Ministry of the Economy of Luxembourg

Luxembourg Circularity Dataset Standardization Initiative

PHASE 1 – FINAL REPORT

Creating a digital circularity fingerprint for products

Development of a proof of concept for a light dataset describing circular properties of products and including an auditable international industry standard.

LE GOUVERNEMENT
DU GRAND-DUCHÉ DE LUXEMBOURG
Ministère de l'Economie

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Acronyms

API	Application Programming Interface
C2C	Cradle-to-Cradle
CE	Circular Economy
DWG	Dataset Working Group
DSG	Dataset Steering Group
FMCG	Fast Moving Consumer Goods
ICT	Information and Communication Technology
ILNAS	Institut Luxembourgeois de la Normalisation, de l'Accréditation, de la Sécurité et qualité des produits et services
IT	Information Technology
MSDS	Material Safety Data Sheet
PCDS	Product Circularity Data Sheet
POC	Proof of Concept

Terminology

Various specific terms are used in the report. The definitions of these terms are described here:

Auditing Sub-Group	A consultative body whose main purpose is to co-create an outline of how the Product Circularity Data Sheet (PCDS) will be audited for quality.
Dataset	A collection of information or properties.
Data sheet	A document providing the dataset in a human-readable format.
Data template	A blank form with a standardized structure to enter information. Once the information is filled in the template, it becomes a data sheet.
Dataset Working Group	A consultative body whose main purpose is to co-create with the Contractor a Circularity Dataset Standardization protocol. The final authority for approving the protocol is the Ministry of the Economy.
Industry Standard	In this context, an industry standard is an informal standard that is generally accepted by participants in the Dataset Working Group. It is not an officially accepted standard, as this requires a formal approval process by a standards organization.
Product Circularity Data Sheet	A product declaration which presents standardized and trustworthy information on the circularity aspects of a product i.e. the circularity dataset, which could be used partially or entirely by other stakeholders (e.g. databases, platforms or consultants) to enable circular evaluation of products. A "light" Product Circularity Data Sheet contains a limited set of information related to the circularity aspects of the product and which are non-confidential. The "light" PCDS is primarily intended for use in business-to-business communication, but its use in business-to-consumer communication under certain conditions is not precluded.
Stakeholders Group	An informal group whose main purpose is to provide feedback on how the POC could be implemented in their respective organizations, and to support the PCDS initiative moving forward.

Executive Summary

Progress Towards Objectives

The ultimate objective of the Circularity Dataset Standardization Initiative is to establish an official standard for communicating data on the circular economy properties of products, in consultation with other standards organisations. The short term objective is a de facto industry standard in order to (a) fill a gap in the marketplace data for the circular economy (CE), (b) save costs for manufacturers and other stakeholders who are being asked to provide similar CE data in many different formats, (c) improve CE data sharing efficiencies across supply chains, (d) protect the integrity of data to assure its reliability (e) provide the data in an open format readily available to other platforms without a need for proprietary fee-based software. The Ministry of the Economy of Luxembourg mandated +ImpaKT to develop a proof of concept for a light circularity dataset including its audit process and IT exchange protocol. The solution envisioned by +ImpaKT is called the Product Circularity Data Sheet (PCDS) and a proof of concept has been successfully developed.

Potential uses of the report

- As a roadmap to guide further development steps.
- Segments could be used as topic areas for the third-party verification process and the IT system development.

Key Achievements

+ImpaKT developed a light PCDS in collaboration with a group of 30 international organizations (Dataset Working Group (DWG)). The PCDS system is an outstanding solution which aims at solving what had never been solved before i.e. a workable and standardized tool for facilitating the access and the exchange of circularity data throughout the supply chain which is a key paradigm shift. In addition, the PCDS is intended to be completed on the basis of how the manufacturer designed its own product to be used, and not on how the next user in the value chain intends to use this product.

The Steering Group:

1. created a high engagement and a constructive dynamic in the DWG;
2. developed a proof of concept that was tested and adopted by a series of companies and some of their suppliers;
3. developed a Guidance Document for a light PCDS, which represents a strong basis for the development of a standard;
4. developed a skeleton audit procedure and a guiding framework for the IT system, which serve as key inputs for further development;
5. gained significant support for this initiative from many stakeholders including thought leaders and key leading circularity evaluators;
6. gained active support from certification bodies such as the Cradle-to-Cradle Product Innovation Institute.
7. identified potential pilot projects to demonstrate the added value of the PCDS and are collaborating with Cobuilder to integrate the PCDS into their platform according to the recent ISO standards 23386 and 23387.

The achievements in phase 1 and the positive feedback received so far provide a strong impetus for the development of the PCDS as an international standard in the circular economy.


...save costs for manufacturers
and other stakeholders

Introduction & Purpose

Purpose of the report

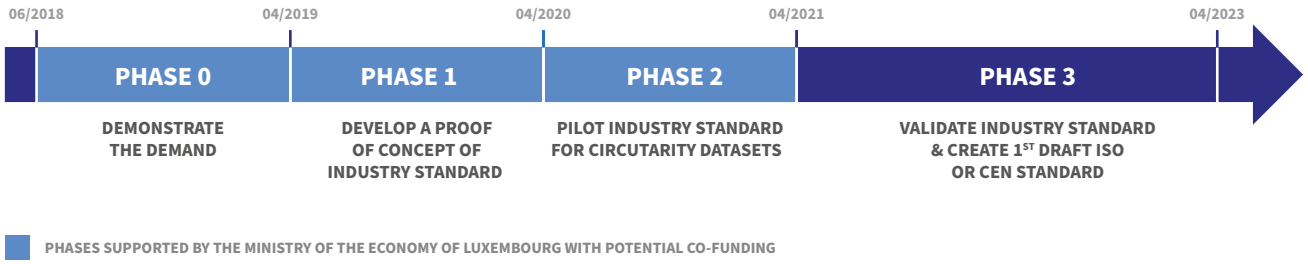
A. Present results of Phase 1 “Development of a Proof of Concept”

B. Summarize the key features of the Product Circularity Data Sheet (PCDS) and the key lessons learned from the testing phase, in order to provide a strong basis for the next phases of the initiative.

Introduction

An effective circular economy that is designed for high-quality continuous material loops requires the circulation of not only resources but also information. However, a lot of circularity information is missing, as its generation and handling requires too many human and financial resources. In order to solve this, the Ministry of the Economy of Luxembourg launched the Circularity Dataset Standardization Initiative (http://www.circularitydataset.lu/) in 2018. This standardization effort is organized in several phases as depicted in Figure 1.

Figure 1 - Overall timeline of the Circularity Dataset Standardization initiative



After a successful Phase 0 demonstrating the demand for a standardized circularity dataset, the Ministry mandated +ImpaKT to develop a proof of concept (POC) of a light data set describing the circular properties of a product. To make this POC a success, it must be accompanied by an industry standard, including an audit process and a data exchange protocol. The envisioned solution by +ImpaKT is called the Product Circularity Data Sheet (PCDS) and a POC was successfully developed in collaboration with the Dataset Working Group[1] (DWG).

