Piattaforma digitale per l'economia circolare e passaporto digitale di prodotto: stato di sviluppo ed implicazione per i dismantlers

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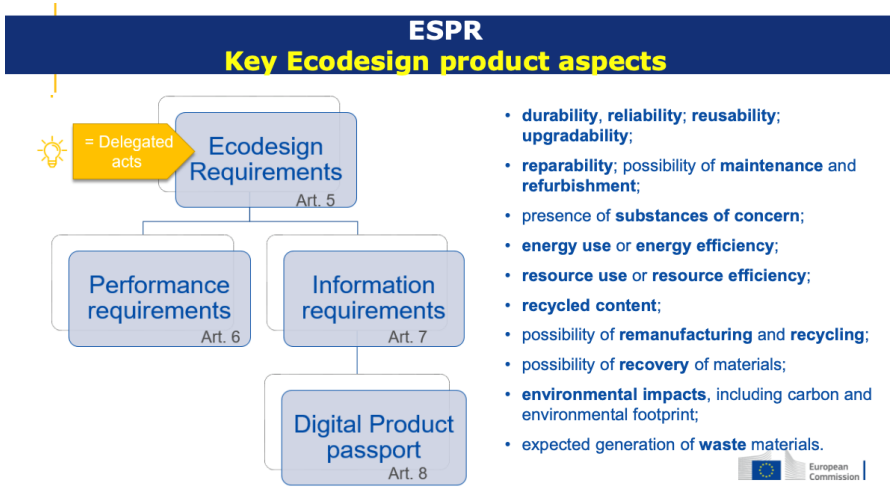
ESPR – Ecodesign for Sustainable Products



ESPR "includes the creation of a digital product passport to electronically register, process and share product-related information amongst supply chain businesses, authorities and consumers. This is expected to increase transparency, both for supply chain businesses and for the general public, and increase efficiencies in terms of information transfer. In particular, it is likely to help facilitate and streamline the monitoring and enforcement of the regulation carried out by EU and Member State authorities. It is also likely to provide a market-intelligence tool that may be used for revising and refining obligations in the future.

DPP characteristics in the ESPR

- The **DPP will not replace but complement** non-digital forms of transmitting information such as information in the product manual or on a label.

- The DPP should **offer free access to data to actors along the entire value chain** including customs authorities. This information must be based on open standards and inter-operable formats and be machine readable, searchable and structured.

- To balance accessibility and IP protection, **DPP will allow differentiated access depending on the type of information and typology of stakeholders**. It is expected that actors may introduce or update information in the DPP, including, where needed, the creation of a new DPP.

- To support SME's in filling the digital divide gap, it is expected that ***DPP-as-a-Service* operators will offer low-cost DPP data storage and access facilities** but will not be allowed to sell, re-use or process data beyond what is necessary.

DPP characteristics in the ESPR

- A DPP will be specific to the **item, batch or product model**, depending on the complexity of the value chain, the size and nature or impacts of the product considered. A DPP can be assigned to intermediate goods or materials.

- When applicable, the DPP should be **easily accessible by scanning a data carrier**, such as a watermark or a QR code. The data carrier should be on the product itself to ensure the information remains accessible throughout its life cycle.

- To ensure interoperability, the types of permitted data carriers, the data carrier, the unique product identifier, and unique operator and facility identifiers **will be standardized** to guarantee compatibility with external components such as scanning devices.

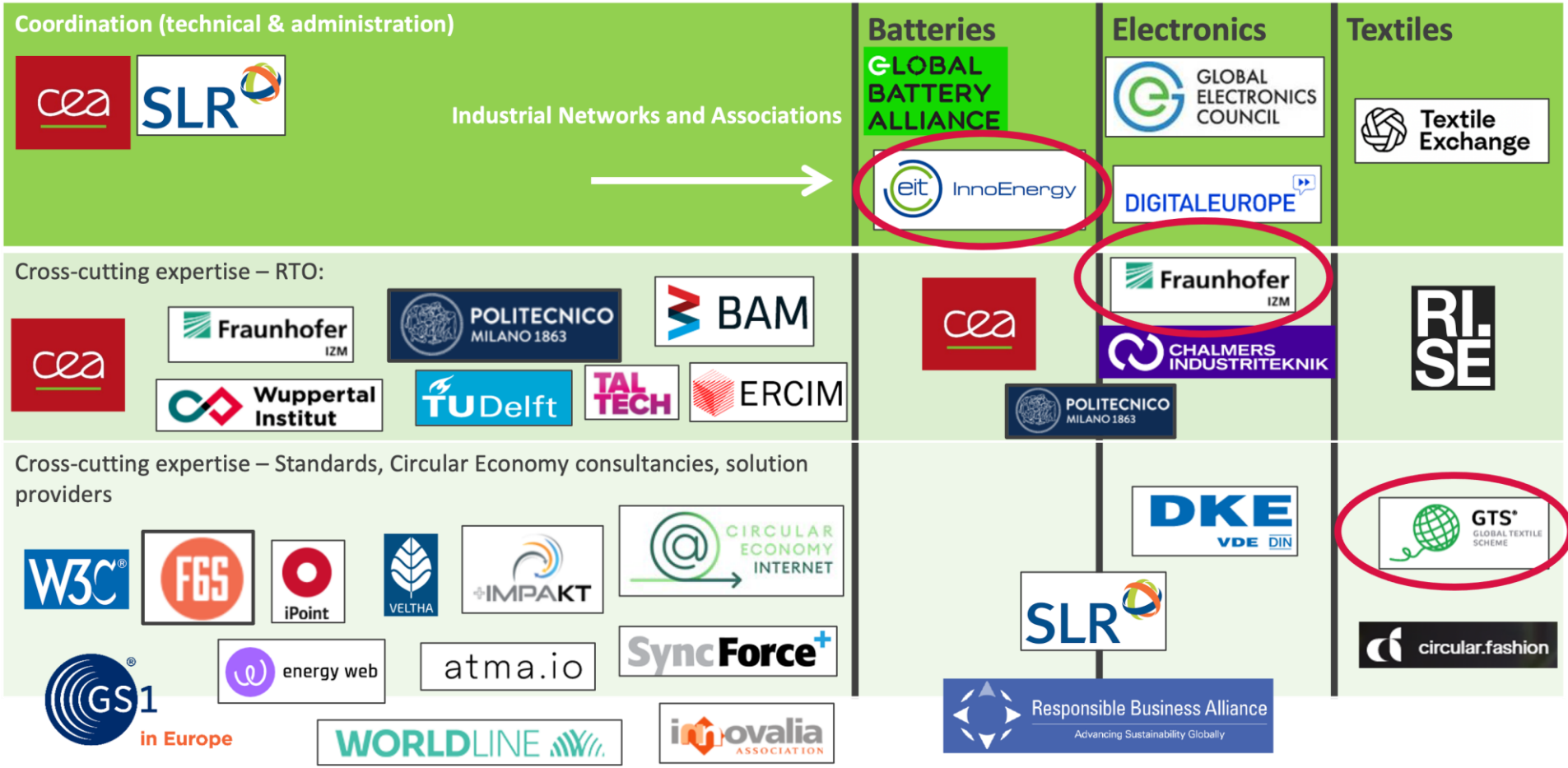
- The Commission will **set up and maintain a product passport registry** to, at minimum, store a record of all data carriers and unique identifiers linked to products placed on the market or put in service. This registry will be **interconnected with the EU Customs Single Window Certificates Exchange**.

- However, the DPP itself should be based **on a decentralized data system set up and maintained by economic actors**.

