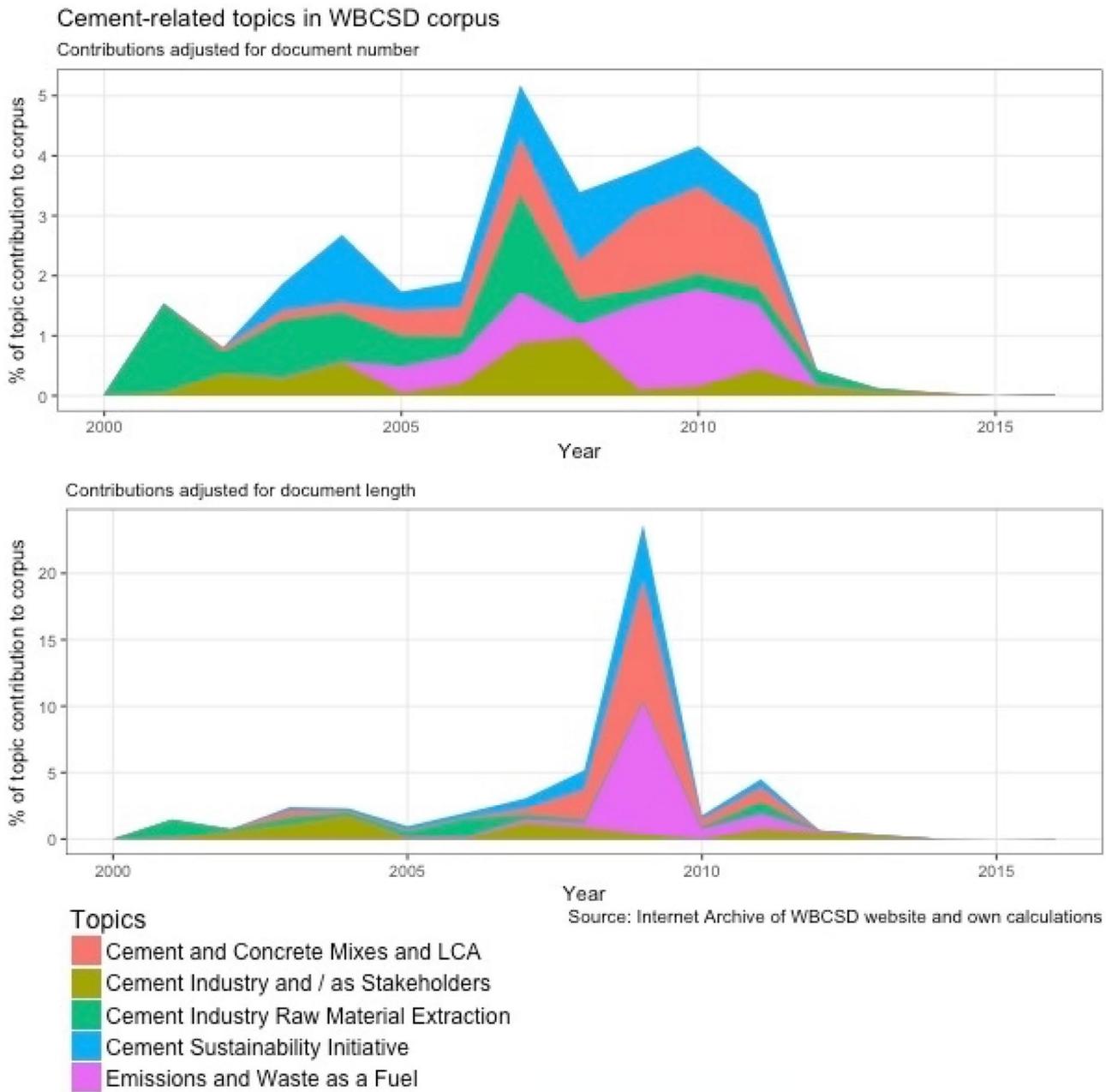


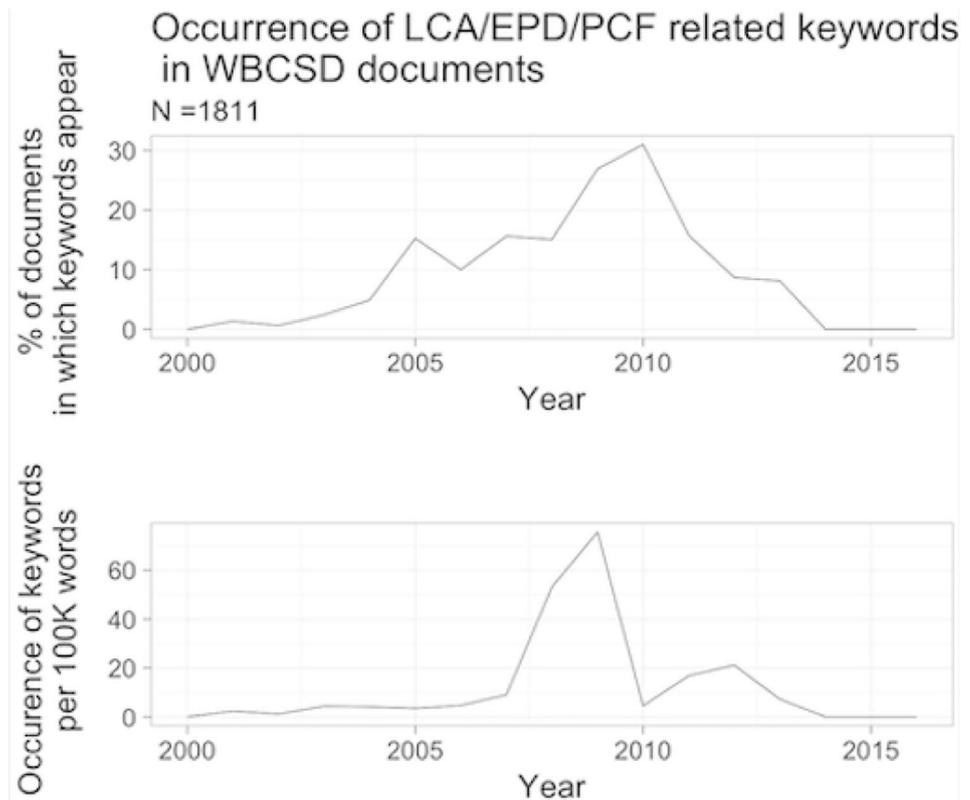
Fig. 3 Occurrence of cement sustainability and LCA-related topics in documents on the WBCSD website

shape EU climate policy. Stronger demand from both consumers and governments may have a more important role to play. Yet, at least for the carbon emissions, related aspects of steel production coordinative action to shape EU climate policy action were causally *sufficient*, if not *necessary*, to bring about a regionalised dataset for Europe. Once this was successfully done for one—particularly sensitive—environmental impact category, the transaction costs for additional impact categories must have drastically dropped.

## 5 Negotiated collective agreements

National sectoral associations also gather environmental data as part of negotiated collective agreements (NCAs). Here, Germany and the USA contrast starkly with regard to the adoption of NCAs as alternatives to regulation. Whereas the German environmental policy landscape is marked by a plethora of environmental NCAs between government and industry, this approach has not flourished in the USA (Delmas and Terlaak 2002, pp. 6, 14).

**Fig. 4** Occurrence of LCA/EPD/PCF-related keywords in documents on the WBCSD website



NCA requires industry to adopt a common negotiating position. Highly organised industry associations can more credibly commit to NCAs than those lacking the ability for cohesive action (Delmas and Terlaak 2002, pp. 8, 11). A joint commitment and the negative consequences from a lack of compliance incentivise the building of collective self-monitoring capacity, requiring strong coordination across a sector and strengthening the role of trade organisations.

In the USA, the dispersion of responsibilities across levels and functional branches of the state makes it more difficult for the government to guarantee that the rules of the game agreed to under NCAs remain in place, standing in the way of credible commitments. Observers emphasise that specifically US anti-trust regulations, which at least historically used to be much stronger than Germany's (Quack and Djelic 2005), limit the extent to which industry can legitimately self-organise (Matten and Moon 2008, p. 409).<sup>23</sup> In addition, the individualistic attitude of US firms—perhaps being a product of the other factors—stands in the way of collective commitments (Delmas and Terlaak 2002, p. 11f.).

