

Circularity Dataset Standardization Initiative

PHASE 2 – Final Report

Scaling Up The Digital Circularity Fingerprint For Products

Project management to position and strengthen the product circularity data sheet (PCDS) including its auditable industry standard



THE GOVERNMENT
OF THE GRAND DUCHY OF LUXEMBOURG
Ministry of the Economy

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Acronyms

API	Application Programming Interface
CE	Circular Economy
CEN	Comité Européen de Normalisation
CENELEC	Comité européen de normalisation en électronique et en électrotechnique
DWG	Dataset Working Group
ETSI	European Telecommunications Standards Institute
EU	European Union
FMCG	Fast Moving Consumer Goods
ID	Identifier
ICT	Information and Communication Technology
ILNAS	Institut Luxembourgeois de la Normalisation, de l'Accréditation, de la Sécurité et qualité des produits et services
ISO	International Organization for Standardization

IT	Information Technology
MSDS	Material Safety Data Sheet
NWIP	New Work Item Proposal
PCDS	Product Circularity Data Sheet
POC	Proof of Concept
SMEs	Small and Medium-sized Enterprises
ToIP	Trust Over IP
UBL	Universal Business Language
USA	United States of America

Terminology

Below are listed the definitions of specific terms used in the scope of this document:

Business requirements vs. Functional requirements	Business requirements relate to business objectives, vision and goals. Business requirements relate to a specific need that must be addressed to achieve an objective. Functional requirements break down the steps needed to meet the business requirement or requirements. Whereas a business requirement states the 'why' for a project, a functional requirement outlines the 'what'.
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.
Global Node	The global node is a main element of the IT architecture for exchanging PCDS. It shall be responsible for the issuance of a unique ID for each PCDS created. It shall support the management of PCDS audit and shall play the role of authorizer as it maintains a list of all allowed users of the unified communication scheme (local node and standalone user). As a value-added service, the global node may act as secondary repository for PCDS.
Local Node	A local node is a value-added part of the IIT system that provides automation services for exchanging PCDS. Users are not obliged to use it, but they have the option to. The local node system uses a

	unified communication scheme to ensure interoperability when exchanging with other nodes in the ecosystem. This IT-based system with software layer is used to manage PCDS creation, editing, data segregation (public vs sensitive datasets), data access. It aims at automating the information flow in between actors and can allow multiple SMEs to use a common local node.
Open standard	Standards which are made available to the general public and are developed (or approved) and maintained via a collaborative and consensus driven process. In addition, <i>Open Standards</i> facilitate interoperability and data exchange among different products or services and are intended for widespread adoption. (Source: https://www.itu.int/en/ITU-T/ipr/Pages/open.aspx)
Product Circularity Data Sheet (PCDS)	Product declaration which presents standardized and trustworthy information on the circularity characteristics of a product. It is based on a template containing pre-set true/false statements which describe circular economy properties of the product (ex.: design for reuse and disassembly, recyclability, recycled content, hazardous materials thresholds, etc.). The PCDS is not intended to be a scoring mechanism, but it could be used partially or entirely by other stakeholders (e.g. databases, platforms or consultants) to enable an evaluation of the product circularity.

1 Executive Summary

1.1 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 data market for 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. For Phase 2 of this initiative, the Ministry of the Economy of Luxembourg mandated +ImpaKT Luxembourg (<http://positiveimpakt.eu/en/>) to:

- 1) develop the Product Circularity Data Sheet (PCDS) beyond the proof of concept by working on the actual technical development of the PCDS system, using the PCDS in pilot projects to demonstrate the potential gains;
- 2) outline a governance scheme that will support the future development of the whole PCDS system as a standalone initiative.

1.2 Key Achievements and Learnings in Phase 2

Phase 2 outlined the following:

- The general trend observed in the past is persisting. Initiatives on CE product data are rapidly multiplying in sectorial silos, and they are still missing standardized fundamental data to establish a reliable flow of information across sectors. This creates an increasing market fragmentation.
- Identification of specific value propositions which are key elements in ensuring its success of the PCDS. The main value drivers for PCDS adoption are perceived to be:
 - Linking the PCDS data to circular economy performance metrics.
 - Adoption of the PCDS by aggregation platforms.
 - PCDS Assembly (i.e., automation of PCDS creation based on suppliers' PCDS)

However, the absence of regulations or standards requiring its use and the implementation costs with no financial benefits in the short run were perceived as key barriers for the PCDS uptake. This points to the urgent need to implement useful tools like assembly, and to pilot regulations & standard in Luxembourg to test scale-up.

- Identification of 20 pilot projects to validate the value propositions. The platform Cobuilder, a Norwegian company leading the construction data standardization, and Toxnot, a USA-based platform streamlining the chemical transparency process for healthier and sustainable products, integrated the PCDS in their solution, as did Madaster.
- Definition of a lay-out of the governance system and a funding mechanism to support the future development of the PCDS. The Ministry of the Economy is currently preparing the creation of an independent organization.
- Substantial contribution towards ISO Technical Committee 323 – Circular Economy to develop the norm ISO/PWI 59040 Product Circularity Data Sheet;
- Development of a machine-readable format for the PCDS (xml format) to automate data exchange.
- Establishment of a list of requirements for the IT architecture, identified key IT partners for developing and testing a Proof of Concept, validated the global design concept with global actors.
- Development of a network of supporting partners.

1.3 Recommendations on the way forward

Below recommendations are designed to ensure the next steps for PCDS as a successful tool in the circular economy:

- Develop an operational IT architecture.
- Assure continuity of technical tasks until the stand-alone independent organization can fully operate on its own.
- Continue to support the development of related standards.
- Position the PCDS to provide leadership examples towards future DPP ecosystems.
- Continue to grow the network and search for partners.

2 Introduction

2.1 Purpose of the report

1. Present the main results of Phase 2
2. Summarize the key advances and lessons learned to provide a strong basis for the next steps of the PCDS initiative.

2.2 The Circularity Dataset Standardization Initiative

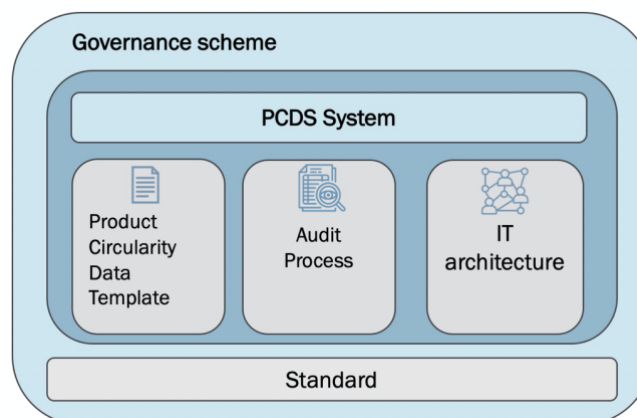
An effective circular economy that is designed for high-quality continuous material loops requires the circulation of not only resources but also information. However, a lot of circularity information is missing, as its generation and handling require too many human and financial resources. To solve this, the Ministry of the Economy of Luxembourg launched the Circularity Dataset Standardization Initiative in 2018. The solution envisioned is called the Product Circularity Data Sheet (PCDS).

