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SUSTAINABLE DEVELOPMENT

Comparing product category rules from different programs: learned outcomes towards global alignment

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Abstract
Purpose Product category rules (PCRs) provide category-specific guidance for estimating and reporting product life cycle environmental impacts, typically in the form of environmental product declarations and product carbon footprints. Lack of global harmonization between PCRs or sector guidance documents has led to the development of duplicate PCRs for the same products. Differences in the general requirements (e.g., product category definition, reporting format) and LCA methodology (e.g., system boundaries, inventory analysis, allocation rules, etc.) diminish the comparability of product claims.
Methods A comparison template was developed to compare PCRs from different global program operators. The goal was to identify the differences between duplicate PCRs from a broad selection of product categories and propose a path toward alignment. We looked at five different product categories: milk/dairy (two PCRs), horticultural products (three PCRs), wood–particleboard (two PCRs), and laundry detergents (four PCRs).
Results and discussion Disparity between PCRs ranged from broad differences in scope, system boundaries, and impacts addressed (e.g., multi-impact vs. carbon footprint only) to specific differences of technical elements. The differences primarily reflected the different purposes of the PCR (e.g., label/report), the different standards they were based on (e.g., ISO 14025/PAS 2050), the use of different product categorization systems, or simply the result of being developed independently. Differing degrees of specificity and terminology between PCRs allowed for varied interpretation—at times making direct comparison difficult. For many of the differences between PCRs, however, there was no clear rationale why they could not be consistent in the future.
Conclusions These results were used to outline a general guidance document for global alignment of PCRs which recommends (1) alignment of PCRs for different purposes, (2) provision of guidance for the adoption of aspects of other PCRs, and (3) provision of greater specificity on content. The overall recommendations also suggest collaboration among program operators to facilitate alignment on issues that evolve from independent development.

Keywords Comparison template · EPD · ISO 14025 · Product carbon footprint · Product category rules · Sector guidance

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1 Introduction

Life cycle assessment (LCA) and carbon footprinting are established methodologies for the quantification of product environmental performance and are increasingly being used as a basis for labels and reports that inform purchasers in the supply chain and final consumers (Fava et al. 2011). Common life cycle-based quantitative claims exist in two forms: multi-criteria claims called environmental product declarations (EPDs) and single-criterion claims such as product carbon footprints (CFPs). Life cycle-based quantitative claims for products require the modeler to make many choices regarding the sources of data, the boundaries of the system, allocation of impacts between the co-products or the recycled products, and the choice of metrics used to estimate impacts, among others. De Koning et al. (2010) indicate that the uncertainty margins around CFPs broaden when the assessment moves from an internal comparison to that performed by third parties due to varying choices. Despite existing and emerging international standards for these methodologies, there is insufficient standardization to make fair comparable claims, which is essential for differentiating products in the marketplace based on their environmental performance.

Programs and international standards, for life cycle-based quantitative claims, provide some general guidance to promote consistent assessments. The ISO 14040 (ISO 2006a) series of standards set principles, requirements, and guidelines for carrying out LCA. The ISO 14025 (ISO 2006b) standard for developing type III EPDs (aimed primarily at business-to-business communication) states that program operators should provide general guidance (general program instructions) to guide the overall administration of the program. Product carbon footprints standards (such as the PAS 2050 (BSI 2008), TQ 0100 (JEMAI 2011a), and ISO 14067 (ISO TC207)) and the GHG Protocol Product Standard (WRI and WBCSD 2010) provide requirements and guidance for all products—based on ISO 14040—but more specific to carbon.[1] However, general guidance is still insufficient in providing enough specificity to ensure that consistent assumptions and measurements are made to support comparable claims, within programs and across programs. Despite the complexity of LCA and the continual evolution of methods used in LCA, the immediate need for standardization in product category rules (PCRs) is analogous to what has been voiced by Draucker et al. (2011) for the overarching product carbon footprinting standards. They state that without consensus on best practices and methodologies, there is an undue risk of division between stakeholders, extended confusion in the market place, and prolonged delay in the collection of information that can help improve standards and accelerate the reduction of emissions.

This problem was identified in the course of development of the ISO 14025 standard (first developed in 2000). To support comparable EPDs, it was determined that a PCR is necessary to define specific rules for products serving the same function. ISO 14025 sets out a procedure for developing PCRs and the required content of a PCR, as well as requirements for comparability. Since then, it has also been recognized in the development of other life cycle-based standards (such as carbon footprints of products) that further specificity within sectors is needed beyond the overarching standard to ensure consistent assessments. Consequently, other forms of PCRs have arisen, which are not necessarily based on ISO 14025 (i.e., for the purposes of EPDs). These are sometimes referred to as "sector guidance," "supplementary requirements," or "product rules" and can be for different purposes beyond environmental product declarations, e.g., consumer labeling, general guidance to business to aid uptake, etc. Here, we refer to all such rules as PCRs for simplicity. PCRs offer some distinct benefits: greater consistency and comparability of assessments based on the same rules; modularity of assessment scope; transparency of requirements and in the development process; guidance and clarity to users undertaking assessments within product sectors; and flexibility of use by any entity (Costello and Schenck 2009; ISO 2006b).