<sup>23</sup> For example, the Aluminum Association (2011, p. 8) notes: "The principles of U.S. antitrust law limit the ability of trade associations to collect economic value related information from their member companies."

In contrast, Germany is a parliamentary republic, with a correspondingly higher affinity between the legislature and the executive, and has a more corporatist political tradition with an extensive role for coordination between governments and peak industry associations. Table 2 compares the relevant features of the institutional environment in Germany and the USA.<sup>24</sup>

The German Agreement on Global Warming Prevention is an example of a voluntary NCA that was adopted in lieu of regulation. In 1995, the German cement industry, alongside other industrial sectors, took on the voluntary obligation to reduce its energy consumption. In return for a commitment by industry to reduce their emissions between 1990 and 2005 by 20%, the government refrained from the introduction of an energy tax (Delmas and Terlaak 2002, p. 7). For monitoring purposes, the Association of German Cement Plants (VDZ) then began to systematically collect environmental performance data from its members on an annual basis. In 2000, the deal was ramped up in ambition and extended until 2012 (Rheinisch-Westfälisches Institut für Wirtschaftsforschung 2013, p. 140; VDZ 2013a, p. 3, 2013b, p. 9, 2017).

<sup>24</sup> Based on Delmas and Terlaak (2002, p. 23).

In 2012, VDZ published an EPD for an average German cement. In the process of creating the EPD, “almost all the German cement and grinding works... provided information on the material and energy resources” for the year 2010 (VDZ 2012, p. 140). When VDZ collected data for their sectoral EPD, to achieve representativeness, it was important to achieve a high response rate to their survey of member companies. For this members needed to trust in the confidential handling of their data, which was helped by the fact that the VDZ had already been surveying the environmental data of the German cement factories for a long time.<sup>25</sup> Consequently, the cement manufacturers were already accustomed to the VDZ’s data gathering exercises when the VDZ requested additional data for their EPD.<sup>26</sup> Even more so, the German Lifecycle Data Network’s cement LCAs drew on the data provided by VDZ in response to their NA with the government (Nemuth and Kreißig 2007, p. 15).

In addition to the IPPC and ETS benchmarking processes, its NCA with the government provided the VDZ with another important rationale for collecting environmental company data. By drawing on these data gathering efforts, EPD creation was a fairly smooth process.

The European cement industry’s coordinative role also benefitted EPD production in the USA, when the US Portland Cement Association (2017) (PCA), representing “92 percent of US cement production capacity”, used the CSI EPD Tool to compute the LCA for three industry average cement EPDs released in 2016.<sup>27</sup> One of the PCA EPDs was incorporated into the data basis of the National Ready Mixed Concrete Association’s (2016) EPD for ready-mixed concrete, thus enabling EPD creation further downstream.

When it came to data availability for their EPD, the PCA’s more service-oriented role resulted in a stark contrast to their German counterpart. While the PCA had an idea of the cement and concrete emission factors relevant for an EPD, it lacked accurate national averages for some of this data. PCA members have traditionally reported energy use to the EPA and the Department of Energy as part of ongoing reporting. Prior to their EPD data gathering efforts, the PCA had to rely on publicly available data through these, and data extrapolated from emission factors published by the International Energy Agency. For the EPD creation, PCA was able to get plant-specific information from about 75% of the plants in the USA. Its members confidentially provided production data to the market intelligence department within PCA, where it was analysed for quality. On occasion, a plant would report something which they understood as a different name or boundary condition and their results would deviate

**Table 2** Comparison of the institutional environments in Germany and the USA

Features of the institutional environment	Germany	USA
Industry access points to state institutions	Some	Numerous
Industry interaction with regulatory agencies	Consensual	Adversarial
Companies attitude towards collective action	Cooperative	Individualist
History of antitrust law	Follower	Leader
Potential for implementation of negotiated collective agreements	Medium	Low

by an order of magnitude of two or three from the industry average. PCA would then have to call them to understand what they were reporting, to improve the data quality. Eventually, the data gathering as part of the EPD process significantly improved the PCA’s data basis.<sup>28</sup>

