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Challenges and requirements of exchanging Product Carbon Footprint information in the supply chain

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Abstract. The reduction in greenhouse gas (GHG) emissions is of high importance to society. Companies therefore have an increasing interest in understanding and reducing the GHG emissions of their supply chains and to generate data to track and prove this, for example by calculating product carbon footprints (PCFs). Besides serious gaps in PCF data within companies and in LCA databases, there is still missing experience and knowledge on how to consistently prepare and exchange these data. Based on our experience as LCA practitioners in the industry, we discuss the key challenges and requirements such as data formats, data quality, confidentiality concerns and comparability issues of PCF data. Aiming to contribute practical recommendations to ongoing initiatives working to enable PCF-exchange along value chains, we scope approaches that match industry requirements.

1 Motivation

The frame to reduce GHG emissions as a company is set by the Paris Agreement [1] and several green deals have been announced globally, striving to push the impact of humanity into the safe zone of our planetary boundaries. The European Green Deal [2], for example, stimulates markets towards climate neutrality and circularity, with policies and programs underpinned by life cycle assessment (LCA). The ultimate goal is to empower public and private consumers by introducing digital "product passports" containing environmental performance indicators such as product carbon footprint (PCF) or information on recycled

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content and substances of concern. This initiative will require the individual actors in the value chain to collaborate and exchange the relevant data.

2 The accounting dilemma

The generation of meaningful LCA data is an effort along the value chain. Reliable information is mostly only available to the company running the respective process and knowledge on up-/downstream processes is limited (cf. Fig. 1). These external processes in most cases contribute the largest part of a footprint. Thus, companies acting as isolated entities have little chance to generate PCFs with a reasonable level of data certainty. LCA results and PCFs currently rely on a large number of assumptions, estimations, and multiple data sources, commonly representing industrial averages, rather than supply chain specifics. Consumers as well as companies understandably hesitate to base their decisions on these indicators.

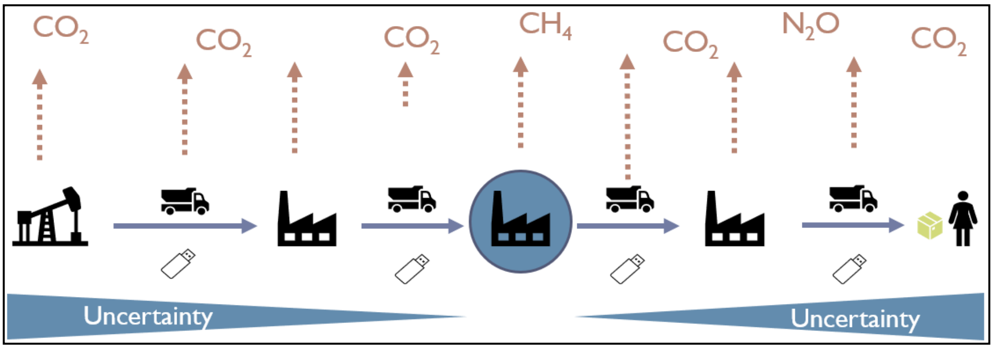

Fig. 1. Varying uncertainty of life cycle data along the supply chain from the perspective of a single accounting process

To overcome this obstacle and produce coherent footprint information, exchange of reliable information across industry players is key. With this paper, the authors aim at illustrating a promising pathway towards trusted PCF sharing mechanisms.

In a first step, the current state regarding the variety and the resulting challenges of existing guidance documents for PCF assessments is presented. This is complemented by a discussion of the trade-offs between transparency and confidentiality inherent to different data exchange formats.

In a second step, a future PCF sharing approach and its key factors for increasing trust while maintaining confidentiality – thereby circumventing current challenges – are described. This approach reflects the point of view of a cross-industrial panel of LCA experts within the International Sustainability Practitioners Network (ISPN) [3]. For this contribution, a qualitative analysis of inputs from the broader industrial and academic network of the ISPN was performed. Two criteria were defined for selecting relevant information: 1) aspects describing the drawbacks of current as well as needs for future PCF sharing practices; and 2) key attributes of promising IT solutions.