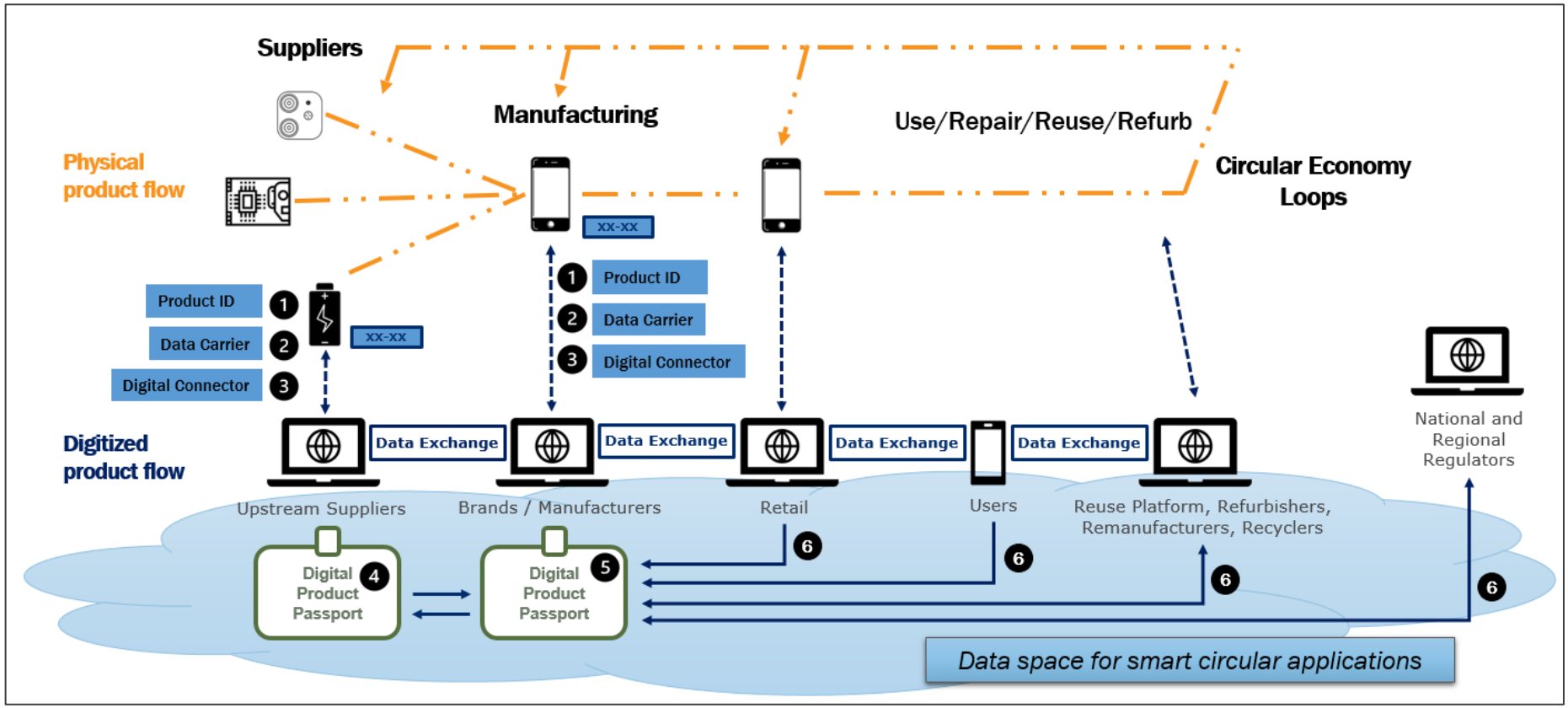
Collaborative Initiative for a Standards-based Digital Product Passport for Stakeholder-Specific Sharing of Product Data for a Circular Economy

Consortium – 30 partners

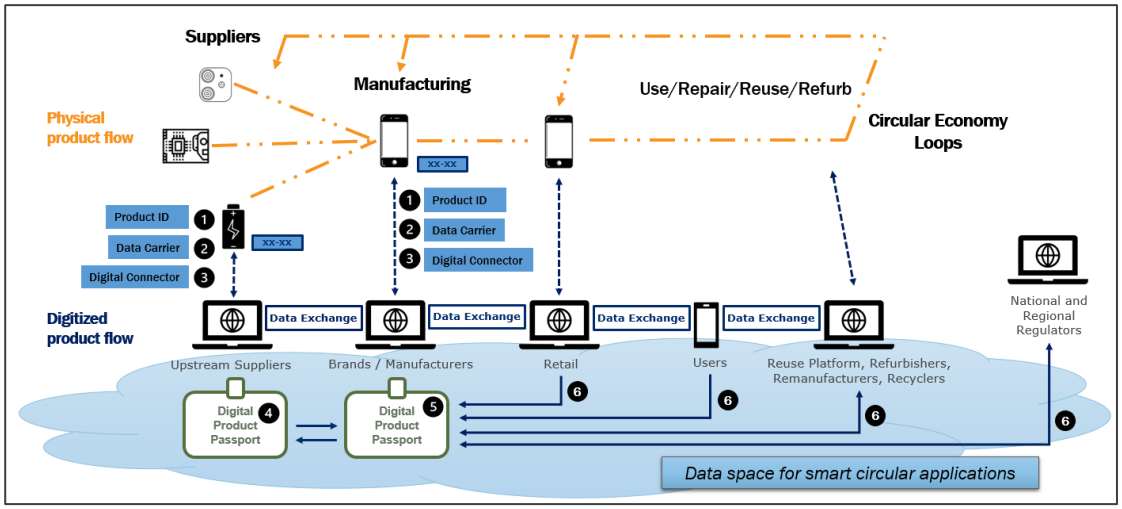
Sector lead



Collaborative Initiative for a Standards-based Digital Product Passport for Stakeholder-Specific Sharing of Product Data for a Circular Economy

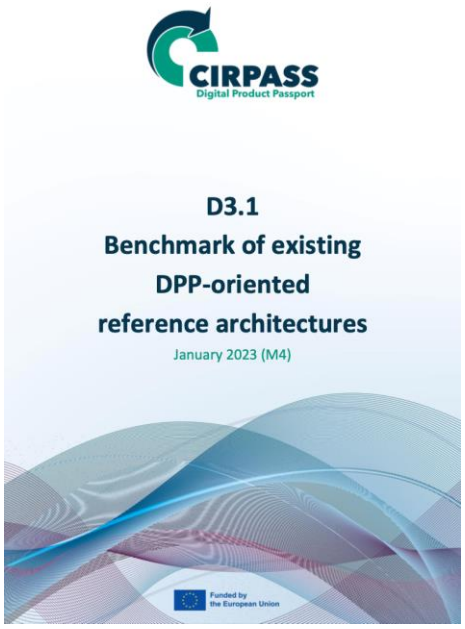


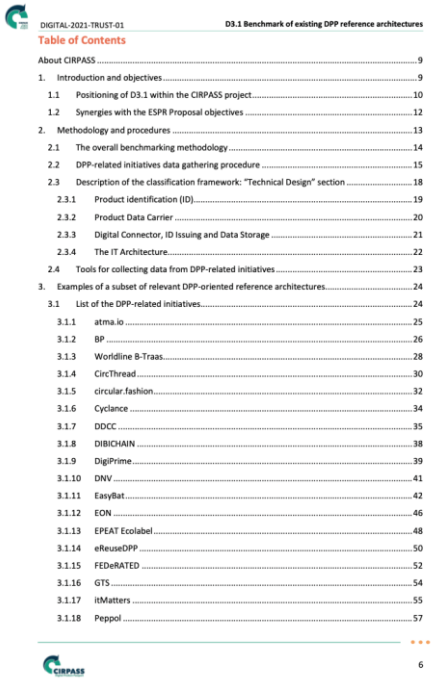
Collaborative Initiative for a Standards-based Digital Product Passport for Stakeholder-Specific Sharing of Product Data for a Circular Economy



- A unique persistent ID for the product (including batch and/or serialization as necessary) **(1)**
- A persistent data carrier (RFID, QR Code, digital watermark, Bluetooth tag, etc.) **(2)**
- A Digital connector between physical product and the digital place of information on the product (e.g., URI address) **(3)**
- An IT architecture for facilitating the data exchange **(6)** composed of:
  - Standardized vocabulary
  - Standardized data exchange protocols and formats
  - Standardized stakeholder-dependent access mechanisms (read/edit rights)
  - Distributed storage of information (in connection with EU dataspaces)
  - A stakeholder-dependent interaction layer

- Methodology for initiative selection
- Published dataset of 206 initiatives
- Detailed descriptions for 32 (now 98) pilots
  - →provided by initiative owners!
  - →invited only if they provided at least one entry in the IT Architecture area of the framework