The direct comparison between Germany and the USA may not be entirely adequate in terms of levels of government. California, a subnational actor with a high level of autonomy and ambition in environmental policy making, may perhaps be more adequately compared with a Germany situated within the European Union (Schreurs 2008, p. 345). Since 2006, under the direction of the California Public Utilities Commission, investor-owned utilities have worked with cement corporates and plants on energy efficiency projects (Sperberg et al. 2018). This is a utility-to-corporate or -plant approach rather than a sectoral programme, from which one cannot expect any intra-sectoral incentives for information-sharing. In 2010, Horvath et al. (2010), in a study for the California Air Resources Board and the California Environmental Protection Agency, were still screening the voluntary sectoral energy efficiency programmes in other countries, including the German Agreement on Global Warming Prevention, on the basis of which they recommended to engage California’s industrial sector in a support programme to help them meet the requirements of California’s Global Warming Solution Act.

## 6 Spillovers between sectoral coordination types

Once a trade association has taken on the task of collecting data for the purpose of any one of the information-intensive sectoral coordination types described above, it enjoys

<sup>25</sup> Interview with VDZ representative, September 2017.

<sup>26</sup> Interview with VDZ.

<sup>27</sup> Interview with PCA representative in August 2017.

<sup>28</sup> Interview with PCA.

spillover effects by partly re-using or reactivating the same organisational structure to also gather data for any of the other types. All of these types, and in particular their conjunction, are conducive to the creation of LCIs and EPDs, as each provides incentives for the intra-sectoral sharing of information.

Divergences in prior sectoral information exchange account for important differences in the VDZ's and the PCA's EPD data gathering exercises. The VDZ had already been gathering data from members for their NCA with the German government, as well as data usable for the IPPC process and ETS benchmarking. Some of that data gathering was perhaps even redundant across coordinative actions in relation to various policies. Transaction costs for data gathering were successively lowered, from NCAs, over the BREF process to contributions to the GNR database.

In contrast, prior to their EPD data gathering efforts, the PCA had not established a direct flow of data from their member companies but had to rely on publicly available data. The PCA had less privileged access to its members' energy and carbon emissions data and less well-established procedures for requesting such data than its peer in Germany. The VDZ already had a dataset and data sharing process honed by an NA, the IPPC process and EU ETS benchmarking. In contrast, the PCA had to invest significant resources into collecting, compiling and validating the information required for their EPD.<sup>29</sup> VDZ therefore had much lower transaction costs for producing their EPD than the PCA.

NCAs and the IPCC process both mobilise industrial sectors. Trade organisation used to coordinating their members rather than just servicing them are better equipped to initiate and implement sectoral initiatives seeking to influence carbon pricing benchmarks via data gathering exercises. The presence of any of the environmental policy factors above would have helped the emergence of regionalised LCA profiles for the US steel industry by reducing associated transaction costs.

## 7 Discussion

The hypothesis that a political environment setting incentives for an intra-sectoral exchange on the environmental impacts of production is conducive to the creation of sectoral life cycle data sets can be confirmed. There are spillovers across sectoral coordination types and the generation of LCIs, mediated via reductions in transaction costs. These insights contribute to a more thorough understanding of the informational economy governing the life cycle assessment eco-system. Yet, a

more comprehensive understanding requires to examine additional factors determining the demand and supply of information relevant for LCIs and the eco-labels drawing on them. In particular, the role of environmental reporting at the firm level (see AUTHOR, under review), government support for the life cycle assessment community and the creation of demand for type III eco-labels comprising product LCAs (Jordan and Bleischwitz 2020) are important factors deserving more sustained, rigorous and systematic institutional analysis.

A further, and more conclusive, testing of the hypothesis for the case of the IPPC process could be accomplished by detailed qualitative examinations of the historical interactions, at the level of micro-processes, among firms and trade associations in specific sectors.