As represented by Figure 1, the PCDS system is composed of three main components:

1. A **data template** which contains standardized TRUE/FALSE statements to describe the circular properties of a product. When a manufacturer completes a data template, the output created is called a PCDS. The PCDS version 3.2 is accessible via this link https://pcds.lu/wp-content/uploads/2020/11/20200214_Light_PCDS_v3.2s_FORM.pdf.
2. An **audit process** to validate the quality of the PCDS content and the reliability of the claims.
3. An **IT architecture** to ensure an efficient exchange of trustful data throughout the supply chain.

The PCDS system is designed to comply with internationally recognized standards and a governance scheme will be established by an independent organization.

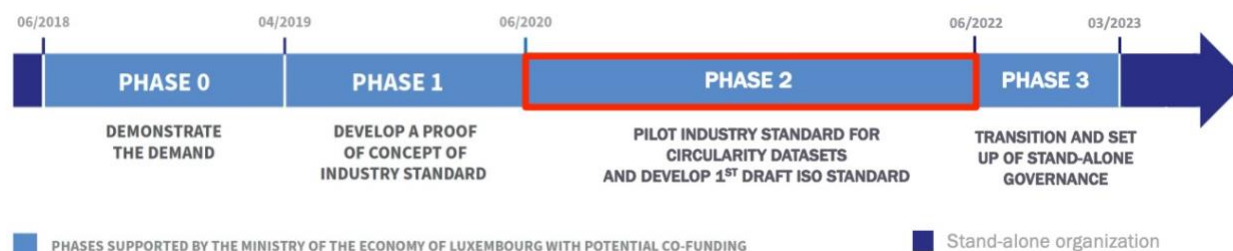
Figure 1 - Overview of the PCDS system



As depicted in

Figure 2, the *Circularity Dataset Standardization Initiative* is organized in several phases.

Figure 2 - Overall timeline of the Circularity Dataset Standardization initiative



Phase 0 has demonstrated that there is a genuine interest in developing such a standardized circularity dataset. In Phase 1, a Proof of Concept (POC) for a circularity dataset was successfully developed and tested in collaboration with a group of 30 international organizations, called Dataset Working Group (DWG)¹. In Phase 2, a series of pilot projects have been identified to validate the value propositions, including the PCDS integration in some leading platforms. The requirements for developing the IT architecture were established. In addition, several activities were performed to strengthen the idea of the PCDS as the universal standard to share circular economy product data, including the launch of an ISO norm development (ISO 59040). Finally, based on the growing maturity of the PCDS project and the need to shape its future ecosystem, it became clear that an organization independent from the Ministry of the Economy must take over the PCDS development to maintain a steady growth and worldwide acceptance.

This report documents the main advances of the PCDS system made during Phase 2 as well as the key learnings. Phase 3 will be dedicated to the set-up of the stand-alone governance based on the recommendations set forth in Phase 2.

It is important to note that the PCDS system described in this report refers to the solution developed by the Ministry of the Economy in collaboration with +ImpaKT and a group of +50 international organizations. This has served as input to the standard process currently underway at the ISO, but it is distinct from it. The system described in this report shall in future comply with the ISO standard 59040 when that standard is published.

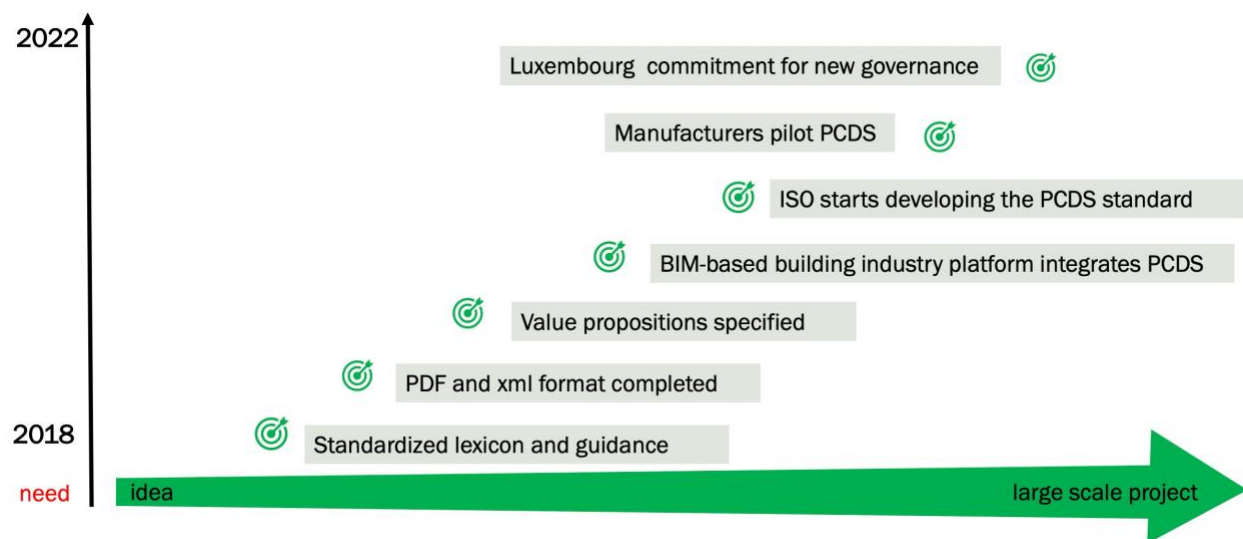
¹ For more details on the Phase 1, please consult the public report of Phase 1 via https://pcds.lu/wp-content/uploads/2020/11/MECO_CEDDataSet_PCDS_Public-27072020.pdf and the scientific article *The Product Circularity Data Sheet—A Standardized Digital Fingerprint for Circular Economy Data about Products* via <https://www.mdpi.com/1996-1073/15/9/3397>.