In addition, a testing phase was organized during which the manufacturers and their suppliers were encouraged to practically test the PCDS with one of their products and provide feedback. Furthermore, a series of key stakeholders who can become potential users and/or ambassadors of the PCDS (platforms, circularity evaluators, etc.) were contacted to collect their feedback and identify potential synergies.

This report presents the key features of the PCDS system, the key learnings of the testing phase as well as recommendations for the way forward.

> *A collaborative process that engaged organizations to provide valuable inputs to the initiative*

1 The Appendix 6.1 provides an overview of the initiative governance as well as the name of the members of both working groups (Dataset Working Group and Dataset Stakeholders Group).

State of play

Despite considerable work by many players to fill gaps in the data marketplace for the circular economy (CE), there are still challenges and opportunities for CE data generation, storage and sharing. In order to move forward and avoid duplicated effort, it was important to know the main outcomes of other related initiatives, as well as the main showstoppers.

In addition, the PCDS is not a scoring or rating mechanism for the circularity of products. Instead, the data serve as inputs for other product schemes and platforms to do that. Therefore, it is important to identify leading initiatives that could use this data, in order to ensure that the PCDS fits and could be adopted rapidly within the ecosystem.

This section provides an overview of the current state of play of the initiatives related to product circularity datasets.

2.1 A fragmented circularity data marketplace

Market fragmentation

Over the last decade, the number of initiatives promoting the use of sustainability- and circularity-related data has been increasing. These initiatives which include research projects, databases, platforms, certifications, product data declaration, etc. cut across a range of products, from built environment to electronics and FMCG. Most initiatives are limited to defined areas. For example, some product schemes focus primarily on health, environmental or other aspects (sourcing of materials, social issues, etc.). Furthermore, reputability, assessment requirements and acceptability/adoption scale vary widely. An analysis of current/past initiatives was performed in Phase 1 to better understand the current ecosystem. Figure 2. shows the leading product- and circularity- related data initiatives which were analyzed in more details[2].

2 The initiatives for the analysis have been selected based on the report from phase 0, based on the experience from BAMB project (https://www.bamb2020.eu/) and Healthy Printing Initiative (https://www.healthyprinting.eu/), and on the experience from participants. The selected initiatives focus on product related initiatives (e.g. including only the product-based segments of initiatives related to buildings), which are dealing material-related information. This sampling is not exhaustive.

Figure 2 – The leading product- and circularity- related data initiatives

However, despite multiple CE product schemes being developed, there is currently no widely accepted one. This can be explained by the following influencing factors:

- **No common definition of what the circularity of product is.** Among the initiatives with a high emphasis on circularity, there is no collectively agreed way to define and assess circularity. A few widescale rollouts of circularity have started at company levels via e.g. the World Business Council for Sustainable Development (WBCSD) and the Ellen MacArthur Foundation, but these platforms still differ in interpretations of data and structure.
- **Circularity product schemes** are getting **very complex.** They **mostly focus on the final product** and they **all face the issue of collecting the required information backward throughout the supply chain,** especially information that companies are not necessarily ready to disclose, except to consulting firms under confidentiality agreement. Therefore, it is important to develop a workable and usable tool for the manufacturers as well as to keep the cost down (especially for the audit process).
- **Companies are still struggling to see where the circularity value is for each of them.** Half of the analyzed initiatives have been recently developed with a focus in the building sector in order to respond to the demand for more transparency on the product content and its toxicology[3] (e.g. Health Product Declaration, Declare Label, Toxnot). For other sectors such as packaging, there is a need for more circularity, but the added value is not often perceived by manufacturers. Therefore, it is crucial to link the PCDS to business cases in order to ensure its adoption. This will be addressed especially in phase 2 of the initiative.

3 Material health was included in the PCDS content because it is considered as a crucial basis for the circularity of product for the following reasons: 1) healthier material have a higher potential for cycling 2) and they have a direct impact on human health and environment.

Policy fragmentation

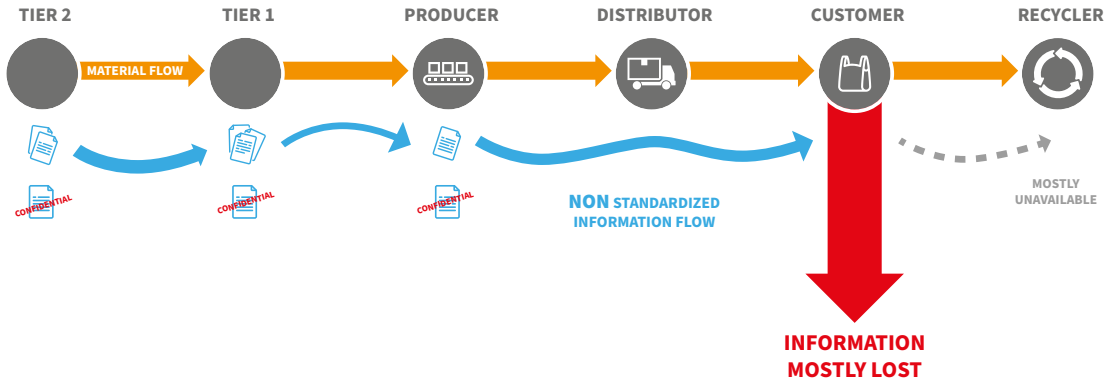
In parallel to these schemes, some sustainability standards are beginning to integrate circularity. As part of phase 0 of the current initiative, ILNAS – the Luxembourgish national standardization organization – realized a standards watch in 2019 to identify technical committees and standards (ISO and CEN) with some connection to Circularity Datasets. Some are currently being developed such as the ISO TC 323 and some are at national levels and/or sector specific such as the BSI standard BS 8001:2017[4] or the platform CB'23[5]. However, there is currently no widely adopted standard for basic circular economy data for products.

2.2 Challenges and opportunities for accessing circularity data

For assessing and promoting the circularity of products, a range of information related to the product and its composition is needed from different actors along the value chain. However, as illustrated by Figure 3, in the current linear economy, basic data for circular evaluation are being lost through the value chain for several reasons:

1. Some of the information is already available from traditional sources like certifications and environmental declarations but not in a standardized format and is stored in different data sources.
2. Other type of information is simply unknown, or is not publicly available, due to trade secrets of manufacturers.
3. Original data are often not validated, or the validation source is difficult to trace, which is critical to create a trustful environment.
4. Most of the circularity-related data is based on different proprietary centralized databases, so there is no universal and open mechanism to easily exchange basic data throughout the supply chain.