PCRs for EPDs have been in development for years. EPD programs began in Europe, with early roots of requirements for quantified environmental product information in Scandanavian countries (based in Sweden), but are now present in European, East Asian, and North American countries. There are at least 300 PCRs (for EPDs and CFPs) that have been published by state-initiated programs alone for product categories ranging from staple food products to advanced electronics like copy machines and computers (Ingwersen and Stevenson 2012), and are quickly growing with the recently launched programs in France and Taiwan.

These efforts, however, have not been systematically coordinated at an international level, thereby leading to the duplication of PCRs within the same product groups. Acknowledging potential problems with conflicting PCRs, various initiatives have emerged to provide further guidance on PCR development with the aim of encouraging alignment of PCRs, or consistency in PCRs to enable legitimate comparisons. The PCR Taskforce was formed under the umbrella of the Product Carbon Footprint World Forum with the objective of forging a path toward increased transparency and consistency in PCR development through a consensus process (PCF-WF 2011). The American Center for Life Cycle Assessment (ACLCA) created a PCR committee to address similar concerns in the North American

[1] Goedkoop et al. (2010) provide a comparison of various criteria from different carbon footprinting standards.

context (ACLCA 2011). One of the early goals of the PCR Taskforce was to explore the similarities and differences in existing PCRs. The purpose of this study was to support that goal by methodologically analyzing a select number of existing PCRs for the same product groups to identify where they are comparable and where they are divergent. By identifying the differences between duplicate PCRs, the objective was then to propose a path toward alignment with sufficient justifications.

2 Method

In order to analyze the disparities between duplicate PCRs and the sources for disparities, a stepwise process was utilized. The duplicate PCRs were first selected, then a common template for comparison was developed and reviewed, and, finally, each duplicate PCR was analyzed using the template and then peer-reviewed.

2.1 Selection of PCRs

Product categories with multiple PCRs were selected based on an online search of existing PCRs (including those for EPDs or carbon footprint guidance/requirements), their public availability in English, and the author's prior knowledge of the sectors. PCRs were identified to be a duplicate if they included products that serve the same function and represented the same or similar scope of a product sector. PCRs for EPDs and carbon footprints will differ in the purpose and impacts characterized, but were assumed to be otherwise potentially identical and, thus, directly comparable. The product categories for comparison were appropriately selected to ensure the representation of a broad range of categories. The four product categories that were selected for comparison are dairy, horticulture, laundry detergents, and wood–particleboard. Within each category, all published or available drafts of PCRs for that category were reviewed. Table 1 provides an overview of the 11 PCRs selected for comparison in these four categories.

Table S1 in Appendix I of the Electronic supplementary material (ESM) provides a summarized list of the programs and standards bodies that create PCRs.

2.2 Creation of a comparison template

A template was created to simplify the comparison process. Use of the template was a way of generalizing and structuring the comparison to ensure a consistent and comprehensive assessment that covered all the key elements of the PCRs. The template that was created and used in this study is included in ESM Appendix II.

Table 2 shows the general structure of the template and the various criteria used for sorting the PCR components. In order to enhance the consistency of use and reproducibility of comparisons by different users, the template structure was streamlined as per ISO 14040 framework and a set of rules established for usage. The structure enabled side-by-side comparisons of PCRs by criterion, with a shared comment section for each criterion to aid interpretation.

Prior to carrying out the comparison, the PCR Taskforce and the ACLCA PCR Committee reviewed the template and had their comments incorporated into the final version. Following a comparison exercise, improvements to the template were made to increase clarity and simplicity in use, as well as to address other ambiguities.

2.3 Comparison of PCRs

The template was used to analyze each PCR by summarizing the content of each PCR within the criteria identified. Comments were provided to highlight any lack of clarity/inadequate explanations, the inclusion or exclusion of certain processes, and consistencies/inconsistencies between PCRs.

To reduce errors or differences in the interpretation of the PCRs, each comparison was internally reviewed once the template was complete. The reviewed comparisons were then sent to the respective authors of the PCRs for comments on our interpretation of their PCRs. In a few cases, the authors provided valuable clarifications that improved our interpretation of the PCR, which were then incorporated into the comparison.