3 The future governance

As part of the overall national and international effort to transform Luxembourg's economy into a circular and digital one², the Ministry of the Economy has been leading the standardization initiative to create the Product Circularity Data Sheet. After validating the need for such standard, a Proof of Concept has been successfully developed over the last 2 years by a group of +50 international organizations from 12 countries mainly from Europe and North America. The key milestones during the period 2018-2022 are summarized in Figure 3.

Since 2018, the PCDS has gained a lot of international interest from companies and other public institutions working on circular data and Digital Product Passports (DPP). Luxembourg is now positioned as the leading country in Europe for standardizing circular product data. The PCDS system is a unique solution, which aims at establishing a universal mechanism for facilitating the access and the exchange of circular properties of products throughout the supply chain. To do so, the PCDS system shall remain an open standard based on decentralized and distributed (peer-to-peer sharing) approach.

Figure 3 - Milestones in the period 2018 – 2022 for the PCDS initiative



Accordingly, the need for a governance system with self-funding mechanism was identified early in Phase 2 to ensure the future development of the PCDS system. Therefore, an analysis of the

² For more details, please consult the *Circular Economy Strategy Luxembourg* via <https://economie-circulaire.public.lu/en/publications/circular-strategy.html> and the *Data-Driven Innovation Strategy for the Development of a Trusted and Sustainable Economy in Luxembourg* via <https://gouvernement.lu/en/publications/rapport-etude-analyse/minist-economie/intelligence-artificielle/data-driven-innovation.html>.

financial and legal structuring of selected international standardization initiatives was conducted. Based on the results of this analysis, a series of recommendations to ensure long-term funding and to maintain the PCDS as an international open standard were identified. The process to create an independent organization to take this project forward will be the main goal of the next phase planned to end in the first quarter of 2023.

One mission of the independent organization is to promote, maintain and develop the PCDS as an open standard for product circularity data exchange across sectors and inclusive for SMEs. To achieve this goal, the following key activities were identified to fall under its responsibilities:

- 1. Create an open ecosystem and engage relevant actors**
- 2. Develop and market a financially viable technical solution of the PCDS system**
 - Develop and manage the versioning of the PCDS Data Template.
 - Develop and manage the IT system allowing secured and efficient data exchange based on standardized protocols, including generation of unique IDs for the PCDS (see section 7).
- 3. Manage and adapt the PCDS ecosystem to future evolution.**

The PCDS system is considered as a tool and an application based on the ISO standard 59040 (under development). It should be maintained, and it must adapt to the evolving business and normative needs. The structure of the PCDS ecosystem under elaboration defined by the ISO TC/323 Working Group 5 could have major impacts on how the PCDS evolves.

4 Monitoring the State of Play

The monitoring of the state of play has been used to identify leading initiatives that could benefit from PCDS data and ensure that the PCDS can be adopted rapidly within the ecosystem.

4.1 Key outcomes and learnings

- More organizations identified the lack of reliable information as a key issue for a true circular economy³. Most initiatives are still missing standardized and fundamental data to establish a reliable flow of information across sectors.
- Manufacturers are reluctant to share confidential information and are concerned with disclosure of intellectual property and the details on the chemical composition. For example, see the 2021 position paper of Orgalim⁴, representing more than 770,000 EU industrial technology companies.
- The general trend is persisting: initiatives on CE product data are rapidly multiplying so the market is increasingly fragmented. While some EU and ISO standardization efforts are underway, other industry sectors are developing their own circularity indicators and frameworks. The number of Distributed Ledger Technology/blockchain-type solutions is growing, and most of them are industry specific, creating barriers for interoperability across sectors.
- Such technology is currently considered for the PCDS IT architecture as one possible option to increase trustworthiness and for authentication mechanisms. The issue of which system to use for wide acceptance is a major point to take into consideration.

Most solutions still start with the final product resulting from a specific supply chain, so detailed transparent information for each supplier component is still hard to distinguish and suppliers are forced to provide the same data in different formats, resulting in extra costs. The challenge remains to ensure that these initiatives consider the PCDS format as the common language for circular economy data, rather than a competitor. This depends heavily on having a working and operational system that can scale up fast.

4.2 The Big Picture

Figure 4 provides a summary of the state of play by grouping leading product passport related initiatives in three categories: 1) standardization related initiatives 2) regulations 3) platforms (including product data schemes, track & tracing solutions, circularity measurement schemes). As it

³ For example, the 2020 UNEP's report *Financing Circularity: Demystifying Finance for the Circular Economy* highlighted that the lack of uniform metrics for circularity is seen as the number 1 barrier for financing CE initiatives. (<https://www.unepfi.org/publications/financing-circularity/>)

⁴ <https://orgalim.eu/position-papers/environment-position-and-recommendations-europes-technology-industries-proposed>

can be seen, while the EU is trying to develop a regulatory framework, platforms and product-passport related solutions in various sectors continue to be developed and promoted. However, there is currently no widely adopted standard for basic circular economy data for products. This results in a confusing environment in the marketplace.

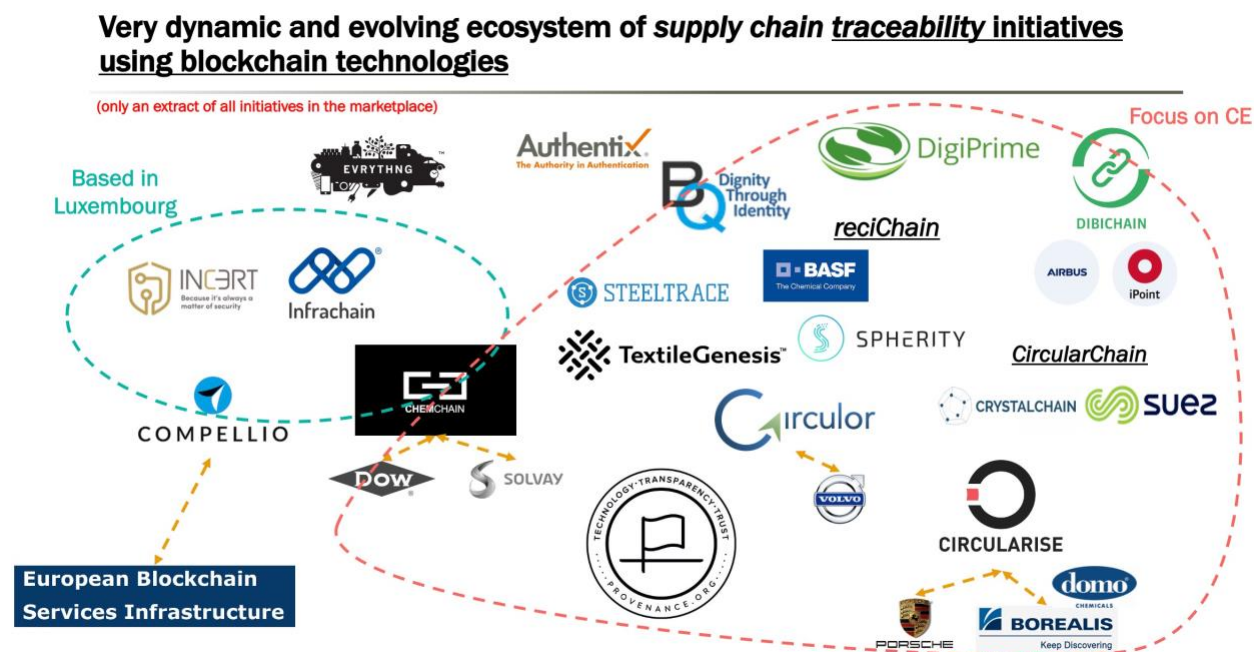
Figure 4 - Market overview of CE-related data solutions (03/2022)