Figure 3 - *Information flow in a linear economy*

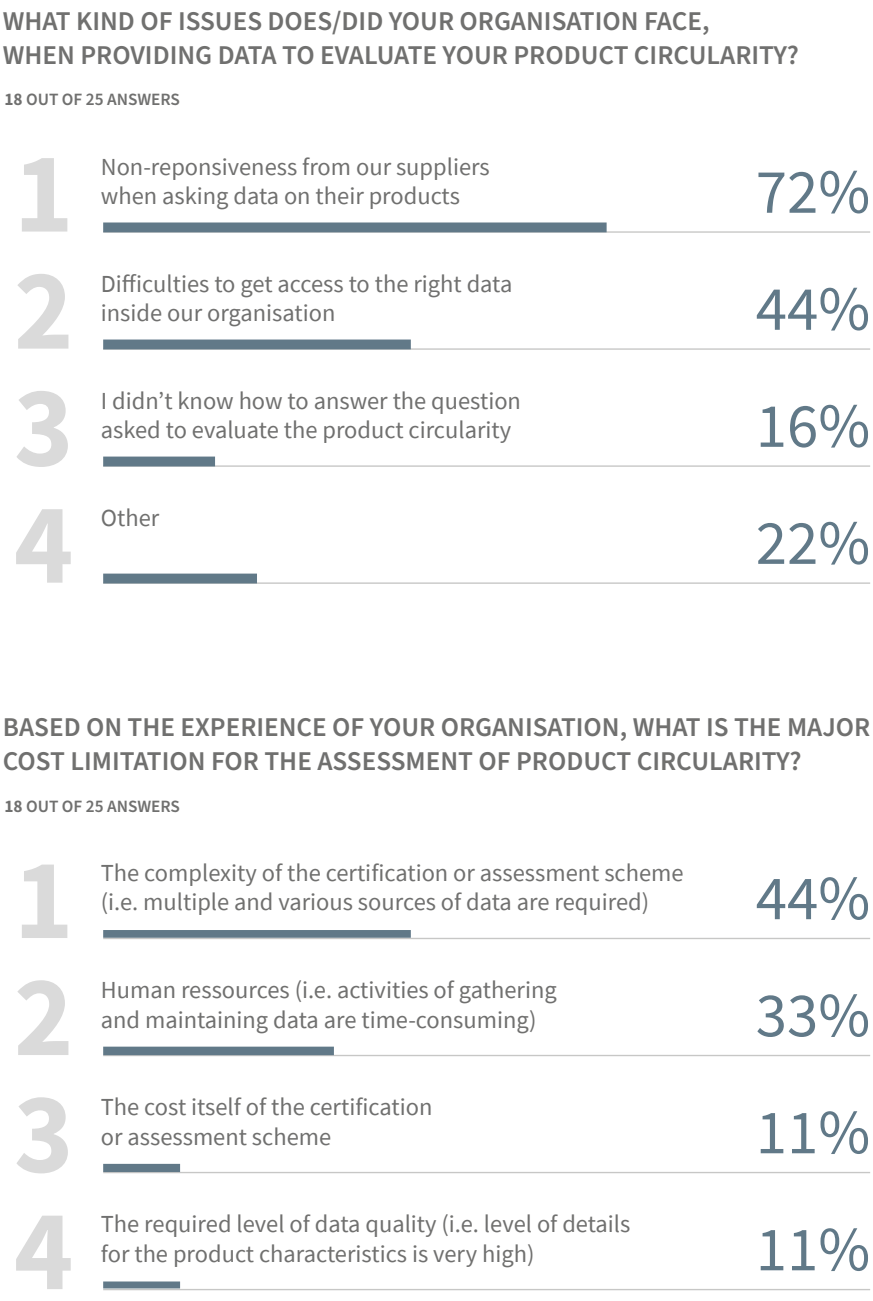


4 The British standardization organization (BSI) published in 2017 the standard BS 8001:2017 describing a practical framework and guidance for organizations to implement the principles of the circular economy.

5 The platform CB'23 was launched in the Netherlands with the aim to establish national, construction-sector-wide agreements on circular construction by 2023.

Circularity data are often missing, as data generation and handling require too many human and financial resources (as reflected by the results of a survey within DWG and Stakeholders Group cf. Figure 4). To enable efficient and secure exchange of product circularity information along the value chain, standardization of the data and format is needed, as well as an auditing process.

Figure 4 - Challenges for accessing data to evaluate product circularity



Source: Survey within DWG and Stakeholders Group, July 2019.


To enable efficient and secure exchange of product circularity information along the value chain, standardization of the data and format is needed, as well as an auditing process.

Product Circularity Data Sheet (PCDS)

3.1 Overview of the PCDS system

The Product Circularity Data Sheet (PCDS) is a three-fold system:

1. a **data template** which contains **standardized and trustworthy statements** on the product circularity,
2. a **third-party verification process** to validate the content of the PCDS (see more details in section 3.4)
3. a **standardized data exchange protocol** based on a decentralized data storage approach (see more details in section 3.5)

3.1.1 Objectives

1. Provide basic data on a product's circularity to all relevant stakeholders;
2. Improve the sharing efficiency of circularity data across supply chains;
3. Encourage the improvement of product performance in terms of circularity.

3.1.2 Design principles

A. Support other systems

The PCDS **is designed to enable later circular evaluations of the product** by providing basic information to others (for example, platforms or consultants). It is **not designed for ranking or rating product circularity itself,** although it might refer to certifications or labels that have already evaluated some aspects of the product performance. Therefore, the content of the PCDS is simply designed with a standard text set, facilitating the extraction of data.

B. Limitations on predicting final usage

The **PCDS is intended to be completed on the basis on how the manufacturer designed its own product to be used** , and not on how the next user in the value chain intends to use this product. Actually, the PCDS describes the circularity properties of a product at a particular point in the supply chain. If the product becomes part of another product, the characteristic could change. For example, a PCDS that describes the reusability of a part will no longer be valid if that part is welded into another product. In this case, the original PCDS is only valid at the point in the supply chain when it is not part of another product.

While each manufacturer is responsible for how its product is designed/manufactured, the pathways of the product are often impossible for the manufacturer to predict accurately. The same product is often used in different applications and assemblies, leading to different circularity scenarios. Therefore, the "Design for…" statements in the PCDS provide valuable information to support the evaluation of the product circularity but do not describe all potential future uses.

For example: a manufacturer designs a product X to be demountable/recyclable. However, the next user in the value chain uses product X in product Y in a way that is not demountable/recyclable (e.g. due to mixing, gluing, etc.). In this case, it is the responsibility of the user at that point in the supply chain to describe the demountability/recyclability of product Y, in a new PCDS.

C. Confidentiality vs. Transparency

To **solve the conflict between confidentiality of information and the need for transparency when implementing a true circular approach**, the PCDS is structured around "**statements**" to describe a certain set of features that can be transparently stated as true or false without having to disclose to every party the manufacturer production secrets. To ensure trustworthy content, the originating data are verified by an independent audit.

D. Standalone structure

The content of a PCDS is **designed to have a standalone structured content**. The PCDS does not include sector-specific provisions and its content is independent of the later use scenario of the product. Depending on the complexity of the product constituents, some statements may not be applicable, and instructions are given on how to complete the PCDS in such cases.