Once the comparisons were complete, key differences or similarities between the PCRs were analyzed for each of the criteria in a summary table. These included differences in the purpose, standards, functional unit, scope and boundary, calculation rules/modeling, data quality rules, cutoff rules, allocation, primary data requirements, and secondary data sources. Using this summary table, we assessed (1) the disparities between PCRs, (2) the sources for the disparities, and (3) the spread of disparity among duplicate PCRs from different programs.

While we could speculate on ways to improve the content in existing PCRs and by adding additional criteria (e.g., uncertainty, referenced LCAs, and other studies), we maintained our focus on assessing the current disparity and how that can be either eliminated or alleviated.

3 Results and discussion

As demonstrated in Table 3, the PCRs were found to be generally inconsistent in their overall purpose and scope as well as their treatment of specific technical rules or requirements. An exception was the comparison of wood material/

Table 1 PCRs selected for comparison

Product categories	Program operator	Title	Purpose	Product classification used	Overarching standard(s)	Year
Dairy	International EPD System, Sweden	Processed liquid milk	Environmental product declaration, EPD®	CPC	ISO 14025:2006	2010
	DairyCo, UK	Guidelines for the carbon footprinting of dairy products in the UK	Carbon footprint B2B communication	Not specified	PAS 2050	2010
Wood–particleboards	Institut Bauen und Umwelt e.V, Germany	PCR wood materials	EPD	Not specified	ISO 14025: 2006	2009
	International EPD System, Sweden	Products of particle board of wood or other ligneous materials	Environmental product declaration, EPD®	CPC	ISO 14025:2006	2011[b]
Horticulture	Japanese Environmental Management Association for Industry (JEMAI)	PCR vegetables and fruits (PA-BF-02): The carbon footprint of products calculation and labeling pilot program	Carbon footprint consumer label	Not specified	TS Q 0010	2010
	International EPD System, Sweden	Basic module: Products of agriculture, horticulture and market gardening	Environmental product declaration, EPD®	CPC	ISO 14025: 2006	2010
	British Standards Institute, United Kingdom	PAS 2050-1: Supplementary requirements for the application of PAS 2050 to horticultural products Draft version (May 2011)	Carbon footprint B2B communication	Not specified	PAS 2050	2011[a,b]
Laundry Detergents	Korea Environmental Industry & Technology Institute (KEITI)	Laundry detergents [EDP 2003-65(1)]	Environmental declarations of products	Not specified	ISO 14025:2000	2003
	The Japanese Environmental Management Association for Industry (JEMAI)	(Provisional translation) Product category rules (PCR) (approved PCR ID: PA-AC-01) PCR Name: Powdered laundry detergent. CFP calculation and labeling pilot program	Carbon footprint consumer label	Not specified	TS Q 0010	2009
	International EPD System, Sweden	Detergents and washing preparations	Environmental product declaration, EPD®	CPC	ISO 14025:2006	2011[b]
	The Sustainability Consortium (TSC), United States	Laundry detergent	Sustainability measurement and reporting system	GPC	ISO 14025:2006	2011[b]
	ADEME (French Environment and Energy Management Agency) & AFNOR (French organization for standardization)	Draft guideline for household heavy-duty laundry detergents—GT3	Environmental communication on mass market products	Not specified	BP X 30-323-1	2011[b,c]

Sources: IBU (2011), METI (2011), GEDnet (2011a, b), JEMAI (2011a, b), KEITI (2011a, b), IES (2011), AFNOR and ADEME (2009), TSC (2011), BSI (2008), DairyCo (2011)

[a] Initially published in the Netherlands, currently being developed into PAS

[b] Currently in draft form

[c] Not included in the study

particleboards, in which a fair level of consistency between the PCRs was found.

The PCRs were found to be directly inconsistent (e.g., included different functional units or required a different approach to allocation) as well as indirectly inconsistent (e.g., specified calculation rules for different types of activities or provided different levels of detail that could lead to divergent results). In this section, we discuss the different sources of these discrepancies and how they have led to differences between PCRs.

Table 2 PCR comparison template structure and included criteria

Number	Categories	Criteria
1	General information	Product category name, classification codes, language, dates of publication and expiration, renewal information, program operator information, geographic region of use, external critical review, information on referenced PCRs, sponsoring organization, overarching standard
2	Goal and scope	LCA type, application, audience, function, functional unit, system boundary with specific mention of included and excluded processes in each life cycle stage, process flow diagram, general data requirements (temporal, technological, geographical, capital infrastructure, cutoff criteria, allocation, and modeling), primary/foreground data (methods and tools for data collection, processes for data collection in each life cycle stage), secondary/background data (includes a hierarchical choice of data sources or the criteria to determine which)
3	Life cycle inventory analysis	Inventory parameters and analysis methods
4	Life cycle impact assessment	Impact indicators and characterization methodology, normalization rules, weighting rules
5	Communication	Format, structure
6	Miscellaneous	Additional environmental information, safety information, glossary, reference literature, general comments

3.1 Sources of inconsistencies

Four key factors that influenced the level of consistency were the purpose of the different PCRs, the overarching standard used, the level of product classification, and the independent development process. The variation between these factors are shown in Table 3 and discussed further below.