DIGITAL-2021-TRUST-01 D3.1 Benchmark of existing DPP reference architectures

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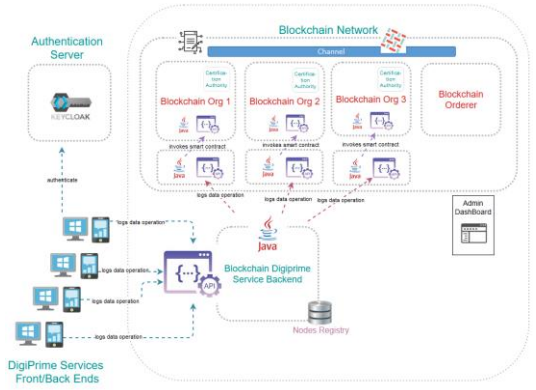
CIRPASS 6

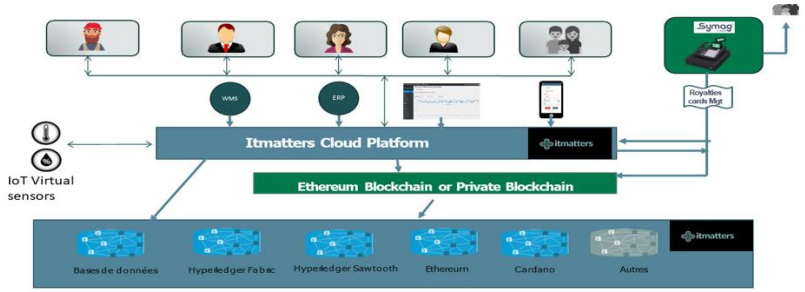
Reference classification framework for mapping DPP-related initiatives Technical Design section							
Product ID	Type	Instance			Category		
	Granularity	Model		Batch	Prod. order		Single item
Product data carrier	Type	RFID	QR Code	Digital watermark	Bluetooth label	Bar Code	Other
	Machine readable data carrier	Yes			No		
	Resolver	Yes			No		
Digital connector	ID minting	Centralized			Decentralized		
	Data storage location	Centralized			Decentralized		
IT architecture: Data transport	Openness level	Standardized	Proprietary		Data ports		Others
	Data packaging	Data transfer			API		
IT architecture: Access control	Level	Simple			Advanced		
	If advanced	Attribute based			Role based		
IT architecture: Data use	Labelling	Enforcement			Others		
IT architecture: Data mgmt features	Evidence	Blockchain		Verifiable Credentials			Others
	Convenience	Wallet		Data Ports			Others
	Data protection	PETs		Anonymization			Others
	Traceability	Tagging (QR, NFC, RFID)			Others		

D3.1: Benchmark of existing DPP-oriented reference architectures

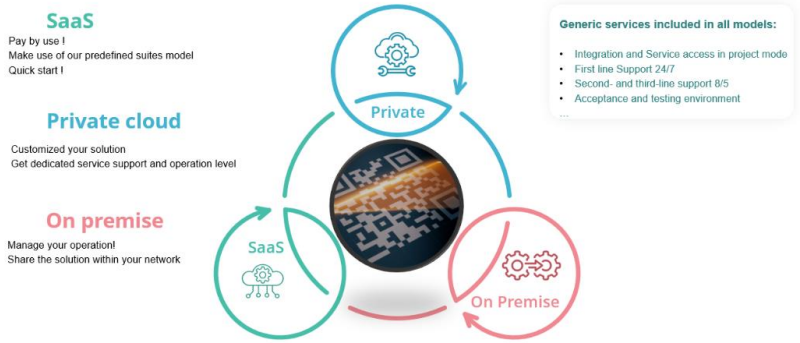
ID	Initiative short name	ID	Initiative short name
1	atma.io	17	itmatters
2	BP	18	Peppol
3	Wordline B-TraaS	19	QI-Digital
4	CircThread	20	RCS BP
5	Circular.fashion	21	RR
6	CYCLANCE	22	Worldline TCS
7	DDCC	23	TextileGenesis
8	DIBICHAIN	24	Tings
9	Digiprime	25	Tokenized Distributed Ledger
10	DNV	26	Toxnot
11	EasyBat	27	Worldline TBD
12	EON	28	TRACE
13	EPEAT Ecolabrl	29	TRICK
14	eReuseDPP RR	30	TrusTrace
15	FEDeRATED	31	Vine
16	GTS	32	ZVEI DPP4.0

DigiPrime





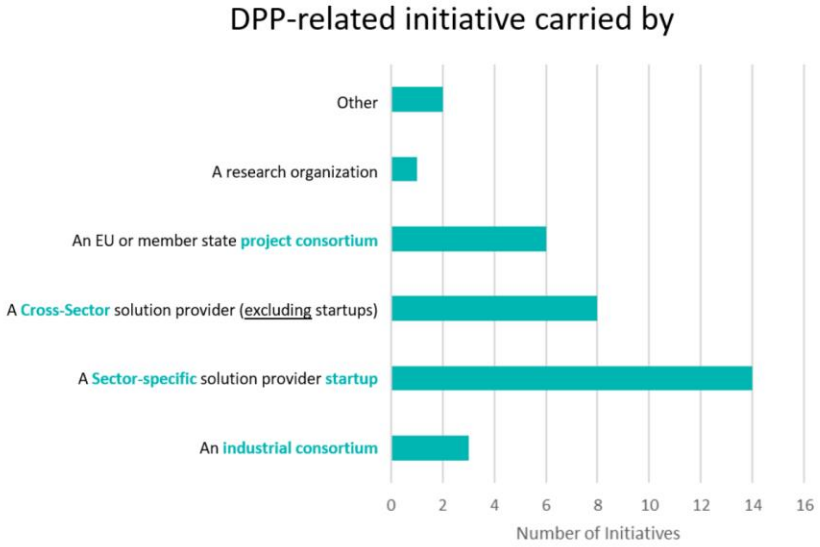
Itmatters



Worldline TCS – Tax Control Suite

Lessons Learnt:

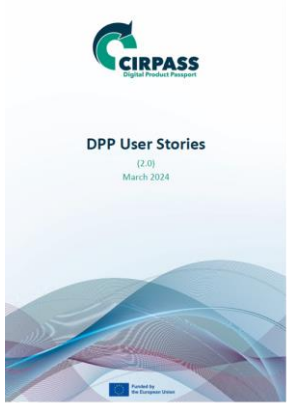
- Variety of approaches and lack of a dominating approach.
- Stakeholders developing DPP-initiatives.
- Centralized vs. Decentralized approach.

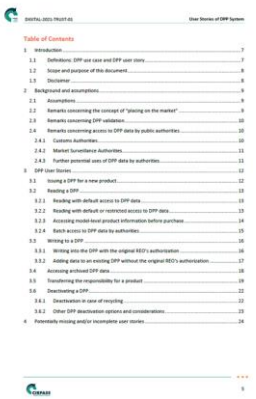


Recommendations and outcomes

- Need for standards to focus and systematize the initiatives.
- Potential adoption of the CIRPASS reference framework for initiative mapping.
- Customize the suitable granularity levels on a sector-to-sector basis and/or on a stakeholder-to-stakeholder basis.
- Invite developers to position and map their DPP approach and IT architecture with respect to a reference framework.
- Monitor and foster the industrial uptake of the promising platforms emerging from ongoing EU projects.

- User Stories
- DPP system architecture
- UNTP DPP vs EU DPP

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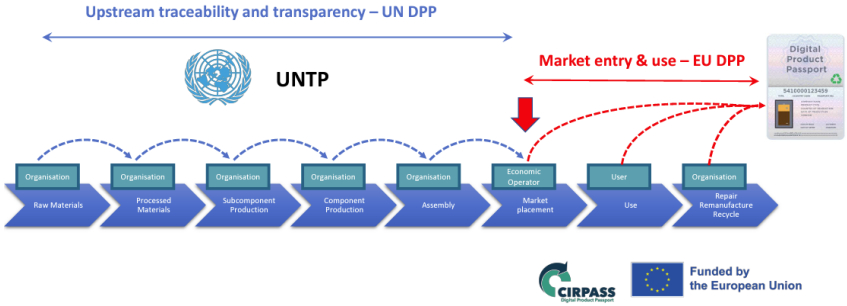
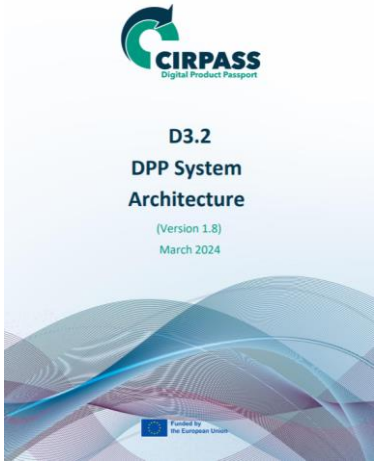
And complements other initiatives.