4.3 Tracking and tracing

It is also important to see how technology is used to address the need for traceability. Most of the emerging initiatives use blockchain-based technologies and often focus on a specific industry segment (see Figure 5).

Figure 5 - Market overview for traceability solutions using blockchain technology (12/2021)



4.4 Silos Identified

➤ Sectorial silos

Most of these initiatives are still in the early days and it is not clear which ones will scale up. However, the fact that they are working in silos is going to create a major problem for material traceability and data management across sectors. The use of many products, ranging from agricultural products and chemicals to pumps and electronic circuit boards, is not restricted to one sector. So, if each sector has its own way of organizing the data, cross-sector data exchange for e.g. with recyclers, becomes expensive and problematic. This problem has also been identified by the EU initiative relating to the Digital Product Passport (DPP). The DPP however will be limited to finished products and will not solve the problem of data acquisition and exchange up in the value chains. While the EU DPP is not global in scope, many countries are watching it as they will have to conform with it for product to enter the EU.

Three sectors were identified to be very active in product related data management: construction, textile, and battery industries. These are also priority areas for the EU DPP. The siloed initiatives of these 3 industry sectors are illustrated by Figure 6.

Figure 6 - Illustration of market fragmentation for CE-related data solutions (12/2021)

Increasing fragmentation due to silo initiatives



➤ IT silos

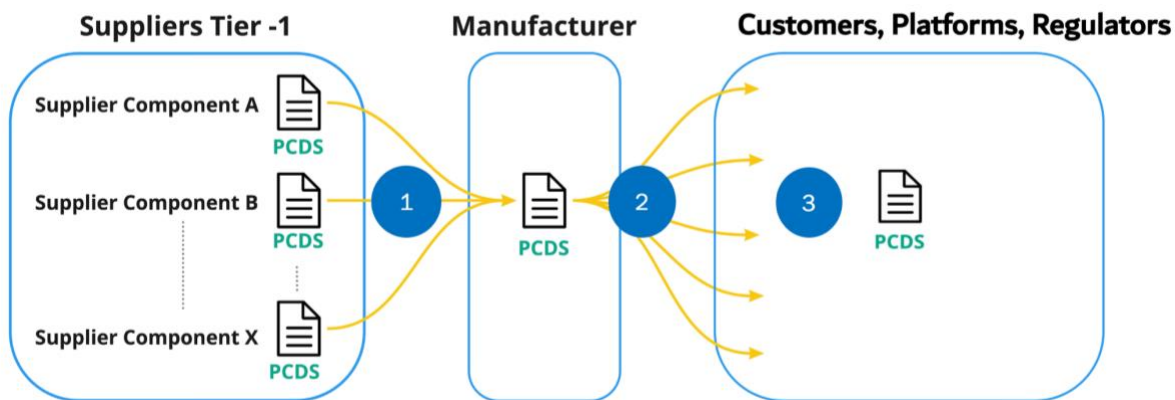
Most of the IT solution companies analysed lack of knowledge of circular economy data, disassembly properties, etc... and are developing solutions that do not solve the problem of standardized data acquisition, data quality or impact of certain actions along the material value chain like material mixing or gluing. Their main objective is to sell an IT solution, not a circular economy solution. Therefore, initial discussions with such companies are complicated by lack of awareness of the CE as a barrier to scale up.

5 Progress on scaling up the PCDS

5.1 Outcomes and learnings from pilot projects

The pilot projects, identified in Phase 2, tested PCDS value propositions for different stakeholders (with a focus on manufacturers and platforms). This provided valuable feedback on how companies and platforms perceive the PCDS in relation to their own needs. In addition, the collected feedback was compiled as a basis to update PCDS content, to improve usability, and ease the completion of the PCDS. These value propositions are key elements in ensuring the PCDS long-term success. The information flow with the 3 main value propositions is illustrated in Figure 7.

Figure 7 - Schematic data flow of PCDS for different stakeholders



Value propositions for manufacturers and platforms

Discussions with project partners led to the identification of the following value propositions at different stages of the process and with different partners.

1: For suppliers or manufacturers (internal view):

- Support my company to fill data gaps from suppliers
- Introduce new suppliers to circular product design
- Great data collection tool for our existing internal systems
- Easy use of individual PCDS statements within existing internal systems
- Support for future internal product design for circularity

2: For suppliers or manufacturers (external view):

- High Interactivity with external platforms (e.g., chemistry or certification platforms)
- Data integrity preservation for download, use and redistribution by future customers
- Improved brand value through verifiable transparency statements

- Improved trustworthiness of data on chemical substances of concern
- Support my company to pro-actively guide EU product passport & ISO standards

3: For platforms (internal and external view)

- Easy adaptation to my company's platform
- Improved data reliability for circular product properties
- Standardized data input to support circularity metrics
- Great support for ranking or certification

Technical drivers for PCDS adoption

The main technical drivers for PCDS adoption were perceived to be:

- PCDS Assembly (i.e., automation of PCDS creation based on suppliers' PCDS), especially for system integrators, i.e., manufacturers of complex products which assemble a large number of various components (including pumps, electrical/electronic equipment, etc.).
- Adoption of the PCDS by aggregation platforms.
- Linking the PCDS data to circular economy performance metrics.

5.2 Increasing recognition through communication efforts

During Phase 2, considerable efforts were made to raise the awareness of the PCDS and to convince more stakeholders to engage in the initiative. In total, meetings with more than 50 international organizations and presentations of the initiative at more than 20 international events were performed, which contributed to position the PCDS as the leading standardized effort for product circularity and to build a network of supporting partners.