3.1.1 Differences in purpose

Some PCRs were developed for the purpose of EPDs addressing multi-environmental impacts under ISO 14025. Other PCRs addressed only carbon footprints—either for a consumer label, business-to-business communication, or for providing guidance about how to carry out an assessment in a particular sector. As stated in Table 3, the horticulture, detergent, and milk/dairy PCRs had distinctly different purposes from one another and were based on different overarching standards, while these factors were both consistent for the wood–particleboard PCRs.

Differences in the target audience of the EPD/PCF can result in differences in the approach, the scope/system boundaries, and the level of detail within the PCRs. The PCRs developed for "The Carbon Footprint of Products Calculation and Labeling Pilot Program" in Japan and the "Sustainability Measurement & Reporting System" in the USA, for example, tend to be prescriptive in detailing the processes to include/exclude and standardizing the assumptions and calculation rules for variable factors (e.g., use/transport/disposal). Such level of detail is expected if the aim of the PCR is to promote consistency and comparability of labels directed at consumers, whereas a PCR addressed at business-to-business communication, like the developing supplementary requirements to PAS 2050 for horticulture, would understandably provide more detail at the upstream part of the supply chain rather than use/disposal.

Multiple environmental impacts must be characterized for EPDs, whereas only the carbon footprint is characterized for product carbon footprints. As a result, PCRs for EPDs generally require keeping inventory of a broader set of elementary flows that are associated to the impacts specified (e.g., to develop an EPD based on the processed liquid milk PCR, SO_x, NO_x, and other emissions that have characterization factors for acidification must be tracked to characterize the acidification potential). This difference does not make PCRs for EPDs and those for PCFs incompatible, but rather one that could be overcome with expansion of PCF-PCRs for creating EPDs, or similarly a limited implementation of an EPD-PCR when used only for a product carbon footprint. Resolving the differences between PCF-PCRs and EPD-PCRs due to references to different overarching standards is more challenging to reconcile and is addressed in the next section.

3.1.2 Differences in overarching general standards

The overarching general standards (e.g., PAS 2050 vs. TQ 0100) on which individual PCRs are based led to variations between PCRs by setting out different approaches (e.g., to allocation/treatment of capital goods) as well as influencing the structure and detail the PCR must follow. Although most (or all) overarching standards are broadly based or build on ISO 14040/44, they tend to have different purposes, scope, and detailed technical requirements.

Table 3 Assessment of consistency across different aspects of the PCRs

Consistency Factors	Horticulture	Laundry Detergents	Wood Particle board	Dairy
Purpose	Inconsistent: Purpose	Inconsistent: Purpose	Consistent	Inconsistent: Purpose
Environmental impacts addressed	Inconsistent: Purpose	Inconsistent: Purpose	Consistent	Inconsistent: Purpose
Standards used	Inconsistent: Sources	Inconsistent: Sources	Consistent	Inconsistent: Sources
Functional Unit	Inconsistent: Modeling rule	Inconsistent: Modeling rule	Consistent	Inconsistent: Level of Detail
Scope and boundaries	Inconsistent: Scope / Level of Detail	Inconsistent: Scope / Level of Detail	Inconsistent: Scope/level of detail	Inconsistent: Scope
Calculation rules/modeling	Inconsistent: Modeling rule / Level of Detail	Inconsistent: Modeling rule / Level of Detail	Consistent	Inconsistent: Sources, Level of Detail, Modeling
Data quality rules	Inconsistent: Level of Detail	Inconsistent: Scope/Level of Detail	Unclear	Unclear
Cut-off rules	Inconsistent: modeling rules	Inconsistent: modeling rules	Consistent	Consistent
Allocation	Inconsistent: modeling rules / level of detail	Inconsistent: modeling rules/level of detail	Inconsistent	Inconsistent: modeling rule
Primary data requirements	Inconsistent: modeling rules / level of detail	Inconsistent: Level of Detail	Unclear	Inconsistent: Level of Detail
Secondary data sources	Inconsistent: sources	Inconsistent: sources	Inconsistent: Sources	Inconsistent: Sources

Each aspect is categorized as to whether the PCRs were consistent (*dark gray*), inconsistent (*light gray*), or unclear (*white*). The different types or sources of inconsistency are also categorized depending on whether resulting from its "purpose," "scope," "sources," "modeling rule," or "level of detail"

Whether the overarching standard or PCR addresses multi-environmental impacts or only carbon impacts, it results in obvious differences between PCRs. For example, those that address carbon tend to provide more specific or defined calculation/modeling rules addressing carbon emissions compared to a more generic approach covering a wider range of environmental impacts. Requirements for secondary data sources, when specified, were often specifically linked with a program operator for the country in which the PCR was developed—therefore divergent between PCRs (e.g., JEMAI PCRs). The one example of duplicate PCRs that were closely aligned (i.e., wood–particleboard) were both based on ISO 14025, therefore have a similar scope/purpose.