E. Supplier network integration

The PCDS is **designed to be integrated throughout the supply chain**. A standardized approach allows the assembly of information from multiple sheets in cases where a product contains multiple components each with its own PCDS. Statements are formulated to facilitate the assembly of information, which will be automated at a later stage with an IT solution.

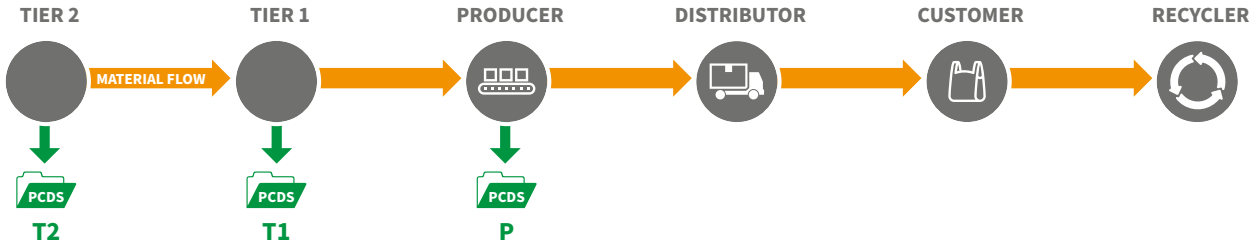
> *"The PCDS is intended to be completed on the basis on how the manufacturer designed its own product to be used, and not on how the next user in the value chain intends to use this product.*

3.1.3 Who creates the PCDS?

A new PCDS is created and managed by a manufacturer at each stage where one product becomes part of another, as illustrated in Figure 5. This includes remanufacturers or refurbishers: if a product is refurbished or remanufactured, it gets a new PCDS. Each manufacturer is responsible for this, and for the storage of the documents and for making the PCDS accessible to other stakeholders. Accordingly:

- A PCDS is only modifiable by the original manufacturer of a product. If the product is modified by a third party after manufacture e.g. refurbished, then a new PCDS is created to reflect those modifications.
- The PCDS should be revised as soon as there is a change in product composition or when new information /regulations on related hazards or other circular characteristics becomes available.

Figure 5 - Who creates the PCDS?



3.1.4 Who uses the PCDS?

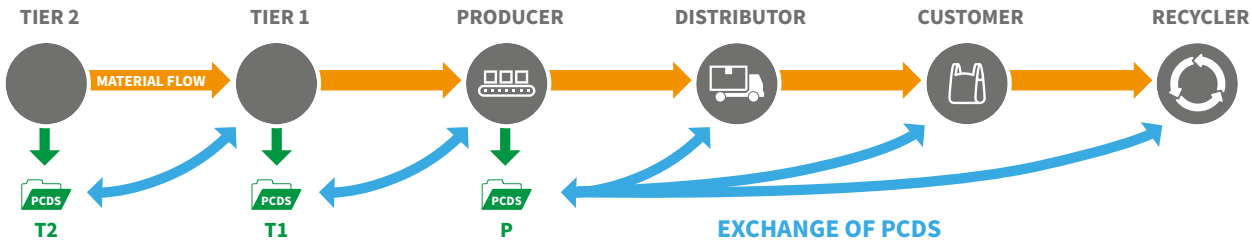
The main target group is any manufacturing company and the relevant stakeholders involved in establishing circular business models, as illustrated by Figure 6. The overall objectives are to:

- **Establish a common language on how to describe the circularity features.**
- **Save significant costs to manufacturers and their suppliers by providing a standardized approach to offer product information to their customers.**
- **Support the design of circular and healthier products.**
- **Support the implementation of cost-effective circular business models.**

At any stage of the supply chain, manufacturers receive multiple PCDS from their suppliers and integrate the data into a new PCDS for their own products for delivery to customers.

The PCDS is designed to be harmonized with major current circularity tools and platforms. In that regard, the content of PCDS has been reviewed with leading circularity leaders to ensure alignment in terms of definitions (e.g. C2C Product Innovation Institute, Ellen MacArthur Foundation, World Business Council for Sustainable Development, UL).

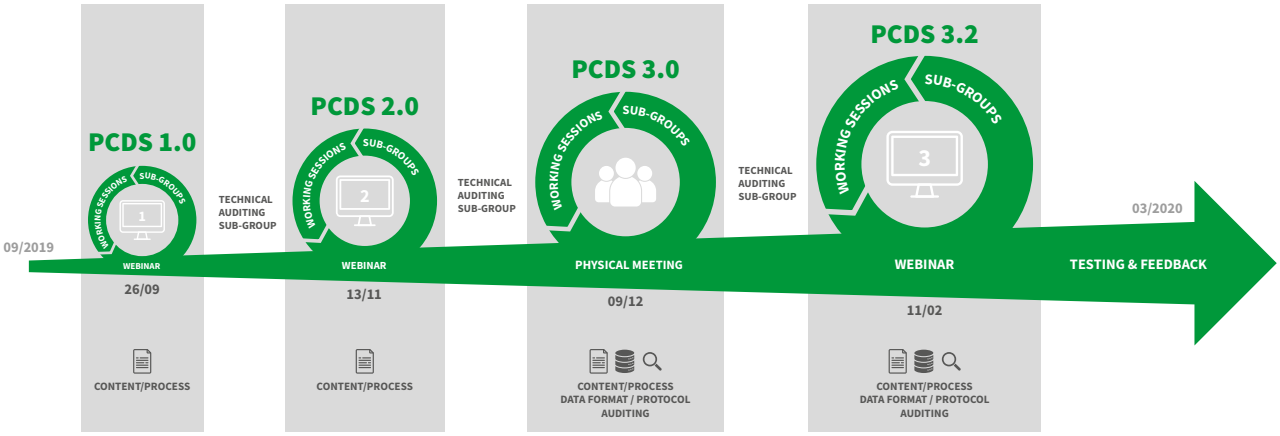
Figure 6 - Who uses the PCDS?



3.2 Development of a Proof of Concept

+ImpaKT organized a collaborative process, engaging organizations to provide valuable inputs to this initiative (cf. Figure 7). Considerable additional effort went into ensuring quality feedback from the stakeholders and experts. In total, 3 plenary webinars, 9 working sessions in sub-groups and a face-to-face meeting in Luxembourg were facilitated in order to develop the POC and integrate the feedback from all members of the DWG. Afterwards, a testing phase was organized during which meetings with manufacturers and key stakeholders were organized to assist them in the testing and to collect their feedback (see section 4 for more details).

Figure 7 – Collaborative process to develop a Proof of Concept



This collaborative process resulted in:

- A high engagement and a constructive dynamic from many stakeholders. This was reflected by the high participation rate and the outstanding feedback received by the participants;
- The development of a POC for the PCDS which was tested by many stakeholders and of a ***Guidance Document for a light PCDS,*** which represent a strong basis for the development of a standard (see details in section 3.3);

- The development of a skeleton audit procedure and a guiding framework for the IT system, which serve as key inputs for further development in phase 2 (see details in sections 3.4 and 3.5);
- Gaining active support from different certification bodies and key circularity evaluators and identifying barriers to implementation of the PCDS system (see details in section 4).