Further research should be directed at the more systematic identification of instances where anti-trust legislation is a deterrent to the production of sectoral LCIs (cf. Baitz et al. 2013, p. 9; Sonnemann and Alvarado 2018, p. 97). Government could then help to increase legal certainty by providing guidelines for the creation of sectoral LCIs in line with the prevention of anti-competitive collusion.

As there is good evidence that policies providing incentives for sectoral data sharing have facilitated the diffusion of EPDs, future evaluations of the qualities of different policies should include considerations of such unintended side effects. However, an acknowledgement of the beneficial effects of sectoral coordination should not be used to discredit a regulator's use of 'divide and rule' tactics in order to obtain vital information (on the latter, see Coglianesi 2007, pp. 189f.).

The aforementioned policy types solely target improvements within product categories.<sup>30</sup> Any shifts in relative prices and demand are solely accidental to the striving for greater environmental efficiency. In contrast, life cycle information can support a range of policies, such as carbon tariffs, which would help to reduce or end the free allocation of emission permits and thereby endow products with more ambitious and thus transformative price signals. These would shift demand across product groups and thereby stimulate more systemic industrial transformation towards low-carbon societies.

While intra-sectoral information sharing may be problematic where it facilitates anti-competitive collusion in the form of cartelisation, once firm-specific EPDs are phased in, new policies can help to stir both inter- and intra-sectoral competition over the lowest embodied environmental impacts. Amongst these policies are

<sup>29</sup> Interview with PCA.

<sup>30</sup> In principle, the EU ETS—as a carbon pricing scheme—should contribute to shifts in supply and demand *across* product groups. However, what really drove sectoral action here was benchmarking *within* fixed product categories.

embodied carbon standards, carbon tariffs and public procurement. Such downstream competition may also yield improved BATs and emission benchmarks. A combination of up- and downstream measures would exert greater transformative pressure on industry—stimulating eco-innovation.

The European Green Deal (European Commission 2019) could be a suitable initiative for bringing these elements into place. It suggests the possibility of border carbon adjustments with some mechanism for assessing the carbon content of imports and aims to strengthen legislation and guidance on green procurement, which could both increase demands for EPDs. It also seeks to review the Construction Products Regulation, whose current stipulation on the use of EPDs<sup>31</sup> could be strengthened to use conservative values if EPDs are not (yet) available.

A key element of the European Green Deal's ambition to finance the green transition, the EU Taxonomy Regulation of 2020 (European Parliament and Council 2020), foresees to extensively base the assessment of the sustainability of investments on LCAs. This creates incentives for individual companies to acquire EPDs or Product Environmental Footprints or at least to conduct LCAs in order to demonstrate a better-than-average environmental performance. Crucially, the prior existence of sector-level data provides an important baseline for assessing claims of individual products' relative environmental superiority.

## 8 Conclusion

This paper provides an important building block towards a theoretical model of the factors accounting for variations in the availability of life cycle data across countries by showing that a political environment setting incentives for an intra-sectoral exchange on the environmental impacts of production is conducive to the creation of sectoral life cycle data sets. This reduces the transaction costs for the creation of sectoral EPDs and is thereby conducive to the diffusion of labels that inform about the environmental impacts embodied in products.

Environmental policies mandating industry to commit to ambitious reduction targets and/or to provide benchmarking data on environmental performance brings industry actors in sector associations together to create data. The availability of such industry data then facilitates the creation of product-level data. In this way, there are spillover effects from data collection and sharing as part of coordinative sectoral action

oriented towards government policy aimed at the level of *production* to the release of lifecycle assessment data at the *product* level.

Industry associations' institutional role within environmental policy processes can partially explain cross-national variations in the availability of product life cycle inventories. However, this is only one factor accounting for variations in the availability of life cycle data across countries. Instead of choosing an *indirect* supply-oriented approach and trying to replicate the conditions for such data creation by incentivising sectoral action, policy makers may more effectively focus on using public procurement and standards for creating *direct* demand for EPDs, flanked by measures to support small and medium-sized companies in EPD creation.

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<sup>31</sup> "For the assessment of the sustainable use of resources and of the impact of construction works on the environment [EPDs] should be used when available" (European Parliament and Council 2011).

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