Regulatory passports : UNTP provides the cross-border upstream data
Industry passports : UNTP provides the interoperable cross-industry core.



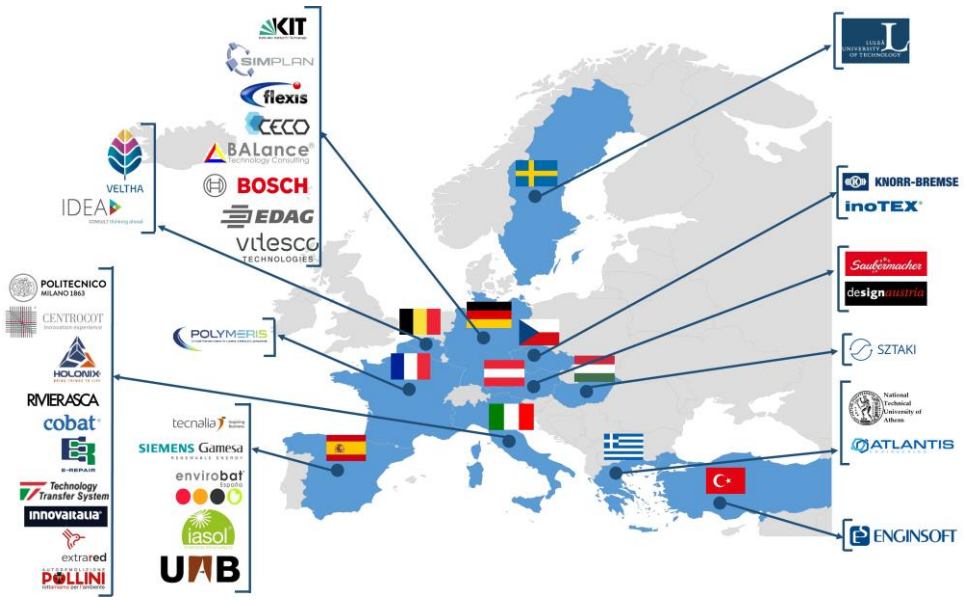


2.2.3.4 Indicative Tools for the key Steps

Here, we provide an indicative list of tools for the key steps, which are also presented in Table 1.

- OpenRefine is an open-source tool that handles messy data. It runs as a Java-based web application that supports loading a dataset, cleaning and reconciling it, as well as transforming it from one format to another.
- Protege is a free, open-source platform that provides a suite of tools to construct domain models and knowledge-based applications with ontologies.
- CSV2RDF is a streaming/transforming CSV to RDF converter, which can build resource URIs on the fly, can fix and remap datatypes and can map different groups of values to different RDF structures.
- R2RML is a mapping language expressing the transition from relational databases to RDF datasets. R2RML mappings refer to logical tables to retrieve data from a source database. Those logical tables are then mapped to RDF using a triples map, a set of rules that maps rows of the logical table into RDF triples. The R2RML mappings are themselves expressed as RDF graphs.
- X3ML Framework is a suite of tools that is able to support the data aggregation process by providing mechanisms of data transformation and URI generation. Mappings are specified using the X3ML mapping definition language, which is a declarative, human readable language that supports the cognitive process of a mapping. The X3ML Engine is responsible for the transformations.
- Ontop provides a platform and a mapping language that can describe how to generate RDF data from relational databases. Ontop relies on the construction of a virtual knowledge graph, using a virtual integration approach. This means that the original data reside in their original data sources and are not transformed or replicated anywhere. They are rather accessed at query time. The mapping definitions rely on R2RML language.
- KARMA is an information integration tool that enables users to integrate data from a variety of data sources in various formats, such as relational databases, JSON, XML, CSV and others. Users describe their mappings based on a target ontology using a user interface that automates much of the process. The tool also supports the transformation of the data and their publishing as RDF data.
- EasyRDF is a library designed to make it easy to consume and produce RDF. It was designed for use in mixed teams of experienced and inexperienced RDF developers. It is written in Object Oriented PHP.
- RDF serializer is a web service for parsing RDF data and transforming it into other RDF serialisation format, including Turtle, RDF/XML, RDF/JSON, N-Triples, and N-Quads.

The DigiPrime project



- 36 European organizations from 11 EU states;
- 6 manufacturing sectors;
- 25 **industrial partners**, 18 of which are SMEs;
- 8 **research centers and universities.**

CALL

H2020-DT-ICT-07- 2018-2019

Digital Manufacturing Platforms for Connected Smart Factories

BUDGET

Project costs: *19.257.130,00€*
Funding: *15.963.173,50€*

DURATION

January 2020 – Dec 2023

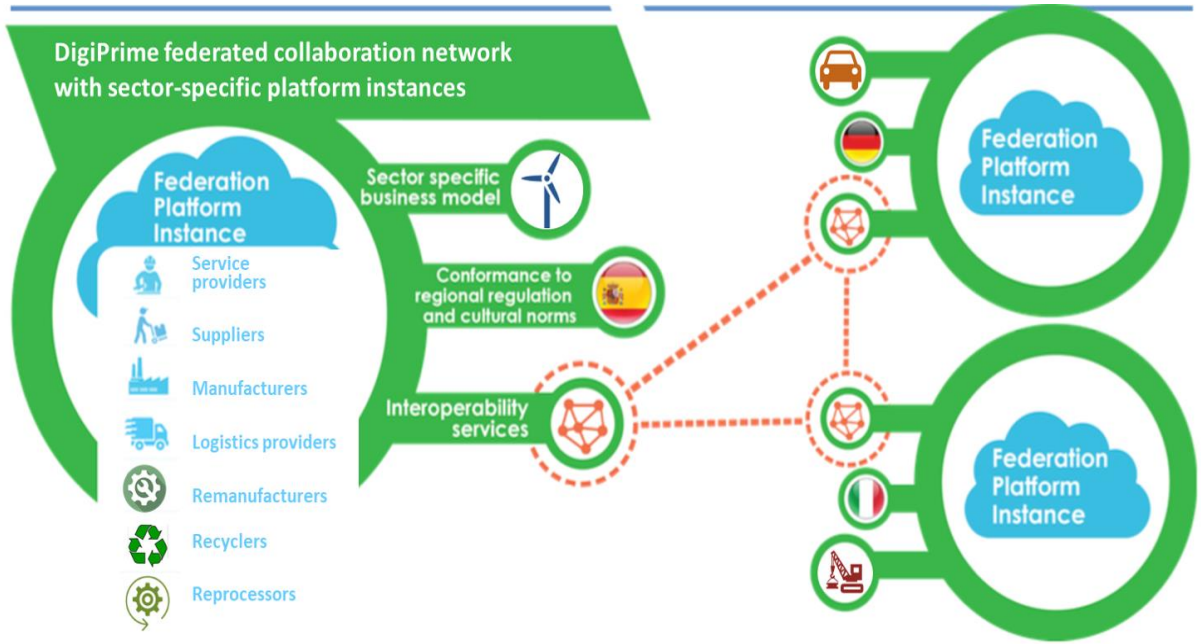
OBJECTIVE

To develop a new concept of Circular Economy digital platform overcoming current information asymmetry among value-chain stakeholders, in order to unlock new circular business models based on the data-enhanced recovery and re-use of functions and materials from high value-added post-use products with a cross-sectorial approach.

Platform Architecture: concept of federation

The overall architecture level of the DigiPrime platform includes:

- A **Multi-node federation structure**, replicable on different existing and new sectorial platform instances, which will support the future systematic creation of cross-sectorial circular value-chains.
- A **Semantic data infrastructure,** based on ontological repositories and semantic search, able to manage and standardize the Babel of information coming from heterogeneous nodes.
- A **Data Policy Framework** to ensure privacy, security, authentication and authorization policies to any information shared among registered users.