3.3 Guidance Document to complete a PCDS

The ***Guidance Document for the light PCDS*** became a very significant element. The production of such a document required extensive research on existing co-related standards and definitions. It is evident that without this document the PCDS could not be used effectively by a larger group of people. In addition, this Guidance Document provides a strong basis for the development of a standard for the PCDS.

3.3.1 Structure

The general structure of the PCDS system is inspired by the MSDS system (Material Safety Data Sheet) that provides standardized statements to describe the safe use of chemical products/mixtures. Similarly, a PCDS is a basic data source for others to establish how circular a product is. On the one hand, it offers a standardized format with verified content, independently of the later use of the product in the supply chain. On the other hand, it helps manufacturers take the first step in transparency and product circularity practice. This is of critical importance because the final circularity of a product depends significantly on how it will be used and how the product will be handled at the end.

The light PCDS is organized in the following 5 major sections which describe the key characteristics of a product circularity (cf. Figure 8). Each statement is numbered according a logic given by the overall PCDS structure. It will help to facilitate automation of document creation and reading. At the end of the document, specific terms are defined and more than 90% of the definitions refer to ISO/CEN standards and/or EU regulations.

> *A PCDS is a basic data source for others to establish how circular a product is.*

The PCDS should be revised when there is a change in product composition or when new information/ regulations on related circular characteristics becomes available. For example, the same product is manufactured in 2 production sites, and for one production site, recycled content is used. The physical properties of the product may be within the claimed ranges, but the chemical composition is different, impacting some PCDS statements. Therefore, two PCDS shall be created in this case.

Figure 8 - General structure of the light PCDS

SECTIONS	STATEMENTS (EXAMPLES)
GENERAL INFORMATION	
COMPOSITION	THE PRODUCT CONTAINS > 75-95 % POST-CONSUMER RECYCLED CONTENT BY WEIGHT THE PRODUCT DOES NOT CONTAIN SUBSTANCES OF VERY HIGH CONCERN FROM THE REACH CANDIDATE LIST IN CONCENTRATION ABOVE 0.1% BY WEIGHT
DESIGNED FOR BETTER USE	THE PRODUCT CAN BE MAINTAINED & REPAIRED BY UNTRAINED PERSONNEL AT THE LOCATION OF THE PRODUCT USE
DESIGNED FOR DISSASSEMBLY	THE PRODUCT IS DESIGNED TO BE INSTALLED AND DEMOUNTED USING REVERSIBLE CONNECTORS
DESIGNED FOR RE-USE	THE PRODUCT IS DESIGNED FOR RE-USE AS-IS OR WITH MINIMAL MODIFICATION THE PRODUCT IS DESIGNED FOR COMPOSTING IN A HOME COMPOSTER

> *The PCDS should be revised when there is a change in product composition or when new information/regulations on related circular characteristics become available.*

3.3.2 Requirement for statements

Each statement in the PCDS is mandatory and shall be considered to be TRUE or FALSE or "Not Applicable" (N/A).

- For section 1: information is entered after each statement.
- For sections 2 to 5, three options are possible:
  - If the statement is **VALID**, then the statement is set as "**TRUE**".
  - If the statement is **NOT VALID** or if no data are available to complete the statement, then the statement is set as "**FALSE**".
  - **Only for the statements 2300-2330**: if the statement is not applicable for the product (not when data are not available), then the answer is "N/A" at the end of the statement.

For testing phase, the terms "true" or "false" were themselves entered into the PCDS. In a later version, this may change to make the PCDS more workable and easier to read.

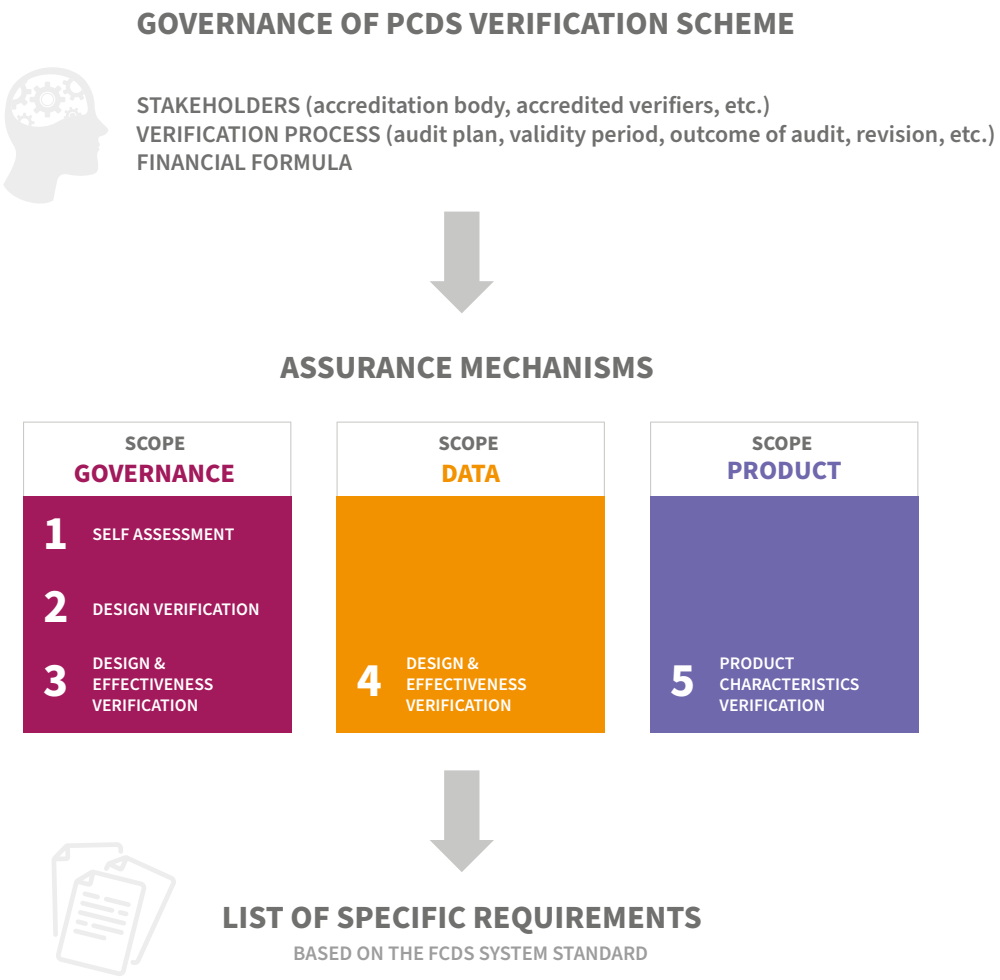
3.4 Third-party verification scheme

The purpose of this section is to provide a framework on how the Product Circularity Data Sheet (PCDS) will be verified. This framework (cf. Figure 9) was developed in concert with the Auditing Sub-Group and will serve as a strong basis for the next phase of the initiative. It is important to note that the development of the third-party verification scheme will be dependent on the governance of PCDS system.