The differing overarching standards also led to the variation in the characterization methodology used to assess the environmental impacts of the product systems. The Sustainability Consortium uses the "Impact Bookshelf" which contains six impact categories (global climate change, ozone depletion, ionizing radiation, photochemical ozone formation, acidification potential, eutrophication) that overlap various methodologies, while the KEITI uses an unnamed impact characterization methodology with a slightly different set of six impact categories (resource depletion, global warming potential, ozone depletion potential, acidification potential, eutrophication potential, and photochemical ozone creation potential).

3.1.3 Differences in product classification

The way the product category was classified also resulted in a difference in the scope of the PCRs. At times, product categories were broad, i.e., at a sector level that covered many product categories (e.g., horticulture). In these cases, the instructions in the PCR were flexible enough to accommodate all the products within the sector, resulting in less specificity or detail. Some program operators provided further detail by creating a PCR for a more specific product category. For example, the liquid processed milk PCR from the International EPD System specifies specific allocation rules for the impacts of raw milk processing, for milk carton production and disposal, and milk storage that are not applicable to all dairy products, as is the DairyCo UK dairy product PCR.

Product classification systems offer a taxonomy that clearly defines and distinguishes product categories within

a hierarchical structure of all products. They are used within industry and government for the purposes of product and supply chain management (Hugos 2006). Three commonly used international systems for product (goods and services) classification are: (1) Central Product Classification (CPC), (2) United Nations Standard Products and Services Code (UNSPSC), and (3) Global Product Classification (GPC).[2] Figure 1 compares the use of different classification methods for a compact laundry detergent. It can be seen that the level of detail is the most distinguishing factor in the different classification methods. GPC has the highest and CPC has the lowest level of classification detail. It is notable that the same levels across different classification systems are not identical. Therefore, if PCRs are created for a broad category of products defined by one of those systems, it will not likely correspond to a broad category in another classification system.

3.1.4 Problems with independent development

Other differences between the PCRs seemed to stem not so much from the purpose, standards used, or classification of the product but were simply the result of being developed independently. For example, despite having a similar purpose and being based on the same standard, the wood–particleboard PCRs each provided a distinct approach to allocation. Most PCRs had different functional units, approach to allocation, specific modeling requirements, primary data requirements, or specified inclusions/exclusions. There was no apparent rationale why these aspects of the PCRs were, or needed to be, different. Differences in technical requirements are, however, likely to naturally result from different PCRs being developed by separate operators.

Variations in the level of detail occurred frequently due to independent PCR development. These differences often created uncertainty in PCR comparability. For example, the dairy PCR from DairyCo provides a high degree of detail on how farms should be sampled. This same level of detail is not present in the International EPD System liquid milk PCR, leaving more room for inconsistencies to occur when modeling this stage of the process. Data requirements were a common area where PCRs differ in detail. Requirements for primary data were generally based either on generic rules (e.g., required for all processes controlled by the assessor), or the PCR specified all the particular processes where primary data must be collected.

[2] A mapping tool between UNSPSC and GPC (GS1 2011) is available. The idea of a mapping tool between CPC and UNSPSC was scrapped due to substantial conceptual differences (UNSD 2006).

3.2 Difficulties in comparing PCRs

Overall, each PCR took a different overall approach to their structure, provided different degrees of specificity, and used different terminologies to describe processes or technical requirements. This difference in the overall approach made the direct comparison between PCRs difficult. For example, the KEITI PCR on laundry detergents provided information in less detail and segmented as common rules that apply to all products and product-specific rules, while the JEMAI PCR on laundry detergents provided detailed and often repetitive information on data collection rules, secondary data application rules, and cutoff criteria for every life cycle stage. In the horticulture PCRs, different terminologies (with a lack of clear definitions), e.g., around "cultivation materials" vs. "auxiliary products" and "semi-products" vs. "consumables," made it difficult to immediately understand whether the scopes align.