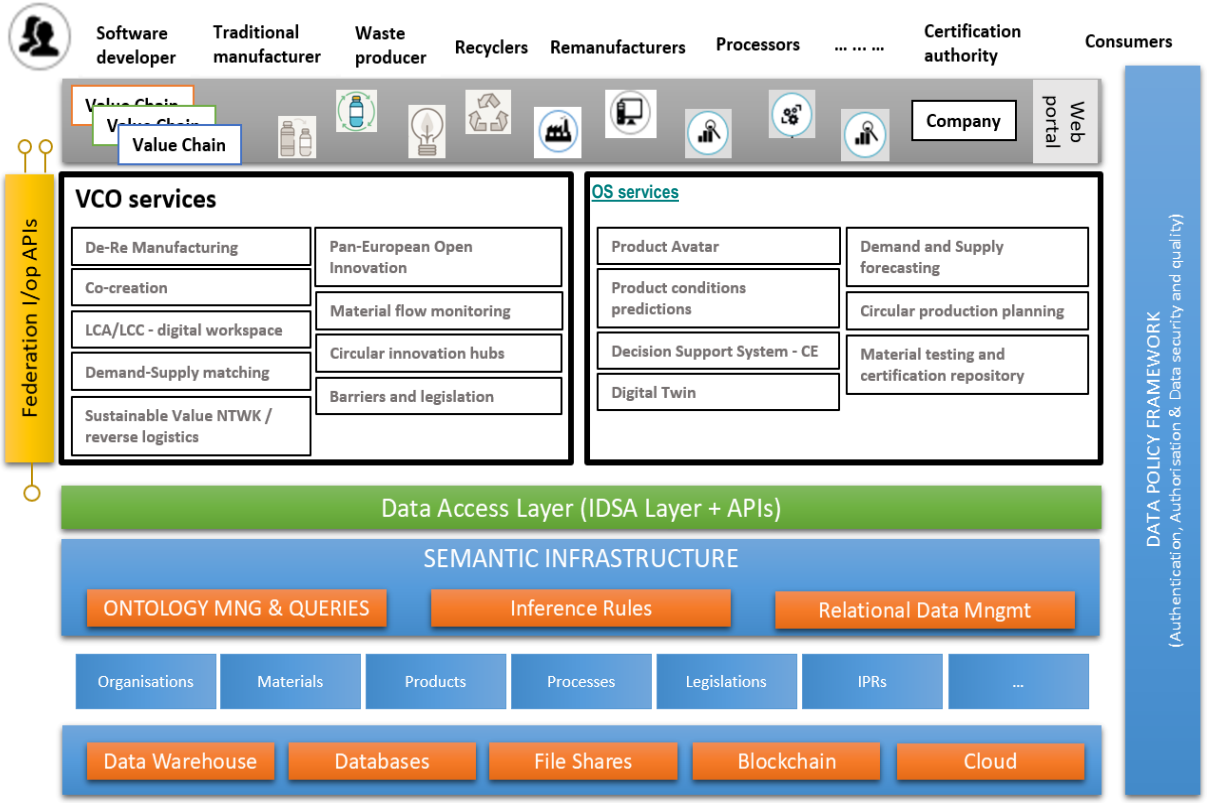


The Blockchain technology will ensure that data cannot be altered, and will keep track of any transaction taking place in the platform.

The DigiPrime platform Services

Value-chain Oriented Services (VCO) and Operational Services (OS).

- **VCO** services are horizontal services that can be made accessible to other nodes of the federation, to offer access to information of interest to stakeholders across sectors.
- **OS** services are vertical services, used by companies internally, mainly to support decision- making aiming at improving the effectiveness and profitability of the circular business processes.



The DigiPrime Pilots

The platform and the related service applications will be **adopted and validated within the DigiPrime cross-sectorial pilots**.

Executing the demonstration experiments for specific use-cases allows to test:

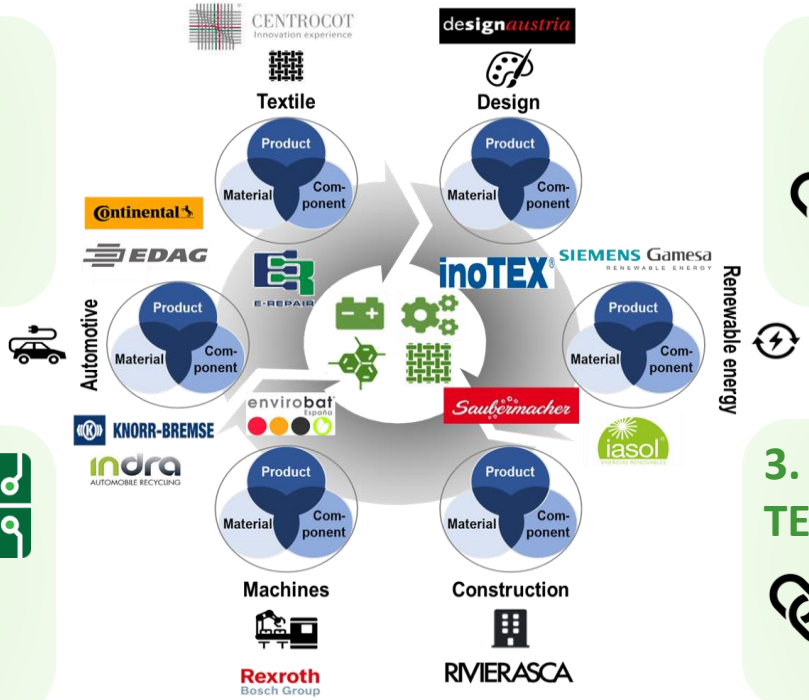
- The interoperability with the company pre-existing ICT infrastructure;
- The continuous interaction with the platform modules and services;
- The generated data to populate the platform for future business cases;
- The industrial feedback for platform maintenance and improvement.

1. BATTERIES

E-MOBILITY
RENEWABLE ENERGY SECTOR
RECYCLING&RAW MATERIALS

2. MECHATRONICS & ELECTRONICS

E-MOBILITY
SMART MACHINING SYSTEM



4. TEXTILE

AUTOMOTIVE
TEXTILE SECTOR

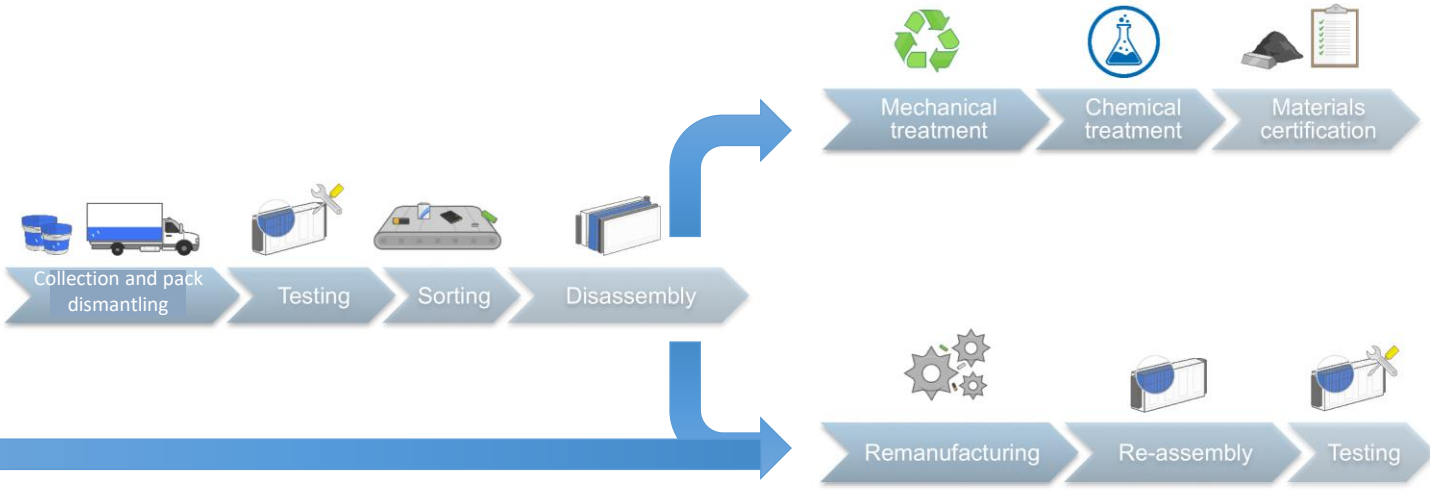
3. COMPOSITES & TECHNO-POLYMERS

E-MOBILITY
RENEWABLE ENERGY SECTOR
CONSTRUCTION
DESIGN SECTOR

The DigiPrime Pilots: example pilot 1 - Batteries

Goal: a new process-chain for the re-use of Li-Ion battery cells under a circular economy perspective, with a cross-sectorial approach.