The overall idea is to provide reliable data about the circularity aspects of the product. The entry of data into the standardized PCDS template is under the full responsibility of the issuer of the document (i.e. the manufacturer of the product). Because of this, a third-party verification scheme does increase dramatically the level of confidence in the data provided and is a significant added value, as emphasized by the Dataset Working Group. It protects the manufacturer against unintentional errors in providing the market with data on e.g. product recyclability. However, there is also a clear market need to keep the cost of this verification scheme as low as possible, as the PCDS system aims at engaging all actors throughout the supply chain from producers of raw materials to final product manufacturers.

Figure 9 depicts the key elements of the PCDS verification scheme which are briefly explained in the sections.

Figure 9 - *Overview of the PCDS verification scheme*



3.4.1 Assurance mechanisms

The PCDS verification process can be carried out for SMEs which are producing only one or two products as well as for large manufacturers which are selling a variety of products. Therefore, the PCDS verification scheme considered multiple assurance mechanisms in order to balance credibility and cost-accessibility. Five assurance mechanisms were discussed in the Auditing Working Group.

The 5 assurance mechanisms can be carried out independently from each other depending on the type of assurance sought. The PCDS verification process will have to define which assurance mechanism should be used and for which cases. For example, self-assessment can be considered as a pre-requisite step prior to an on-site audit within the overall verification process. Or, one could envision two separate verification procedures similarly to the EPD system: a) a PCDS verification (cf. assurance mechanism 4) and b) a PCDS process certification (cf. the assurance mechanism 3).

In the next phase of the initiative, a decision should be made regarding which assurance mechanisms to use. This choice will depend on the overall governance of the PCDS system and will have an impact on cost.

3.4.2 Governance of the verification scheme

A. Governing organization

The recommendation is to have a 2-step approach for the governance:

STEP 1

The PCDS standard could be maintained under the governance of a non-profit organization. This organization will be responsible for:

- organizing regular updates of the PCDS template and maintaining the link with other standards;
- organizing pilot tests and searching for co-fundings;
- potentially accrediting certification bodies for carrying out PCDS verifications.

STEP 2

The 3-year aim is that the PCDS system will become an integral part of an international standard like CEN or ISO.

B. Accreditation of PCDS auditors

A key aspect is to ensure the independence of the verifiers. In addition, the organizations allowed to perform PCDS audits need to be accredited by the PCDS'-governing body. One of the prerequisite is to be at least an ISO accredited auditor. In order to perform the PCDS audit, a training needs to be completed. This is required to understand the structure and content of a PCDS. A particular focus is on the guidance document and the taxonomy as it is critical for the evaluation.

C. Verification process

- Pre-requisite
  - The PCDS can be issued without being verified, but this non-verification to be transparently communicated. A mandatory audit could make the PCDS unaffordable for thousands of SMEs who otherwise might use it. However, there is a certain natural pressure for SMEs to provide accurate data because they are presenting their product data to the market, with an implied liability for inaccurate data. And, the audit provides an added level of confidence for companies and their customers.
  - The audit of the PCDS management system will be reduced for the manufacturers which have their process ISO 9001 certified, because such certification guarantees, from a process point of view, a certain product consistency due to the implemented quality management system and the availability of related documentation.

- Cost
  - The PCDS verification could be combined with a regular audit in order to save costs.
  - Verification certificates should be issued for three years maximum or until an update of the PCDS occurs within the 3 years.
  - Annual controls should be part of the third-party ISO audits.

3.5 IT format and data exchange protocol

The purpose of this section is to describe the objectives and guiding principles for developing an information technology (IT) system which will support the PCDS system. This framework provides the basis to further develop IT system in the next steps of this initiative.

3.5.1 Objectives of the IT system for the PCDS

The IT system should support the PCDS system, in particular by supporting these two objectives:

1. To provide standardized and trustworthy data related to the product circularity to all the relevant stakeholders;
2. To improve the sharing efficiency of circularity-related data across supply chains.

To support those objectives the IT system own objectives are organized around the philosophy of open-data and open-source and can be translated as follows:

1. ensure the **accessibility of the PCDS data** by all **relevant stakeholders** (e.g. platforms, suppliers & customers in the supply chain, third-party verifiers)
2. ensure an **efficient exchange** of the PCDS data **throughout the supply chain**
3. ensure the **integrity of the data**
4. be based on a **decentralized solution**

Each manufacturer in the supply chain will generate a PCDS for each of its products and will be responsible for storing the PCDS and making it accessible by other stakeholders via e.g. the corporate webserver and APIs. There will be no central repository in the PCDS IT system although other platforms might elect to develop repositories for their own markets.*

The main aim of such a solution is that the manufacturer is responsible to ensure the data integrity for its own PCDS. If changes are made to the product by unlinked third parties like refurbishers, then a new PCDS will have to be created and connected to the refurbished product.

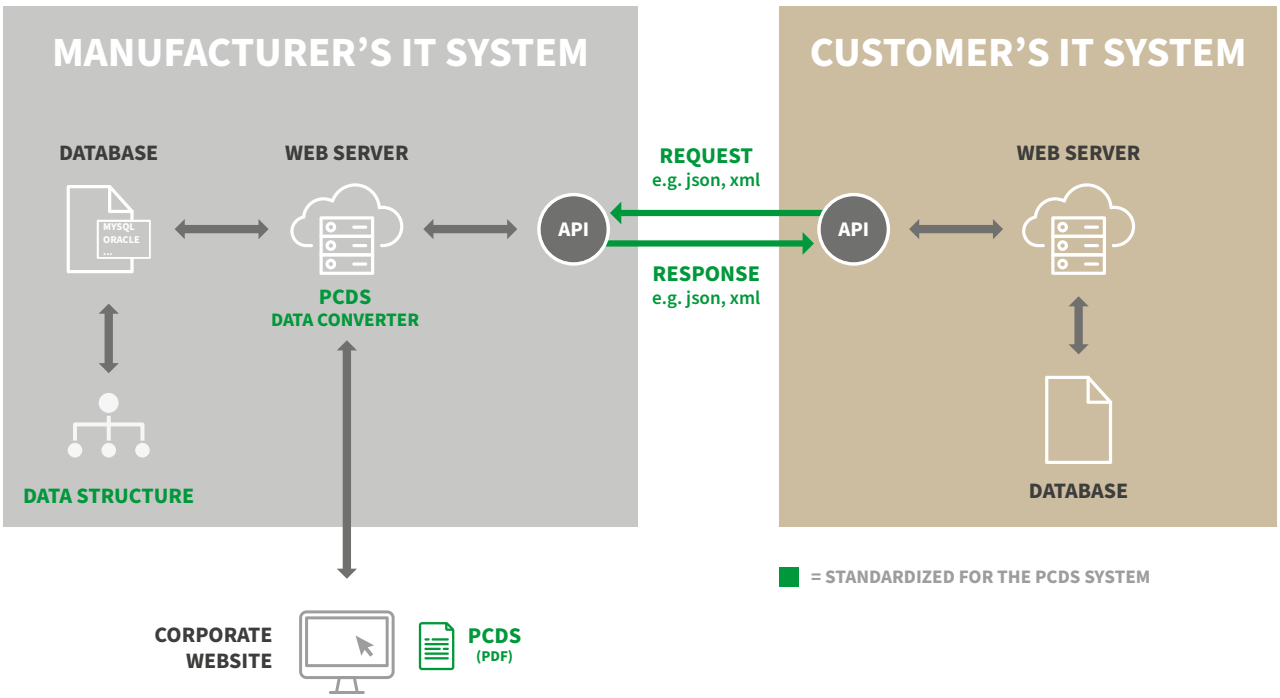
*Note: in a later stage of the initiative, a repository for archiving PCDS data of products which are phased out or when a company runs out of business may be considered. As well, some platforms will definitely create their own repositories of PCDS, for example for a building. However, these are outside the governance of the PCDS system.