A dedicated website with a clear visual identity (<https://pcds.lu>) and a storytelling video (<https://youtu.be/eNbQVlfKLgQ>) were created. The project team applied also to the Landbell Group's Green Alley Award 2022 (<https://green-alley-award.com/>), an award aimed at facilitating Circular Economy innovations in Europe, and the PCDS project made it to the top 20 (out of 189 entries). In addition, a first major peer-reviewed scientific article on the PCDS was published in a special issue of the academic journal "Energies" (see <https://www.mdpi.com/1996-1073/15/9/3397>). The article has been viewed more than 1200 times.

As a result of these efforts:

- Major industry manufacturers and other international stakeholders are referencing and promoting the PCDS. For example, the leading steel and mining company ArcelorMittal integrated the PCDS as part of their sustainability development strategy and released its first

PCDS on their website⁵. ZINQ®Technologie, the worldwide market leader in the field of corrosion protection on steel by zinc, published a whitepaper on how the PCDS standard can facilitate circular data exchange across supply chains and contribute to Digital Product Passport, which was presented to the Eurochambres in January 2022⁶.

- Regular demands from other initiatives have been received, especially for EU funded projects and the development of the EU Digital Product Passport.

5.3 Actively implementing the PCDS on a large scale through collaborations

In parallel to the communication efforts, the project team has been actively working with various partners to implement the PCDS on a large scale, as described below:

➤ Adoption by platforms

○ Cobuilder

Cobuilder (<https://cobuilder.com/en/>), 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 have worked together on the creation of the PCDS Data Template according to the ISO standards and to pilot it with manufacturers in the construction sector.

○ Toxnot

Toxnot (<https://toxnot.com>) is a software company which provides an efficient system for manufacturers to import chemicals data, provide insight into their hazard profiles, report on the results and create safer products. They have started to extend their portfolio to circularity data management and launched mi-November Toxnot Exchange which aims at facilitating the creation and exchange of Product and Material Passports. Since April 2022, Toxnot is the first U.S. based platform to offer companies the ability to create and export Product Circularity Data Sheets globally.

⁵ https://back-corporate.construction.arcelormittal.com/sites/default/files/2021-10/PCDS_v3.2_ArcelorMittal_Promisol_iQ.pdf

⁶ <https://www.zinq.com/aktuelles/2022/zinq-stellt-pcds-zur-verfuegung/>

- **Madaster**

Madaster (<https://madaster.com>) is one of leading platforms in Europe that provides a registry to create material and products bank for buildings. The project team is collaborating with Madaster on several building projects in Luxembourg and the goal is to use the PCDS to facilitate circularity data collection for building circular metrics and circular procurement purposes.

- **Building Material Scout**

Building Materials Scout (<https://building-material-scout.com/en/>), founded by Drees & Sommer (<https://www.dreso.com/de/en/>) and Hoinka GmbH (<https://hoinka.com>), is a planning tool with an integrated and intelligent building product database, focusing on healthy and sustainable materials. This German platform helps all stakeholders involved in construction – investors, builders, project developers, architects, planners, construction companies, operators – to gain easy access to healthy, intelligent and sustainable materials and building products. As part of their product documentation, they have integrated the PCDS.

➤ **Construction Industry Use Case**

- *PCDS as a tool for circular procurement*

EPEA NL (<https://epea.com/en/>), one of the leading consultancy companies in circular economy, has been very supportive of the PCDS since the beginning of the initiative and they have been actively promoting the PCDS in Netherlands. They did a pilot project with the Dutch Real Estate Agency (<https://english.rijksvastgoedbedrijf.nl>) to test the PCDS for circular procurement purposes. Rijkswastgoedbedrijf (RVB) is the largest real estate owner in The Netherlands holding 11,7million m² of buildings. The pilot focused on the general requirements for RVB and were not specific to one building project. The clear outcome of this extensive work was that in order to scale up the PCDS, a machine-readable PCDS format and an automation tool for manufacturers to generate easily a PCDS is required.

➤ **Textile Industry Use Cases**

- *Collaboration with two German leading textile platform*

A German garments industry consortium received funding from one of Germany's leading environmental agencies, the Deutsche Bundesstiftung Umwelt (DBU) (<https://www.dbu.de>), to test the PCDS along with other circularity data methods. The project aims at developing and testing synergies between the PCDS and two

leading textile platforms Global Textile Scheme

(<https://www.globaltextilescheme.org/en/>) and circular.fashion

(<https://circular.fashion/en/>) for enabling efficient data exchange throughout the textile value chain. Most importantly, it will be looking at interoperability between systems, a key function that the PCDS aims to support with standardized data and formats. The project was kicked off in November 2021 and a pilot test is planned with the brand OLYMP Bezner KG

(https://www.olymp.com/lu_en/company/about/) end of 2022.

- *Use case in the footwear sector in the EU funded project Onto-DESIDE*

The Onto-DESIDE project (<https://ontodeside.eu>) aims to address one of the core challenges for the circular economy and for Digital Product Passports, i.e. making decentralized product data understandable and easily accessible. The project intends to leverage open standards for semantic data interoperability in establishing a shared vocabulary (ontology network) for data documentation, as well as a decentralized digital platform (i.e. Open Circularity Platform) that enables collaboration in a secure and privacy-preserving manner. The PCDS standard will be tested for data interoperability across industries. In particular, +ImpaKT will lead the work on a use case in the footwear industry together with Texon (<https://www.texon.com>) and circular.fashion.

➤ **Alignment with the Digital Product Passport**

A collaboration with a consortium of EU organizations led by the French research institute CEA (<https://www.cea.fr/english/Pages/Welcome.aspx>) has been established to answer the EU project call DIGITAL EUROPE work program, 5.1.3. “Digital Product Passport (PP): sustainable and circular systems”. The outcome of this project will provide the foundation for the EU regulation on the Digital Product Passport, and its gradual piloting and deployment from 2024 onwards, with an initial focus on the electronics, batteries and textile sectors. +ImpaKT joined the consortium CIRPASS to promote the PCDS and to ensure alignment of DDP requirements with the PCDS content.