E-mobility



Characteristics:

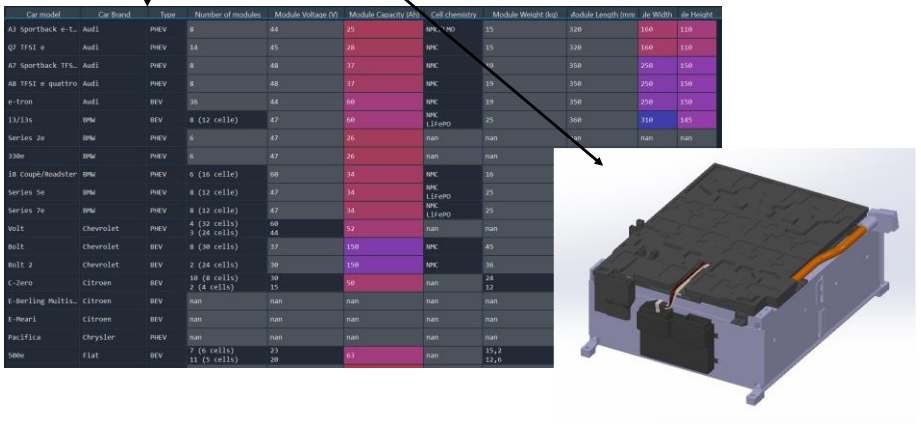
- Average life-time 8 years.
- Current cost 150 Euro kWh.
- Residual capacity >80% (24 kWh on average).
- Warranty for manufacturers usually for 5 years (e.g. Tesla, Nissan).

Second-life stationary systems (renewable energy, home, office)

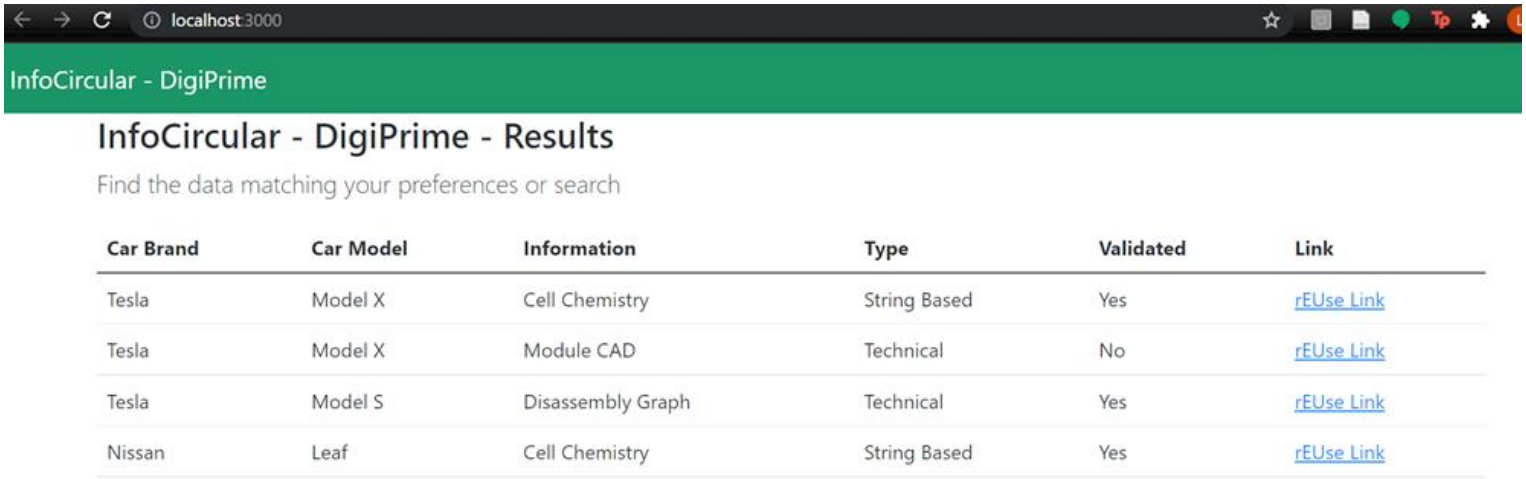
VCO – De-and Remanufacturing Data Management and Sharing

String based and technical files datasets to effectively test the early developments

A service application for boosting a collaborative approach between stakeholders in the cross-sectorial value-chain based on the transfer of relevant product information

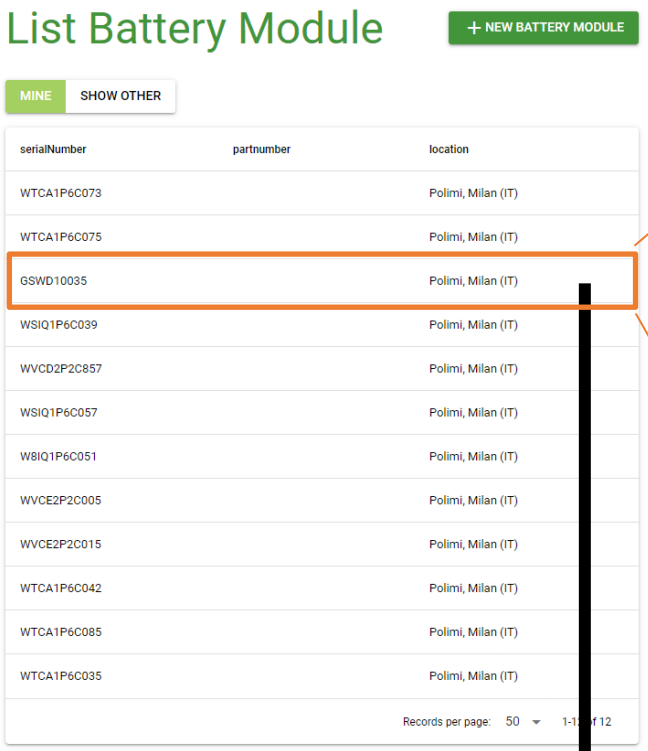


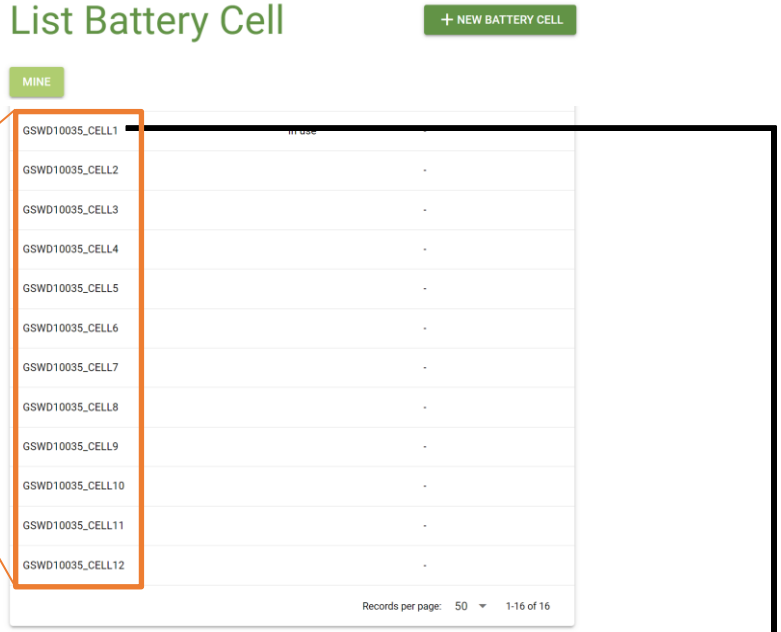
Car model	Car Brand	Type	Number of modules	Module Voltage (V)	Module Capacity (Ah)	Cell chemistry	Module Weight (kg)	Module Length (mm)	ule Width	ule Height
A3 Sportback e-t…	Audi	PHEV	8	44	25	NMC LMO	15	320	160	110
Q7 TFSI e	Audi	PHEV	14	45	28	NMC	15	320	160	110
A7 Sportback TFS…	Audi	PHEV	8	48	37	NMC	19	350	250	150
A8 TFSI e quattro	Audi	PHEV	8	48	37	NMC	19	350	250	150
e-tron	Audi	BEV	36	44	60	NMC	19	350	250	150
i3/i3s	BMW	BEV	8 (12 celle)	47	60	NMC LiFePO	25	360	310	145
Series 2e	BMW	PHEV	6	47	26	nan	nan	nan	nan	nan
330e	BMW	PHEV	6	47	26	nan	nan	nan		
i8 Coupé/Roadster	BMW	PHEV	6 (16 celle)	60	34	NMC	16			
Series 5e	BMW	PHEV	8 (12 celle)	47	34	NMC LiFePO	25			
Series 7e	BMW	PHEV	8 (12 celle)	47	34	NMC LiFePO	25			
Volt	Chevrolet	PHEV	4 (32 cells) 3 (24 cells)	60 44	52	nan	nan			
Bolt	Chevrolet	BEV	8 (30 cells)	37	150	NMC	45			
Bolt 2	Chevrolet	BEV	2 (24 cells)	30	150	NMC	36			
C-Zero	Citroen	BEV	10 (8 cells) 2 (4 cells)	30 15	50	nan	24 12			
E-Berling Multis…	Citroen	BEV	nan	nan	nan	nan	nan			
E-Meari	Citroen	BEV	nan	nan	nan	nan	nan			
Pacifica	Chrysler	PHEV	nan	nan	nan	nan	nan			
500e	Fiat	BEV	7 (6 cells) 11 (5 cells)	23 20	63	nan	15,2 12,6			