3.5.2 Key elements of the IT system for the PCDS

Figure 10 provides an overview of the key elements of the PCDS information technology system and shows which are subject to be part of the standard:

1. **standardized data structure for storing the PCDS,** based on the PCDS structure and including the creation of a unique ID for each PCDS.
2. **standardized data exchange protocol using API** between a manufacturer and a customer (e.g. platform, user of their product, etc.). Scope of standardization includes definition of the data format for the exchange (e.g. xml and json), description of the exchange protocol as well as a standardized PCDS layout for publication in a PDF secured document.
3. **standardized protocols** to ensure an **efficient exchange** of the PCDS **throughout the supply chain**
4. Protocol to create a PCDS from data contained in multiple PCDS sheets
5. Protocol to inform relevant stakeholders when a PCDS revision is made

Figure 10 - Overview of the IT system supporting the PCDS




... standardized protocols to ensure an efficient exchange of the PCDS throughout the supply chain

Testing of the PCDS and feedback

Between mid-February and end of April 2020, a testing phase was organized by +ImpaKT and a series of key stakeholders were contacted.

The sections below provide a summary of the activities performed during the testing phase and the key lessons learned.

4.1 Testing phase

- **Testing PCDS with manufacturers and suppliers**
  - 14 manufacturing organizations (active in the construction or FMCG sector) tested the PCDS v3.2 and sent their feedback. This represents 50% of all manufacturing organizations (manufacturers + manufacturing associations) which are part of the Dataset Working Group and Stakeholders Group. Among these 14 organizations, 4 manufacturers have tested the PCDS with their suppliers.
  - Comments from platforms have been collected, in particular from the Ellen MacArthur Foundation (EMF), Ecopreneur and UL (integrated in v3.2).
  - The feedback was focused on the content and definitions. For the ones who were not part of the collaborative process working on the PCDS, a structured questionnaire during the feedback call was used in order to see if the objectives of the PCDS were well understood and how their organization would see the use of the PCDS.
- **Platforms and key circularity stakeholders**
  In total, more than 30 organizations were contacted and several meetings organized with them in order to: 1) ensure alignment of the PCDS with the key circularity evaluators, 2) identify potential collaborations to scale up the initiative and 3) search for co-funding to support the next phase.

4.2 Achievements and lessons learned

Strong positive feedback

- Manufacturers emphasized the need for a workable and standardized tool like the PCDS for facilitating the exchange of data throughout the supply chain.
- We gained active support from many stakeholders and certification bodies.
- There is a good alignment of the PCDS content with key leading circularity platforms and evaluators (e.g. alphabetically: C2C Product Innovation Institute, Cobuilder, Ecopreneur, Ellen MacArthur Foundation).

Recommendations for next phase

- Recommendations were received to make the process of filling in the PCDS more user-friendly and to improve some of the content. Some of this was done and other work will be addressed in the next phase.
- The PCDS system stands out from other initiatives which are focusing mainly on the final product and on evaluating impacts. During the testing phase, most stakeholders did not understand well the PCDS key characteristics at first glance, especially the PCDS integration throughout the supply chain. Therefore, when presenting the PCDS, it is important to emphasize this **paradigm shift** i.e. basic standard for CE data exchange across supply chain.
- In order to scale up the PCDS system, one key element is to connect the PCDS with a business case. Therefore, in the phase 2, it will be important to identify pilot projects to demonstrate the added value of the PCDS. Based on the feedback from the manufacturers, it includes:
    - A standardized way to access data from their suppliers, which is key a challenge and is currently time-consuming.
    - In the construction sector: 1) credit recognition in sustainable building certifications such as DGNB; 2) a requirement in public tenders.

Key achievements towards an international recognition of the PCDS

- The C2C Product Innovation Institute committed to list the PCDS among the C2C recognized circularity reporting standards as part of the C2C standard version 4.
- The PCDS is now referenced by Ecopreneur.eu, the European Sustainable Business Federation (see https://ecopreneur.eu/circularity-check-landing-page/circularity-check-background/). This NGO works at the European level on advocacy for a sustainable economy and holds six member associations from different countries of the European Union. In partnership with MVO Nederland, they have developed the Circularity Check, a tool to assist companies including SMEs, to become a sustainable and circular or resource-efficient enterprise by developing circular products and services.
- The PCDS is referenced on the European Circular Economy Stakeholder Platform (see more details via this link https://circulareconomy.europa.eu/platform/en/strategies/luxembourg-launches-circularity-dataset-initiative-supported-major-international-industry-leaders)

- The Ministry of the Economy and +ImpaKT made a presentation of the initiative to the DG Grow of the European Commission in November 2019 and in June 2020 with the DG Connect which is in charge of the creation of the EU product passport and the common European "Dataspace for Smart Circular Applications" (EDSCA) (both of which are part of the Circular Economy Action Plan). The general feedback was quite positive. The DG Connect is interested of learning more about the PCDS content. A more detailed presentation will be scheduled soon.

On-going activities to further grow the PCDS system

- **Collaboration with Cobuilder to create and pilot the PCDS Data Template based on two new ISO standards**
  Cobuilder, a world leader in data management solutions for the built environment, is actively involved in the development of the CEN/TC 442 standards, related to Building Information Modelling (BIM), in ISO standards and BuildingsSMART. In particular, Cobuilder Define offers a standard-based data management solution which helps organizations to create and maintain Data Templates according to the new standards ISO 23386 and ISO 23387. In that context, +ImpaKT and Cobuilder are working together on the creation of the PCDS Data Template according to the ISO standards and to pilot it with manufacturers.

- **Supporting the CE100 co.project "Looping on Data" from the Ellen MacArthur Foundation**
  Initiated by the Danish Business Authority, this co.project aims at identifying the best practices and barriers for accessing circular data throughout the supply chain. The first phase will consist in carrying out a survey with CE100 members. In that context, we had the opportunity to share lessons learned from the PCDS initiative and it is envisioned to have the PCDS tested by the CE100 members in a next step.