3 The existing basics

The basic standards and rules for managing sustainability information and performing carbon footprint calculations have already been set. For instance, the ISO developed and is still developing such standards [4–6] that support practitioners in valuable data generation, as illustrated in Figure 2.

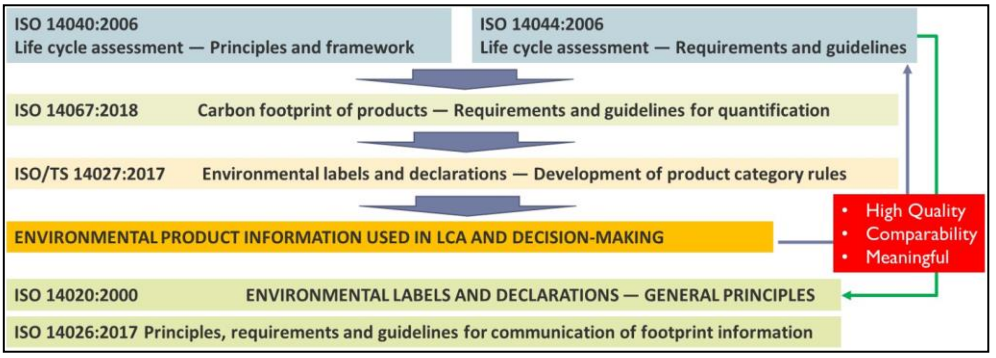

Fig. 2. Standard landscape

In addition, further guidance documents have been published, such as the Environmental Footprint (EF) method [7] or the Pathfinder framework [8]. The EF has been introduced by the European Commission for improving the validity and comparability of environmental performance evaluation and for sharing results via a digital product passport[†]. The Pathfinder has been developed by the World Business Council of Sustainable Development (WBCSD) [8] with a focus on refining the methodology for assessing and sharing product carbon footprint information.

A need for further harmonization of the current guidance documents remains as comparability of assessment results is not guaranteed. This requires the commitment of industry players to develop these rules under such framework.

4 Data exchange options

Successful performance of LCAs and making use of results hinges on the availability of good quality data. In the wake of large projects such as the Product Environmental Footprint (PEF) and Environmental Product Declaration (EPD) programs, as well as industry and NGO initiatives such as Catena-X [9] and WBCSD's pathfinder (also cf. Section 6), the need for a solid data foundation becomes a fundamental requirement.

The question to the projects at hand is how these data exchange may be standardized for future LCAs. An important aspect is the level of granularity required to be consistent, acceptable for all parties and effective. In LCAs, several levels of dataset granularity and transparency exist (cf. Fig. 3). These are: unit processes, with the highest possible detail on processes; aggregated processes, which contain all information to conduct LCIA and impact indicator results, which are the most 'compact' datasets.

[†] Sustainable Products Initiative (SPI) of European Commission

A known obstacle in exchanging LCA data is the need for protection of confidential, business relevant information even up to intellectual property (IP) to secure competitive advantages. LCA data have been suspected to enable retro-analysis of the underlying processes, thus violating this requirement. Unit processes have the drawback of allowing direct insights into IP of companies. Such datasets can be integrated in further models and modified flexibly, enabling transparency and detailed assessments. Adding complexity, this can be perceived as a drawback or benefit. The aggregated processes obscure most details of any process they are based on. However, they can be used in any LCIA calculation, e.g. with experimental or customized impact assessment methods. As a drawback, they are rather verbose and require precise matching of the elementary flows with the complementing LCIA datasets, or else one may derive aberrant indicator results.

The least detail is contained in calculated indicator results. The simplicity of these single figures enables interpretation by non-experts and gives the least opportunity for retro analysis, thus protecting contributors' sensitive/confidential information. The lack of transparency reduces the reluctancy to share information along the value chain. However, the missing transparency has to be overcome.

	Level of detail	Overcoming the confidentiality challenge
Unit Process	++	--
Aggregated Process	O (Data load-)	O
Impact indicators	--	++

Fig. 3. Data formats: Finding the balance between granularity/transparency and confidentiality

5 Outlook on future data exchange in networks

An exemplary poll (non-exhaustive) among the wider life cycle management community taken at the LCM conference 2021 reveals the current opinion regarding the most important aspects of meaningful PCF sharing along the value chain. The findings are represented by a word cloud in Fig. 4. In summary, the community considers collaboration as key activity towards successfully defining the right level of transparency needed to generate trust. Based on these findings, a variety of measures can be taken, as described in the following paragraphs.