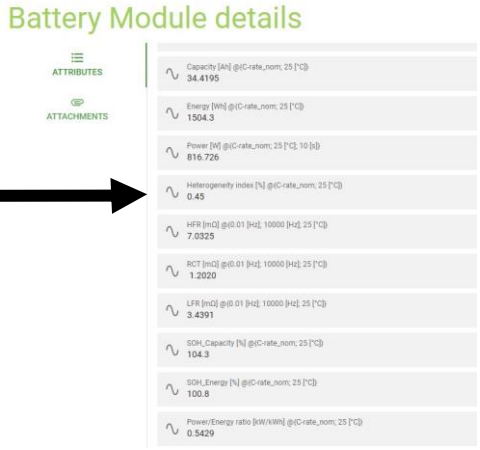


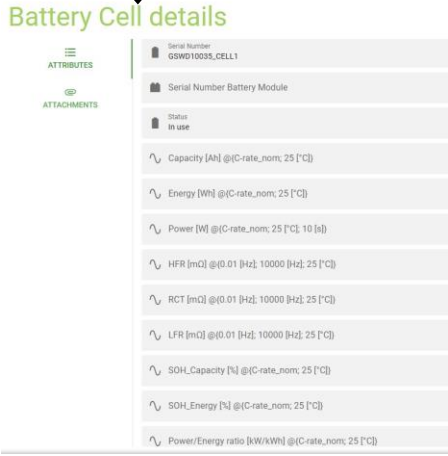
Car Brand	Car Model	Information	Type	Validated	Link
Tesla	Model X	Cell Chemistry	String Based	Yes	rEUse Link
Tesla	Model X	Module CAD	Technical	No	rEUse Link
Tesla	Model S	Disassembly Graph	Technical	Yes	rEUse Link
Nissan	Leaf	Cell Chemistry	String Based	Yes	rEUse Link

VCO – De-and Remanufacturing Data Management and Sharing









A service application for boosting a collaborative approach between stakeholders in the cross-sectorial value-chain based on the transfer of relevant product information

VCO – De-and Remanufacturing Data Management and Sharing

Battery Data Model

General data
Number of modules
Module Voltage (V)
Module Capacity (Ah)
Cell chemistry
Module Weight (kg)
Module Length (mm)
Module Width (mm)
Module Height (mm)

Module data
Number of modules
Cells per module
Electric external connections
Case material
Usable energy system [kWh]
Maximum voltage [V]
Minimum voltage [V]
Nominal voltage [V]
Dimension (including brackets and hoses) [mm]
Weight including brackets and hoses [kg]
Cells configuration
Module testing, standard operating sheet
Module testing, electric connections specs

Pack data
Usable energy system [kWh]
Maximum voltage [V]
Minimum voltage [V]
Nominal voltage [V]
Dimension (including brackets and hoses) [mm]
Weight including brackets [kg]
Cells configuration
Dismantling from the car, standard operating sheet
Battery pack disassembly, standard operating sheet
General data sheet

Cell data
Cell supplier
Case type
Joining technology
Chemistry
Nominal capacity [Ah]
Nominal energy [Wh]
Maximum voltage [V]
Minimum voltage [V]
Nominal voltage [V]

The pilot circular value chain

Information sharing using the product avatar tool

Decisional step are managed using DSS service

Transport assessment through the reverse logistic service

Characterize with a complete dataset a specific automotive battery into product nominal database

Disassembly the battery using data from product nominal database and exploiting the digital twin

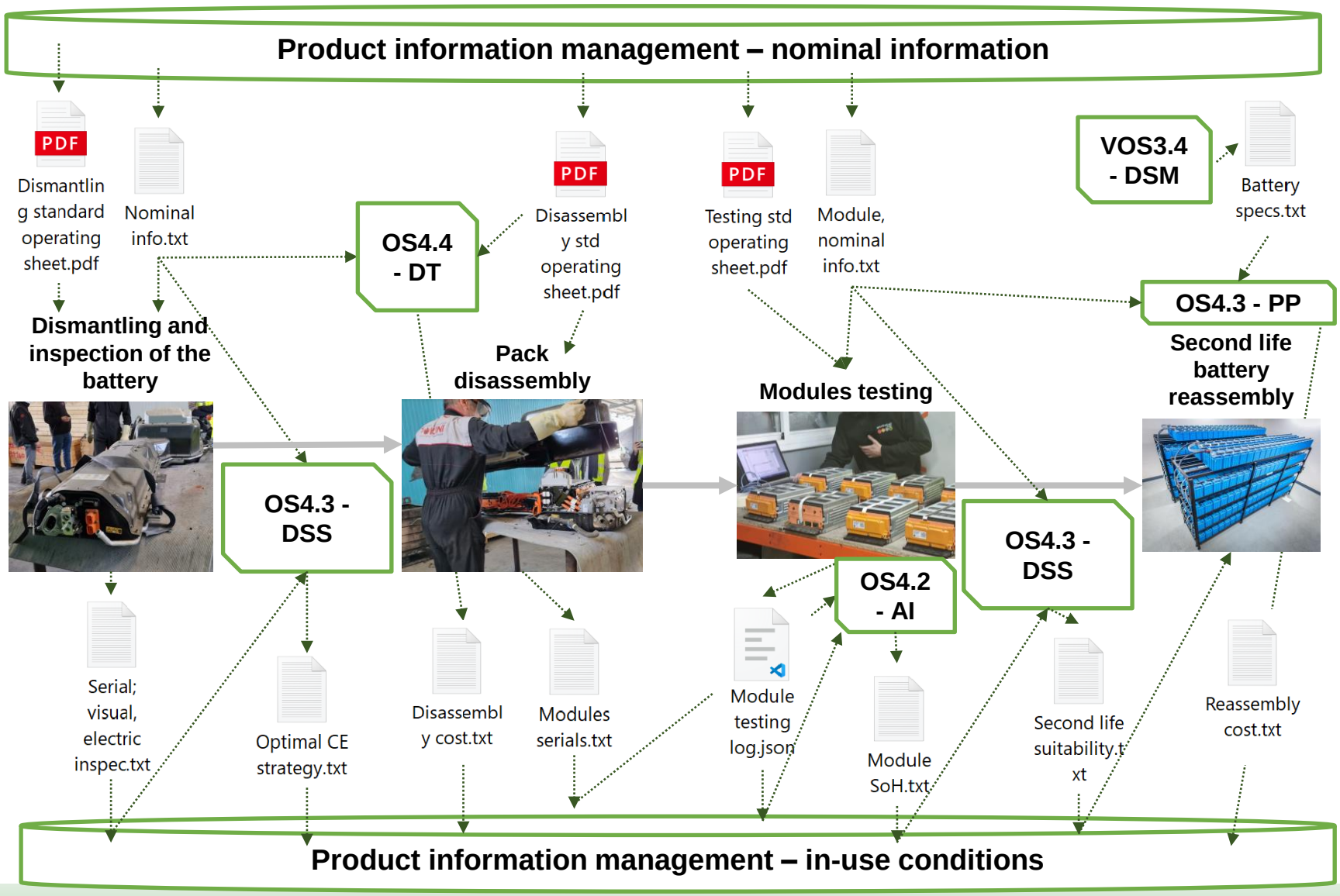
Testing the modules using AI for prediction