The question remains how impact results would differ for claims for the same product using duplicate, inconsistent PCRs. Once a company has committed the time and money to complete and register an EPD, it is unlikely that the work would be done again with a different PCR. Because of this, we can only speculate on the different outcomes, but a possible example would be a significant inconsistency in the total environmental impacts if one PCR required the inclusion of additional life cycle stages beyond those in a competing PCR. For example, flooring PCR may reasonably include or exclude the impacts from installation/construction processes, which can account for significant waste quantities and associated impacts. Additionally, if the life cycle stages are not reported separately, a cradle-to-gate EPD for a product could potentially be forced to be compared with a cradle-to-grave EPD, resulting in the latter having higher impacts. If by-products are present in the manufacture of flooring products, allocation may be done by mass or economic value or system expansion may be preferred. The significance of these choices is product-dependent, but differences in system boundaries and allocation rules have repeatedly shown to result in significant differences in impact results (Cherubini et al. 2009; Gaudreault et al. 2010; Guinée and Heijungs 2007). Furthermore, data restrictions put forth by various PCRs/program operators are difficult to comply with for case study purposes. For example, some PCRs require primary data collection for some stages, while there are others that provide secondary data to only program participants, and lastly, there are some that do not provide clear instructions for secondary data selection and use. Thus so, any modeling that authors perform will add another level of variability and uncertainty to the impact results. Therefore, we predict that impact results using duplicate PCRs that are inconsistent in the aforementioned aspects will be equally divergent.

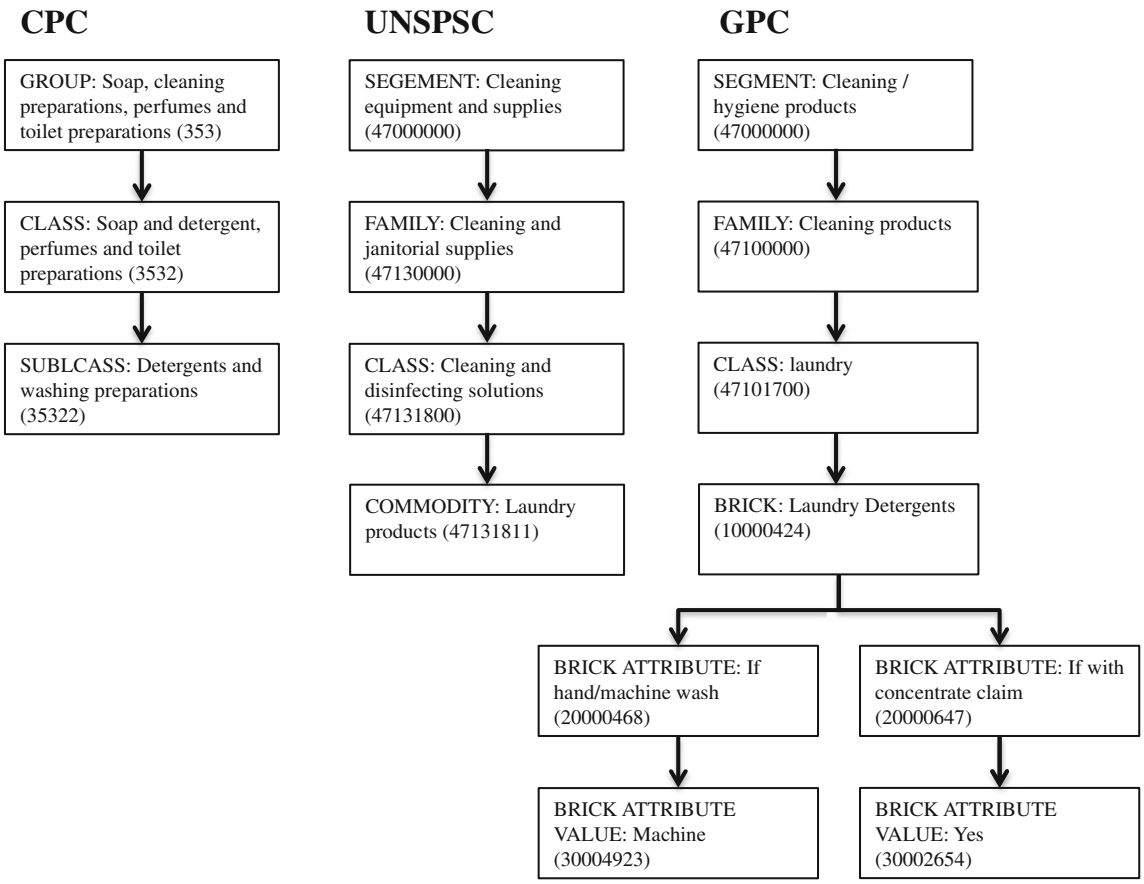

Fig. 1 Comparison of product classification methods used by various program operators for a compact powder laundry detergent, without secondary benefit or sud control. Sources: UNSD (2011), UNSPSC (2011), GS1 (2011)

4 Toward global alignment of PCRs

ISO 14025 (ISO 2006b) states that "Programme operators should facilitate harmonization when developing PCR for a product category by considering the adoption of readily available PCR documents in the same product category and in the appropriate market area. However, there may be valid reasons for developing PCR documents that have a different content from those that already exist. The justification for differing from existing PCR shall be based on content…and…not…on the origin of any particular PCR."