One vision to overcome the lack of transparency in sharing calculated indicator results is to establish a PCF data exchange infrastructure that guarantees fast and at the same time safe data transfer, as illustrated in Fig. 5. Ideally, the respective IT ecosystems are connected to internal accounting systems and allow efficient performance measurement, standardized calculation and reporting, supplier engagement and certification.

Such systems will need well defined interfaces and data exchange formats including sector or even industry wide product-specific unique identifiers to allow precise data mapping. This allows direct connection of data points to ensure seamless data updates across supply networks, e.g. data on energy suppliers used across value chains.

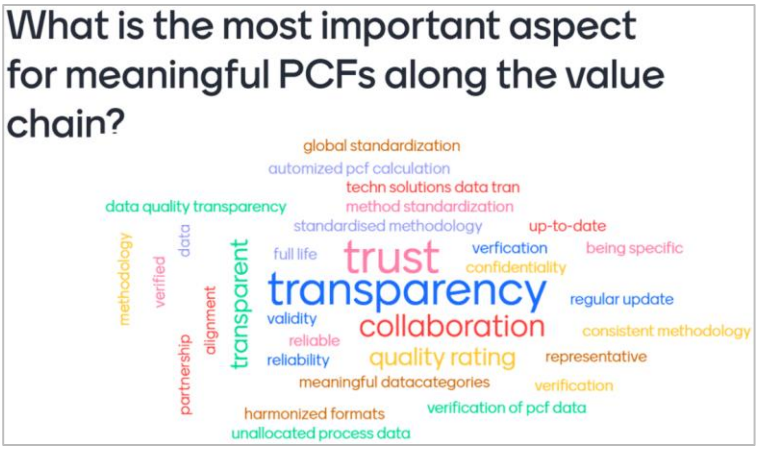

Fig. 4. Poll results for important aspects of meaningful PCFs at the LCM conference 2021

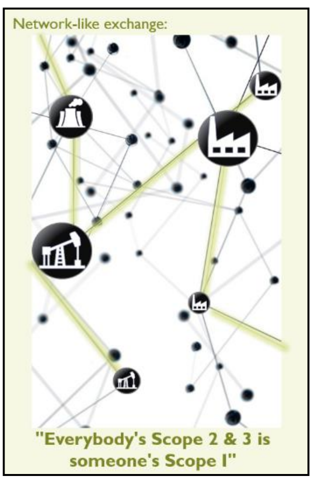

Fig. 5. Network for PCF sharing

The data would have to follow standardized formats for level of aggregation, emission flows and applied impact methodologies. Standards and product category rules should provide clear guidance to PCF modelers, users and verifiers on the application of methods.

Results and underlying decisions for system boundaries, allocations and other scoping parameters, as well as quality indicators have to be provided on a mandatory basis in a machine-readable format. This enables representative use of upstream PCFs as emission factors for downstream assessments in large quantities.

An efficient trust mechanism, including a certification scheme based on regular 3rd party audits could overcome the lack in transparency when exchanging calculated indicator results.

Dedicated infrastructure/ecosystems (distributed or central) for exchange of PCFs and verifications of 3rd party audits would then allow the use of supplier PCFs as emission factors in own assessments with ease.

6 Current initiatives for exchange of PCF impact indicators

Various initiatives for sharing PCF information along the value chain have been started recently. Fig 6. names just an exemplary selection of programs for sharing impact indicators that are known to members of the ISPN forum at the time of writing. These initiatives all strive to enable or facilitate the effective exchange of carbon footprints in one or another way, but show differences in what they focus on, indicated under “Main Focus” in Fig 6. The figure only shows projects and programs from associations/non-profit organizations, not leveraging business models on data. There are many more proprietary solutions from individual stakeholders, which are partly listed further below.