6 International standard

The ultimate objective is to establish an official standard for communicating data on the CE properties of products, in consultation with other standards organisations. As part of phase 0, ILNAS, the Luxembourgish national standardization organization, realized standards watch in 2019 to identify technical committees and standards (ISO and CEN) with some connections to Circularity Datasets. In particular:

- **European level - CEN and CENELEC⁷:** In the past, standardization work at CEN and CENELEC mainly focused on some specific sub-topics related to the circular economy such as recyclability or energy efficiency. After the publication of the Circular Economy Action Plan in 2015, the European Commission requested the three European Standardization Organizations – CEN, CENELEC and ETSI – to develop standards on material efficiency that shall establish future eco-design requirements on, amongst others, durability, reparability and recyclability of products, thus introducing a new focus on material efficiency during the design phase. This resulted in the creation of the CEN-CENELEC Joint Technical Committee 10 on Energy-related products - Material Efficiency Aspects for Eco-design (CEN-CLC/JTC 10). This technical committee developed a group of eight standards (EN45552-45559) containing generic principles to consider when addressing the material efficiency of energy-related products, such as extending product lifetime, ability to reuse components or recycle materials from products at end-of-life, and use of reused components and/or recycled materials in product. However, at the beginning of Phase 2, no transversal standardization technical body working on circular economy was identified. Such topic is being discussed under the CEN-SABE group⁸.
- **International level – ISO:** the ISO/TC 323 (<https://www.iso.org/committee/7203984.html>), established in November 2018, is responsible for standardization in the field of circular economy to develop requirements, frameworks, guidance and supporting tools related to the implementation of circular economy projects to maximize the contribution to Sustainable Development.

In parallel to CEN/CENELEC and ISO, other private standardization organizations such as ISEAL Alliance (<https://www.isealalliance.org/>) were considered as potential host to develop the PCDS standard. To support the decision for the standardization hosting body, several key criteria were

⁷ CEN stands for European Committee for Standardization and CENELEC stands for the European Committee for Electrotechnical Standardization (CENELEC).

⁸ <https://www.cencenelec.eu/areas-of-work/cen-cenelec-topics/environment-and-sustainability/environment/>.

established in alignment with the objectives of the initiative such as open standard, inclusive for SMEs, global scope and transversal/cross-sector application. Based on these criteria, the Ministry of the Economy decided to submit in 2020 a New Work Item Proposal (NWIP) to the ISO/TC 323 to develop a new standard, which was approved by 42 countries.

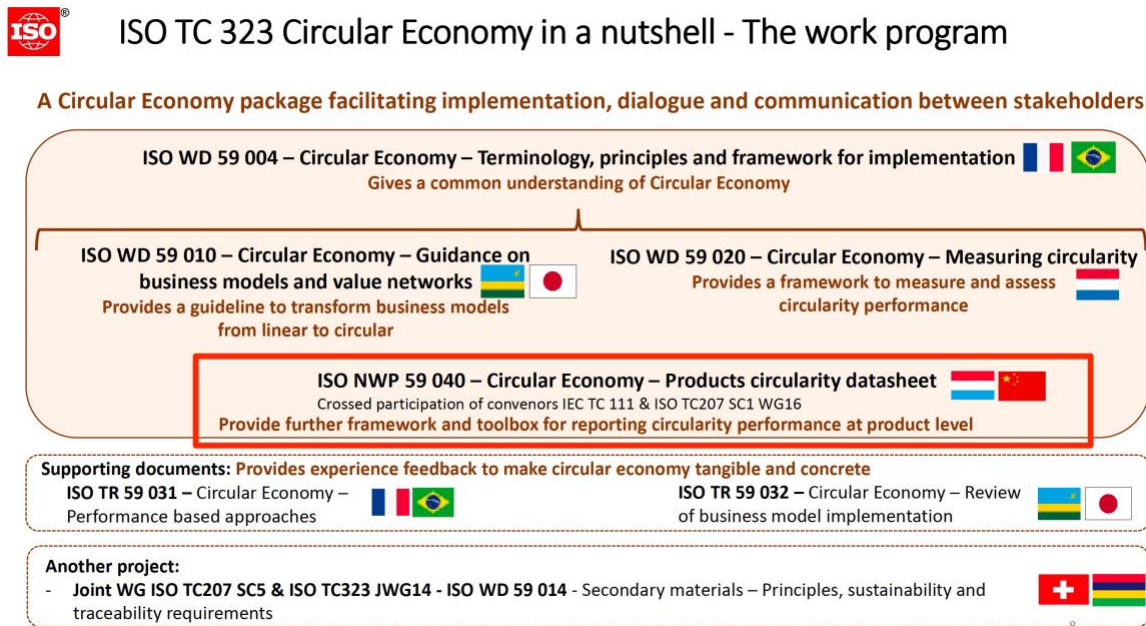
Having the PCDS included in the work of ISO/TC 323 and its lead attributed to Luxembourg together with China shows the great interest in the topic. Given the high number of participants to develop the standard (i.e. over 65 countries in the WG5 of ISO/TC 323) and their diverse backgrounds and interests, the challenge remains to keep the essence of the work performed in the previous collaboration with +50 organizations, useful and applicable. Since the development of the ISO standard is expected to take 1–2 years from the date of this report, it is extremely important to stay aligned with the development of the ecosystem needs.

6.1 ISO standard 59040

The ISO standard 59040 (<https://www.iso.org/standard/82339.html>) called Product Circularity Data Sheet is hosted under the Working Group 5 of the ISO/TC 323. The Figure 8 provides an overview of the standards being developed under the ISO/TC 323. At the time of writing this report, the PCDS standard was in the Working Draft stage. The Committee Internal Balloting (CIB) Vote is expected for early 2023 and the official norm release is currently planned for 2024.

The scope of the standard (as defined in the NWIP) is to provide a general methodology for improving the accuracy and completeness of circular economy related information based on the usage of a PCDS when acquiring or supplying products.

Figure 8 -Structure of the ISO/TC 323 Circular Economy



Source: Presentation of ISO Technical Committee 323 – November 2021.

7 IT architecture development

Markets are requesting and sometimes requiring manufacturers to provide many different product declarations under several formats that often contain similar information. Some of these such as CE marking (Conformité Européenne) or the MSDS (Material Safety Data Sheet) have legal implications if the data entered are not accurate. There is a business and legal need to ensure that the data are trustworthy and not corrupted by third parties. For example, in some regions, MSDS are considered unreliable because “up to four-fifths of all import-export chemical traders in the country use falsified MSDS data”⁹. A trader may intentionally write the wrong chemical name on an MSDS data form to save compliance costs as low-toxicity chemicals cost less to move and store than highly dangerous chemicals. Several solutions such as centralized database, e-stamp or optical scanning system of shipped goods¹⁰ have been trying to address this issue but without great success up to now. Therefore, as the need for trustworthy data has been clearly demanded since the beginning of the PCDS initiative, it is crucial to ensure that the set of data contained in the PCDS document remains unalterable except by authorized parties.