Despite this clear direction for harmonization from ISO 14025, this review demonstrates that different programs have published duplicate PCRs. With the exception of the wood–particleboard PCRs, all the duplicate PCRs compared here were found to be largely inconsistent. Not all PCRs cite ISO 14025 as an overarching standard, but of two duplicate examples based on ISO 14025 reviewed here, neither provided justification for a new PCR, where a PCR already existed. None of the PCRs provide any reference to existing PCRs created for the same product category.

PCRs were created within the context and rules of their specific programs and are generally restricted in application to the geographical context of those programs. The ISO 14025 standard did not create any single entity to organize the process of PCR creation, and neither does it accredit program operators; it merely provides general guidance and encourages program operators to search and refer to existing PCRs before creating original ones. But existing PCRs are often difficult to find or have not been translated into English, and no good precedent has been set for the adoption of existing PCRs. The current situation presents problems for life cycle-based product claims.

4.1 Benefits of global alignment

Product supply chains are often global, and at least some component of production is likely to occur in a different country than that of final consumption; thus, there is a need for PCRs to be applicable to the complete global supply chain. Duplicity of PCRs within the same product category has the potential to threaten the legitimacy of environmental labels and ultimately stifle product claim comparison. As

the main purpose of PCRs is setting consistent parameters within product groups to promote comparable results, the presence of inconsistent duplicate PCRs undermines any comparability across international programs. A plurality of PCRs for the same product also creates potential conflict with international trade conventions and may greatly increase the burden of preparing a claim for producers, which could hinder participation in these schemes and thus reduce the effectiveness of such an approach. Given the larger goals of sustainable consumption and production, consistent global PCRs produced from different programs have a high potential to accelerate the creation of EPDs for various products worldwide by simplifying the adoption and modification process of PCRs.

In the following sections, we provide some specific recommendations to enable alignment based on insights gained from the comparison.

4.2 Suggestions for global alignment

The two components to global alignment are (1) the PCR documents and (2) the program operators.

4.2.1 Provide general guidance applicable to all PCRs

The alignment of PCRs would be greatly facilitated by a general guidance document that is shared among programs (EPD and carbon footprinting programs alike). This document would act as a standard that applies to all PCR development regardless of the overarching standard used (e.g., ISO 14025, PAS 2050, TS Q 0010, or BPX30-323).

The purpose of the document would be to:

- Promote alignment of PCRs developed for different purposes (i.e., beyond EPDs)
- Provide guidance on how different types of programs can adopt aspects of other PCRs (e.g., including requirements that should be standardized across programs vs. those that could be flexible)
- Build on the relevant provisions in ISO 14025 to provide greater specificity on the content of PCRs and guidance on the level of detail/prescriptiveness required

Table 4 sets out the type of information that could be included in such a guidance document. ACLCA's PCR committee has taken a step forward in this direction by drafting the *Standard Practice for Product Category Rule Program Operators* (ACLCA 2011). This document (which is solely focused on PCRs based on ISO 14025) attempts to clarify ambiguities in the operation of a PCR program. While there is content in the document that fulfills some of the needs identified in Table 4, there is still a need for a general guidance document that will address other issues like the use of different overarching standards, the impact methodologies to use, etc. Following a workshop on PCR alignment at the LCA XI Conference (Ingwersen et al. 2012), development of guidance on PCRs has been launched through an open process by a committee of the ACLCA in cooperation with other partners.[3]

4.2.2 Alignment among program operators

In almost all cases, there is little relationship between PCRs in different programs. There are few instances of cross-recognition between program operators. For example, Germany's Institut Bauen und Umweit (IBU) and Sweden's International EPD System have developed preliminary text for a memorandum of understanding between the two organizations (Ryding S-O, MOU between IBU and EDP international, 14 July 2011, personal communication). Other program operators like The Green Standard and the Environment and Development Foundation, which do not create PCRs, adopt them from other program operators to create EPDs. PCRs are created based on program rules and standards that are created or adopted by program operators. Thus, the duplicity of PCRs reflects heavily on the program operators who enabled their creation.