Recycling target raw materials using product nominal database

Testing and remanufacturing the BMS using DSS service

Re-marketize the BMS using demand supply matching

Complete data-flow pilot 1: example



CIRC-eV: Circular Factory for the Electrified Vehicle of the Future

E-mobility
Li-Ion battery pack

Pack Collection and disassembly → Module characterization → Module disassembly → Cell testing and characterization

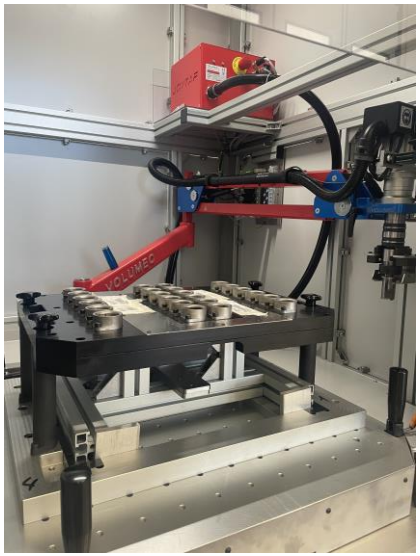
Mechanical Treatment → Chemical Treatment → Materials certification

Critical raw materials (Co, Li), Metals (Al, Cu) and Polymers.

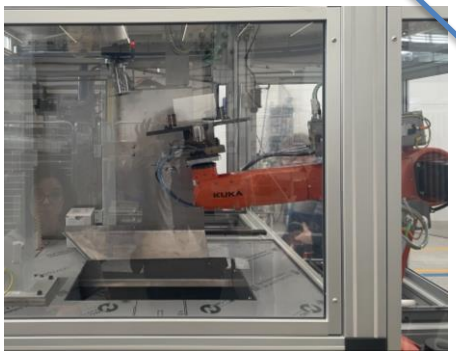
Remanufacturing → Module Re-assembly → Module certification

Second-life stationary systems (renewable energy, home, office)

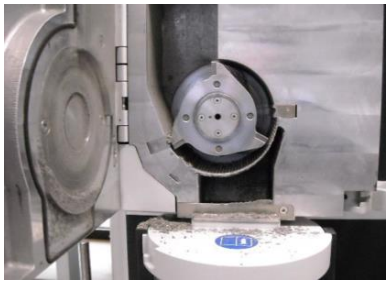
Battery cycling and testing equipment for RUL prediction



Battery module disassembly -reassembly

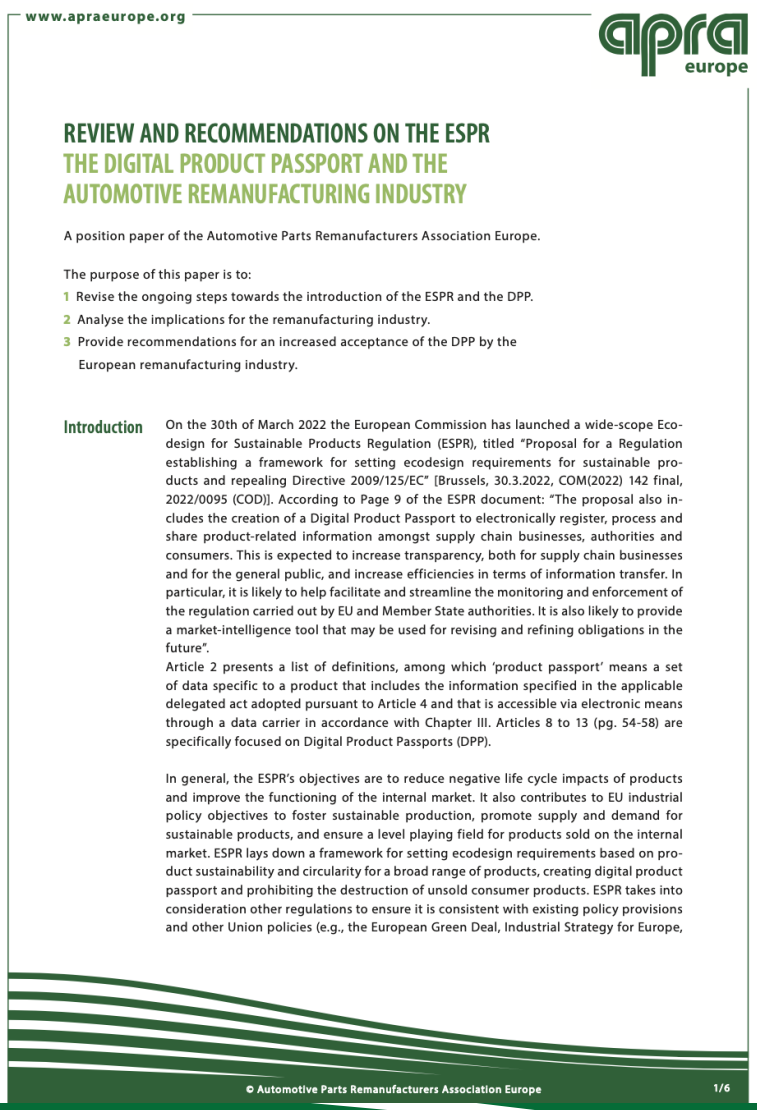


Battery cell case cutting



Material shredding and separation of black mass

APRA Position paper



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REVIEW AND RECOMMENDATIONS ON THE ESPR
THE DIGITAL PRODUCT PASSPORT AND THE
AUTOMOTIVE REMANUFACTURING INDUSTRY

A position paper of the Automotive Parts Remanufacturers Association Europe.

The purpose of this paper is to:

1 Revise the ongoing steps towards the introduction of the ESPR and the DPP.
2 Analyse the implications for the remanufacturing industry.
3 Provide recommendations for an increased acceptance of the DPP by the European remanufacturing industry.

Introduction

On the 30th of March 2022 the European Commission has launched a wide-scope Eco-design for Sustainable Products Regulation (ESPR), titled "Proposal for a Regulation establishing a framework for setting ecodesign requirements for sustainable products and repealing Directive 2009/125/EC" [Brussels, 30.3.2022, COM(2022) 142 final, 2022/0095 (COD)]. According to Page 9 of the ESPR document: "The proposal also includes the creation of a Digital Product Passport to electronically register, process and share product-related information amongst supply chain businesses, authorities and consumers. This is expected to increase transparency, both for supply chain businesses and for the general public, and increase efficiencies in terms of information transfer. In particular, it is likely to help facilitate and streamline the monitoring and enforcement of the regulation carried out by EU and Member State authorities. It is also likely to provide a market-intelligence tool that may be used for revising and refining obligations in the future".
Article 2 presents a list of definitions, among which 'product passport' means a set of data specific to a product that includes the information specified in the applicable delegated act adopted pursuant to Article 4 and that is accessible via electronic means through a data carrier in accordance with Chapter III. Articles 8 to 13 (pg. 54-58) are specifically focused on Digital Product Passports (DPP).

In general, the ESPR's objectives are to reduce negative life cycle impacts of products and improve the functioning of the internal market. It also contributes to EU industrial policy objectives to foster sustainable production, promote supply and demand for sustainable products, and ensure a level playing field for products sold on the internal market. ESPR lays down a framework for setting ecodesign requirements based on product sustainability and circularity for a broad range of products, creating digital product passport and prohibiting the destruction of unsold consumer products. ESPR takes into consideration other regulations to ensure it is consistent with existing policy provisions and other Union policies (e.g., the European Green Deal, Industrial Strategy for Europe,

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- → Introduction:
  - → Positioning of APRA in Europe and Worldwide.
  - → The concept of DPP.
- → Analysis:
  - → Positioning APRA with respect to the DPP: Implications for the automotive remanufacturing industry.
  - → Expected benefits for the remanufacturing industry.
  - → Potential drawbacks.
- → Recommendations:
  - → Recommendations for policy makers towards the implementation.

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