⁹ <https://slate.com/human-interest/2015/08/chinese-explosion-aftermath-officials-investigate-causes-behind-warehouse-blast-and-death-of-88-firefighters.html>.

¹⁰ Cargo checking systems look for fake MSDS using techniques like optical recognition. (<http://www.cinsnet.com/wp-content/uploads/2018/10/CINS-Cargo-Scanning-Request-for-Proposal-October-2018.pdf>).

One of the key objectives of Phase 2 was to explore and test key elements of the IT system through pilot tests. The purpose of this section is to describe the objectives and requirements for developing an information technology (IT) system which will support the PCDS system, as well as to provide an overview of the progress achieved so far.

7.1 Key outcomes and learnings

- The PCDS pdf document was translated into a machine-readable XML format to enable easy exchange of digital information. Several existing international standards for product data exchange are using the xml data format. For example, these include GS1 standards, OASIS Universal Business Language (UBL) standard, IEC 62474 on Material Declaration for Products of the electrotechnical industry, ISO 20078 for the exchange of data with connected vehicles. To ensure interoperability with other standards and wide market adoption, it was decided to test the practical IT implementation of the PCDS based on xml format.
- Through various exchanges with IT actors (start-ups and companies developing solutions for supply chain transparency and traceability, etc.), a description of the key functions and requirements to be fulfilled by the IT architecture was established as illustrated in Figure 9. This serves as a basis for the design and the development of the IT architecture by an IT solution provider.
- A collaboration with Trust Over IP Foundation (<https://trustoverip.org/>) was established to further develop the overview and integration of the IT and governance of the PCDS ecosystem. Several productive workshops were held which resulted in the validation of the overall IT architecture design and a list of specific tasks to move the architecture development forward (see details via this link <https://wiki.trustoverip.org/display/HOME/PCDS+Ecosystem+Task+Force>).
- A pilot project with Compellio (<https://compell.io/>), a Luxembourg-based IT company specialized in the blockchain-based assets lifecycle management, and the European Blockchain Services Infrastructure (<https://ec.europa.eu/cefdigital/wiki/display/CEFDIGITAL/EBSI>) provided valuable learnings on how blockchain technology could be used for the notarization of PCDS documents and the audit certificate. The results were presented to a wider EU community and the recording of the webinar is available here: <https://youtu.be/gbRtzilgzlw?t=4819>.
- INCERT (<https://www.incert.lu/>), an IT company specialized in the field of cryptography, public key infrastructure technologies and cyber security, was commissioned by the Ministry

to take the lead in development of a Proof of Concept. The early design of the envisioned IT ecosystem is presented in section 7.3.

7.2 Fundamental & operational principles for PCDS IT architecture

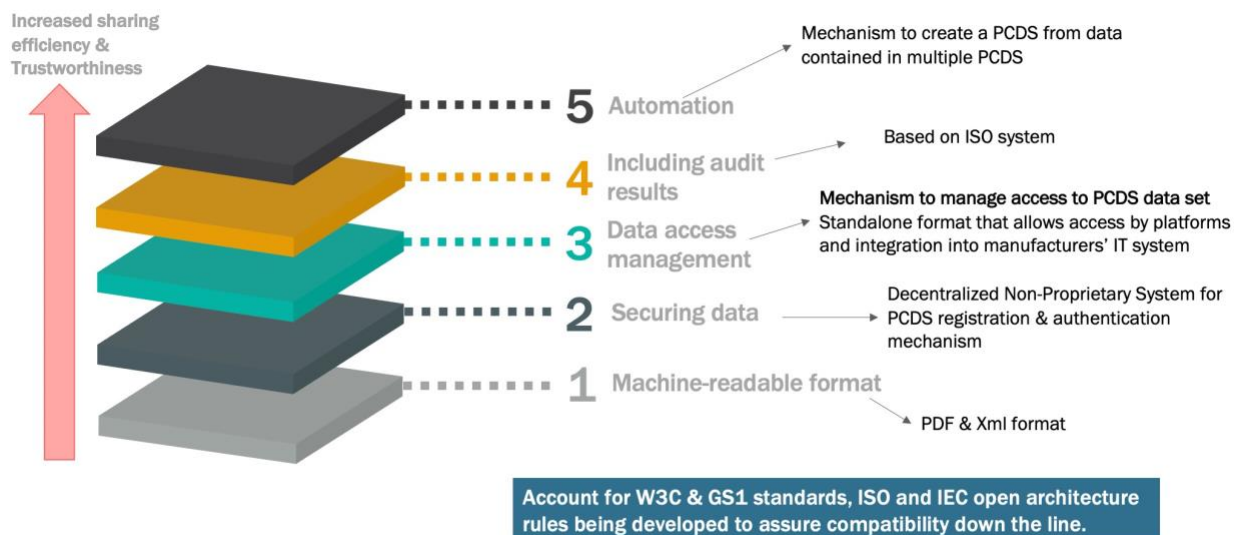
The IT architecture should support the PCDS system, by pursuing these three business objectives (requirements):

1. Provide standardized and trustworthy product circularity data to all relevant stakeholders.
2. Improve the sharing efficiency of circularity-related data across supply chains.
3. Provide a payment mechanism to support operations of the system.

These objectives have been translated into operational principles (see Figure 9) to guide the development of the IT architecture to meet user needs:

- Ensure the integrity of the data (unalterable set of data) and provide a unique identifier for each PCDS allowing a clear identification of its version.
- Include pay-per-use or pay-per-creation scheme to fund governance.
- Ensure interoperability and affordable use for SMEs who constitute 95% of users.
- Be based on decentralized approach for the storage & maintenance of PCDS documents.

Figure 9 - Functional components of the PCDS ecosystem to provide trustworthiness



7.3 IT Ecosystem Design

Figure 10 is a draft schema of the PCDS ecosystem and interactions between actors. The Table 1 provides a description of the key actors in the PCDS ecosystem and their respective role. The key components of the IT ecosystem are briefly explained in the following.