Facilitate collaboration between different program operators Collaboration between programs is essential to facilitate PCR alignment. Golden et al. (2011) have identified the need for a communication platform for organizations addressing product sustainability to share insight and to avoid duplicating efforts. A platform to facilitate collaboration on EPDs, GEDnet, has existed for over a decade, but there are several barriers that limit its influence on global alignment, i.e., including only ISO 14025 program operators and limiting involvement by charging a fee for participation. Recently, other platforms have emerged, such as the Product Carbon Footprinting World Forum's PCR Taskforce and the ACLCA PCR Committee. The PCR Taskforce engages many relevant initiatives (WRI, PAS 2050, ADEME, JEMAI, TSC) and therefore has the potential to facilitate alignment through their efforts to develop a PCR registry and a common PCR guidance, in cross-collaboration with the ACLCA Committee. This platform includes more than just program operators and does not charge a participation fee, but requires more support and wider participation to accomplish its alignment goals at a global level.

Process for external review of PCRs PCRs are reviewed internally within programs and often include a process for open consultation. However, the whole process tends to be

[3] E-mail pcrguidance@gmail.com for more information.

Table 4 Recommendations for general guidance on PCR development

Recommendation	Explanation
Define steps to carry out before developing a PCR	The guidance could set out steps for how to avoid duplication of existing PCRs before new PCRs are developed, e.g., –Review current PCRs within the product category (provide links to PCRs where available) –Engage with program operators of existing PCRs –Assess need for new PCR –If new PCR is justified, adopt content of existing PCRs as much as possible and provide explanation/justification where approach diverges
Procedure for adoption content of PCRs with different objectives/scope	For example, whether and how an EPD-PCR can be built on carbon footprint PCRs and vice versa
Create a common template for PCRs	To establish a standard structural format for all PCRs to comply with. This ensures that the document flows, information is not repetitive, and that the document is easy to use.
Define standardized vs. flexible components of PCR	Certain components of the PCR must be standardized while allowing for other components to be flexible for change, thereby allowing PCRs to be duplicated for valid reason. For example, standardized components include general PCR information, system boundary, cutoff criteria impact assessment methodology, etc., while flexible components include technology, geography, secondary data etc. The guidance is created such that it allows for radical change if deemed necessary.
Establish the level of detail and prescriptiveness of different components of the PCR	Guidance on the level of detail provided in the PCR for data collection, data modeling, data sources, assumptions, and other criteria found in PCRs. Ideally, high level of prescriptiveness enables effective comparison through standardized assumptions, rules, and minimal interpretative differences.
Use a common product classification system	A single product classification to be used by all program operators. The classification system that which is widely used in business transactions and that provides high level of detail that will enable program operators to zoom in and zoom out as needed to create product and sector rules.
Standardized technical terms/guidance on equivalent terms	Adopt general terms from ISO 14040, 14025, and 14067 and supplement the remaining general terms in the program rules or standards. Terms specific to the product/sector must be provided in the PCR document.
Establishing clarity in content	Through examples from existing PCRs, the DOs and DON'Ts that establish clarity in content are listed.

conducted internally within the program itself. If different programs were to work together to develop/review PCRs, this may help ensure cross-collaboration, standardization, and better quality PCRs.

Language translation Language difficulties presented a clear problem in interpreting and comparing PCRs. Given that PCRs are being developed in various countries with different languages, this impediment may be difficult to overcome. However, to promote alignment, it is important that PCRs are translated clearly into English where possible. For this to work well, any PCR guidance/structure should also be translated into other languages so that all programs are working from a common source to start with.

5 Conclusions

Product category rules have been developed as a way to specify common rules for life cycle-based claims such as EPDs and product carbon footprints, but these rules have

been created by many organizations and serve divergent purposes. In some cases, duplicate PCRs have been created for the same category of products. The PCR comparison template[4] was developed as a tool for comparing duplicate PCRs within the same category to determine the significance of differences between these PCRs. A study of duplicate PCRs in four categories revealed more substantial differences in three of four categories. Among the reasons, differences arise in PCRs over different overarching standards, differences in end purpose of the PCRs, differences in product category definitions and choice of different classification systems, and a consequence of independent development. Through this analysis, it became clear that duplicity is a systemic problem with PCRs; therefore, the proposal of principles for a general PCR guidance document was the logical path to moving forward.

The lack of coordination between various program operators has the potential to reduce the credibility of product comparisons and stifle the efforts toward sustainable consumption and production. There is need for collective responsibility among program operators to work toward the alignment of rules that would enable comparative life cycle-based claims.

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[4] The authors envision the PCR comparison template to be a living document. As long as the need exists, the template will continue to evolve based on the needs. The template will be housed online at the PCR Committee section of the ACLCA web site (http://www.lcacenter.org/product-category-rule.aspx). Since publicly releasing this template, it has been used by ACLCA to compare PCRs on shoes to assess the landscape of shoe PCRs and determine the need for a new one and by WRI to adapt this template as a model for carbon footprinting PCRs.

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