- **Participation at ISO TC323 - Standardization in the field of Circular Economy**
  The technical committee ISO TC323 was created in 2019 to develop standards related to the frameworks, guidance, supporting tools and requirements for the implementation of circular economy in organizations. After a presentation of the PCDS initiative at the working sessions in June 2020, the intention is to submit a New Work Item Proposal for developing the PCDS standard within the ISO TC 323.

- **Identification of projects for real-life application of the PCDS**
  At the time of this report, +ImpaKT is currently identifying demonstrator projects where the PCDS is used and creates added value. Potential projects include e.g. a car park project in Luxembourg with Astron Buildings and industrial halls built as material banks with Delta Development. We are discussing with Polyloop, which has developed a breakthrough solution to recycle cost-effectively high quality PVC composites, to enhance their value proposition with the PCDS. During the next phase, these projects should result in first use cases.

> *"Recommendations are designed to support development of the next steps for the PCDS as a successful tool in the Circular Economy.*

Next steps

The testing phase successfully completed phase 1 Proof of Concept of the standardization initiative. For the next phase, a series of recommendations were formulated here below. At the end of phase 2, the main objective is to have a PCDS system which can run as a standalone initiative. Therefore, the focus of phase 2 shall be on developing the system that will support the scale up of the PCDS to a larger market.

Recommendations[6] on the way forward:

- Demonstrate the added value of the PCDS system through pilot tests
- Develop the business model for the PCDS system and define its governance
- Develop and implement the IT solution based on the guidelines defined in section 3.4
- Establish and implement the audit process based on the framework defined in section 3.5
- Continue to grow the network and search for partners
  Active support from many stakeholders was gained in phase 1. It is important to keep this collaborative dynamic and to actively promote the initiative through different communication channels (webpage, presentation at conferences, etc.)

The above recommendations are designed to facilitate the next steps for PCDS as a successful tool in the circular economy[7].

6 See also recommendations for next phase in previous section.

7 Respectfully submitted 29th of mai 2020 by the Report authors: Anne-Christine Ayed, Douglas Mulhall [Associate Researcher, Department of Civil, Geo and Environmental Engineering, Technical University of Munich & Department of Architectural Engineering + Technology, Delft University of Technology], Katja Hansen [Research Fellow, Department of Civil, Geo and Environmental Engineering, Technical University of Munich], Jeannot Schroeder and Thibaut Wautelet

Creating a digital circularity fingerprint for products

Appendix

6.1 Governance of the initiative

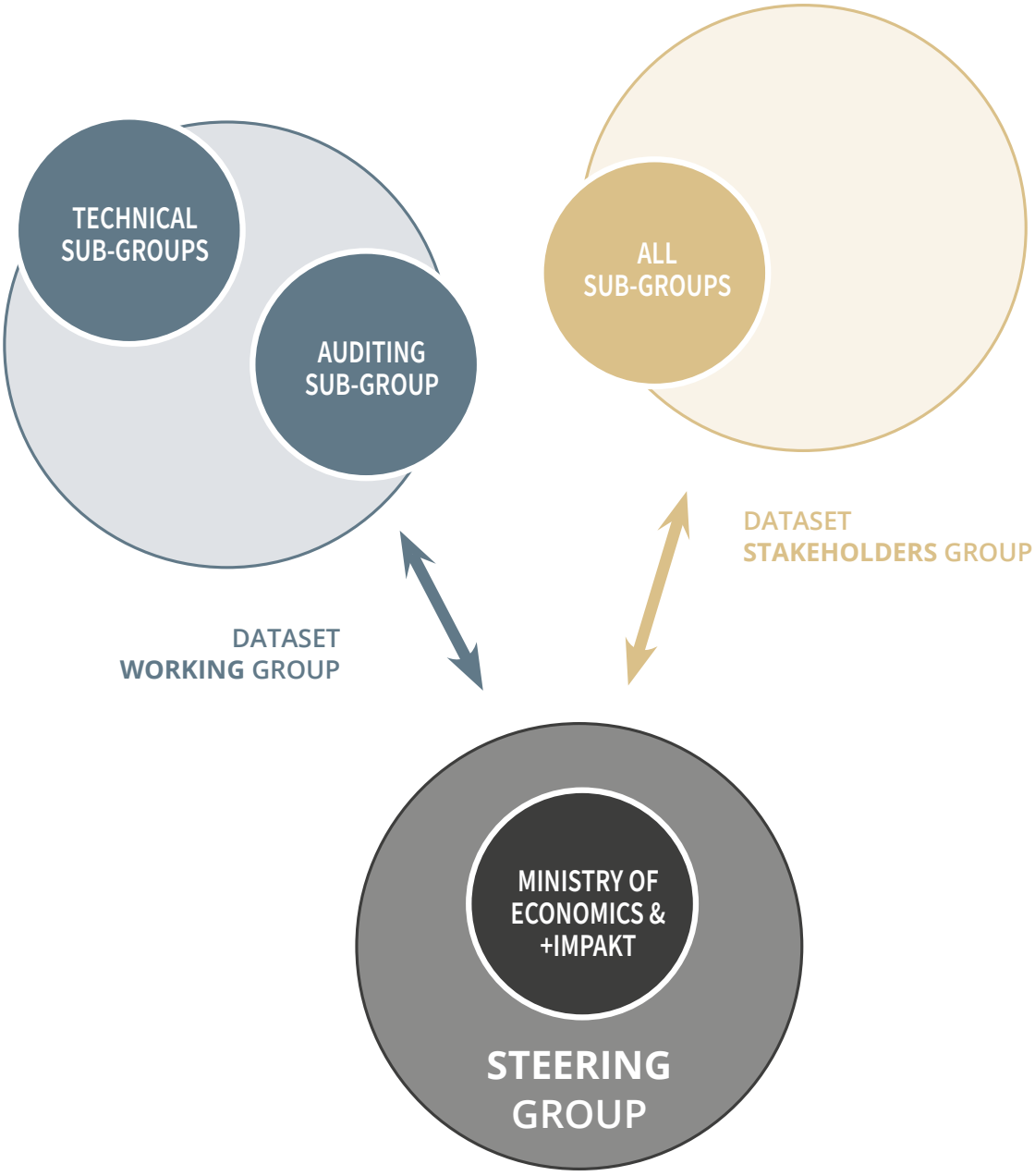
The ***Dataset Working Group (DWG)*** develops datasets and the process for the industry standards

- **Technical sub-groups** develops the inputs (statements) and format for the datasets.
- **Auditing sub-group** develops the audit protocols & where to apply them.

The ***Dataset Stakeholders Group*** follows progress and pilot datasets. They mainly act in phase 2.

The ***Steering Group*** prepares proposals for the DWG and acts as secretary to sub-groups. They also communicate with other standards and platforms initiatives.

Figure 11 - Governance of the initiative



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