Figure 10 – PCDS IT ecosystem and interactions between actors

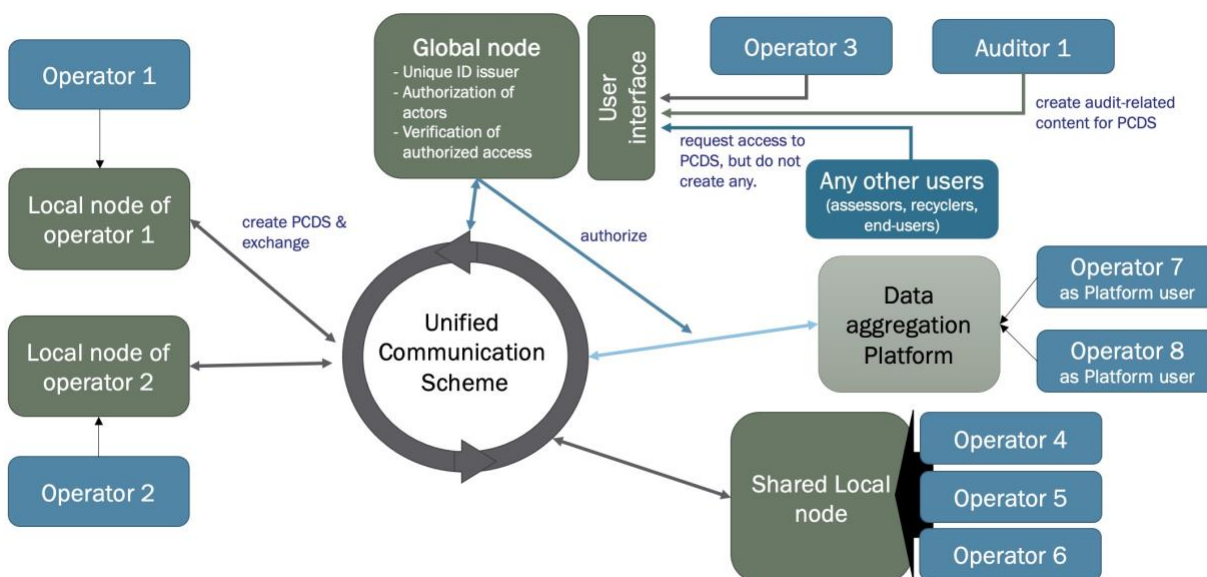


Table 1 - List of key actors in the PCDS ecosystem

Actors	Description
Auditor	User with rights to access PCDS information and to upload audit information to the PCDS.
Operator. Data aggregation platform	Platforms which assemble various types of data about products, and which also could include the PCDS, or data related to a PCDS in their platforms. These play a key role in scaling up PCDS ecosystem acceptance. Integration of these platforms require a business model to structure their activities and can become a major source for PCDS creation.
Operator. PCDS creator	Suppliers (Tier 1, 2, 3 suppliers), integrators or assemblers of complex products (including refurbishers), and data aggregation platforms. These actors can represent a local node of a single operator or a user creating a PCDS manually without the automation features of the local node. This category of actor is a PCDS creator and requests information from other PCDS, and uploads audit information. It must be considered that 95% of PCDS creators are SMEs with limited IT capacity.
Operator. PCDS viewer	Any entity or person that uses the system to view a PCDS or extract data without changing or creating a PCDS. A user can be a supplier, an integrator, an assembler of complex products, a recycler, a retailer, a product distributor, regulator, an assessor, standards organisation, or possibly a consumer.
System governor	The actor(s) who operate the overall system and provide reference materials like templates, user validation, PCDS IDs, and payment schemes for basic system use.

To support the PCDS ecosystem, 5 main components are playing a key role:

1. A global node

- The global node shall be responsible for the issuance of a unique ID for each PCDS created.
- It shall support the management of PCDS audit.
- It shall play the role of authorizer as it maintains a list of all allowed users of the unified communication scheme (local node and standalone user).
- As a value-added service, the global node may act as secondary repository for PCDS.

2. Local nodes for operators

- The local node, which can be deployed by each operator in the PCDS ecosystem, shall connect users to automated functions of the system.
- It has to be noted that local nodes are not mandatory for operators, they are just a way to automate and improve management of PCDS locally. An operator could still manually request unique ID to global node, and then publish their PCDS as PDF file on their website (example of Operator 3 in Figure 10).

3. The PCDS itself

- The PCDS is the artefact being exchanged in the PCDS ecosystem. It is created and managed according to the requirements defined by the system governor in accordance with the standard ISO 59040 (under development).
- Each PCDS shall be identified with a unique identifier provided by the global node. Each update to the PCDS internal dataset shall result in a new version of the PCDS, which shall receive a new unique identifier.
- The PCDS shall be made available in two formats:
 - in PDF format for human readers
 - in a machine-readable format (json, xml, etc.), including only the basic data and the data structure
- The machine-readable format shall be stored at the local node or global node and can be published in multiple locations ranging from the global node to creator's website or data aggregation platform.

4. The unified communication scheme

- A communication scheme is needed to define a standardised and simplified exchange protocol between each actor of the ecosystem, to let minimal margin for error and allow global interoperability. This scheme may support extension to interact with different related ecosystems like the EU Digital Passport Product for example.

8 Recommendations on the way forward

The PCDS is today recognized as one of the most promising solutions for harmonizing data exchange on circular economy properties. Based on the growing maturity of the PCDS project and the need to shape its future ecosystem, it becomes clear that an organization independent from the Ministry of the Economy must take over the PCDS development to maintain a steady growth and worldwide acceptance. However, before this stand-alone organization can fully operate on its own, there will be a need to assure a continuity of the technical tasks performed under Phase 2 and its transition.

In addition to that, the below recommendations are designed to ensure the next steps for PCDS as a successful tool in the circular economy:

- **Continue to support the development of the ISO 59040**
Ensuring that standard content aligns with the initial PCDS objective of cross-sectorial interoperability is critical. Therefore, the co-creation of cross-sectorial statements is of prime importance for a worldwide acceptance of a common solution.
- **Develop an operational IT architecture** to validate the added value of the PCDS.
Several platforms are integrating the PCDS format while an increasing number of manufacturers are testing the PCDS. Therefore, having a working IT structure for ensuring machine readable exchange and automated process for PCDS creation is becoming critical. Interfacing with platforms is a crucial part of the PCDS scale-up. Further development is necessary to strengthen the big picture of how governance, business model and IT architecture fit together.
- **Position the PCDS within the DPP ecosystem**
Digital Product Passports (DPP) are planned by several regulators like the European Commission. Therefore, positioning the PCDS as a role model for DPP could be relevant for its international adoption. In addition, an increasing number of companies are developing solutions linked to DPP as they understand the opportunity of linking circularity data to IT solutions. This fast-evolving ecosystem requires an accelerated implementation pace of the PCDS operating system.
- **Continue to grow the network and search for partners**
PCDS has gained active support from many stakeholders in Phase 1 and Phase 2. It is important to keep this collaborative dynamic and to actively promote the initiative through different communication channels (webpage, presentation at conferences, etc.).

Each of the above activities requires extensive support prior to and during operation ramp-up of the independent entity designed to manage these tasks.



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