Selected Initiatives (ISPN members active)	Organizations / Industries involved	Main Focus (ISPN's perception)			
		Standardisation Methodology*	Harmonization by communication formats*	Infrastructure for Exchange	Verification/ Certification
CatenaX	EU & Automotive Industry	x		**X**	x
Estainium	WEF (World Economic Forum) & Siemens		x	**X**	x
PCF in Asset Administration Shell (AAS)	ZVEI (Zentralverband Elektrotechnik- und Elektronikindustrie)		x	**X**	
Together for Sustainability (TfS)	Chemical Industry	**X**		x	(x)
Value Chain Carbon Transparency Pathfinder	WBCSD (World Business Council For Sustainable Development)	**X**		x	x

*(only one marked depending if it is focusing on standardizing methodology or focusing harmonizing by making different standards compatible using communication formats.

Fig. 6. Current initiatives (exemplary selection)

One of the main challenges for practitioners working with PCFs or emission factors provided by suppliers, is to remain consistent in methodology and to make use of the received data in a representative way.

The first most obvious option to guarantee this, is to define strict rules and limit the freedom of making own decision for a practitioner to an absolute minimum by further standardizing the methodology. Catena-x (automotive industry), Together for Sustainability (Chemical Industry) [10] and the Pathfinder initiative (WBCSD) focus on this. The second option is to request more descriptive predefined meta data from suppliers for their PCFs. It creates transparency about assumptions and the methodology in use, thus allowing the receiving practitioners to make informed decisions on how to/whether to include a supplier's PCF into their own PCF calculation as emission factors. This can be augmented with analytics-based indicators/quality values to support practitioners, receiving PCFs from suppliers, in judging if the provided PCF is compatible with their methodology or level of ambition in terms of quality. ESTAINIUM [11] and the Asset Administration Shell (AAS) Project of the ZVEI [12] have a focus on this.

The first option is tempting, since it guarantees a high level of compatibility of PCFs within one PCF sharing scheme. The second option allows the combination of different sharing schemes and the use of PCFs from existing corporate PCF programs and environmental product declarations ("downward compatibility"). A balanced approach or combination is yet to be found. The first drafts for frameworks have just recently been circulated within the community.

Another challenge is the efficient and save exchange of PCFs and PCF certifications along the value chain based on digital infrastructures. Catena-X, ESTAINIUM and the AAS have a strong focus on the sharing infrastructure and the other initiatives might have that on the agenda. However, a digital infrastructure approach has not been published yet. It will determine the ease at which the exchange of PCFs can be communicated and to what degree we will be able to trust them. If or how PCFs shall be certified, has a distinctive impact on the sharing mechanism and the necessary data formats. Some EPD programs or industry specific programs have already certified large numbers of footprints, but this still does not scale to the degree where these certification schemes could serve as trust mechanisms for entire supply chains of several industries. Several initiatives work on this end as well.

The overview in Fig. 6 is not comprehensive. Other related initiatives & programs for exchange of unit processes, aggregated processes or impact indicators are: VDA LCA data collection format (Verband Deutscher Automobilindustrie) [13]; TED (Volkswagen); SCOTT (BASF); Bonsucro platform [14]; RenovaBio program [15]; Responsible Business Alliance (RBA - Formerly Electronic Industry Citizenship Coalition) [16]; CEFIC (Chemistry) [17]; Climate 2021 (SAP) [18]; Cement Sustainability Initiative (Global Cement and Concrete Association, partnering with WBCSD) [19]; The Pharmaceutical Supply Chain Initiative (PSCI) [20]; CarbonBlock [21] and SustainBlock [22].

7 Conclusion

The pressure for coherent PCF data has increased from regulators, investors and from consumer side and the need for specific data compared to using industrial averages has tremendously increased. As shown above, there are many activities ongoing, pointing towards more coherent PCF data and a more network-like exchange. We have to learn from the wide variety of initiatives and quickly converge for compatibility of data formats and methods to provide comparability of results. To that end, sharing technologies and verification schemes must be agreed upon to facilitate convenient exchange. Researchers/research institutions might take a mediating role or a reviewing/control function for initiatives set up by industry. The industry has to agree with the policy makers on a common level of ambition which works for different sectors as well as large and small companies.

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