Battery Pass

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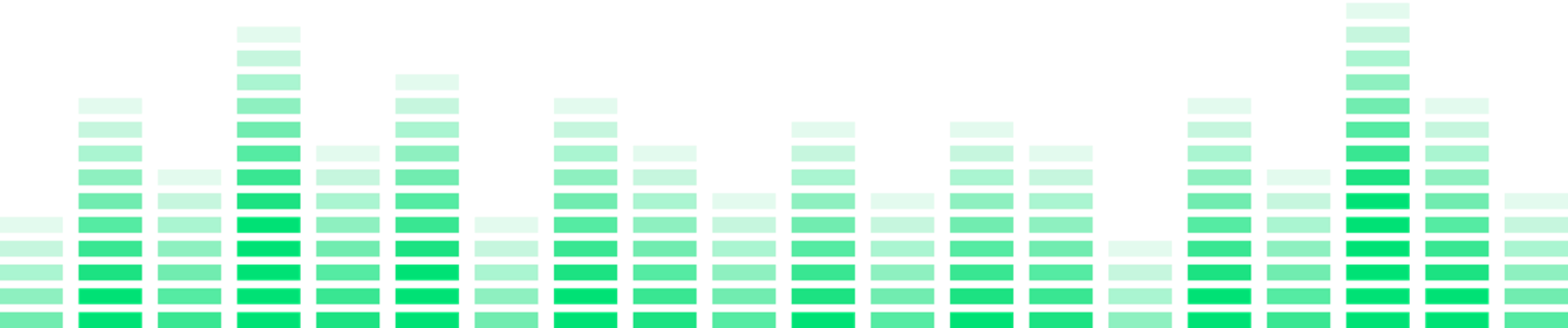
The Battery Pass State of Play

May 2024



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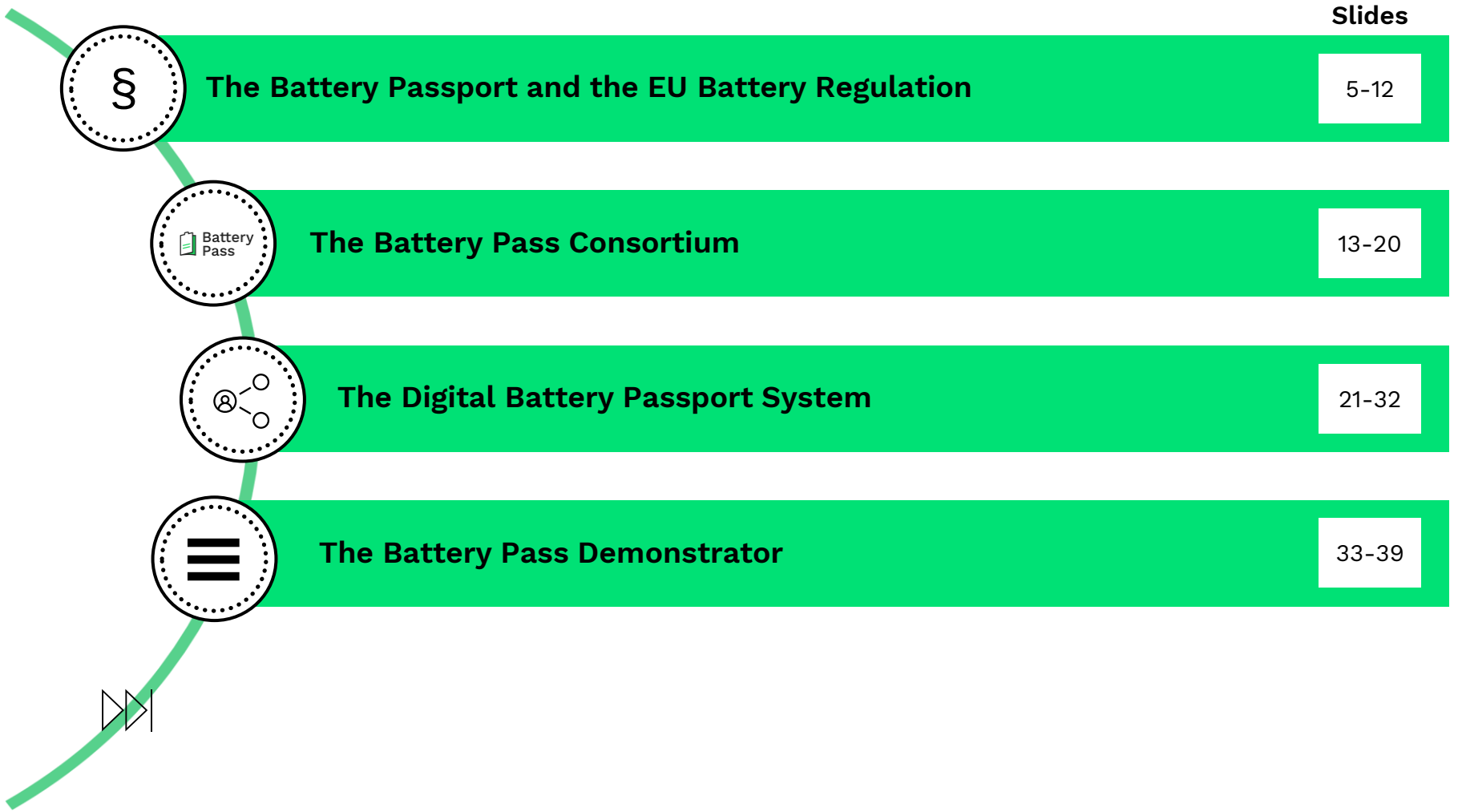
This document aims to provide a brief overview on the Technical Standard Stack developed by the Battery Pass consortium



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The Battery Passport and the EU Battery Regulation

The EU introduces digital product passports (DPP) as part of its broader regulatory ambition towards sustainability with the first being required for batteries from 2027

European Green Deal

Comprehensive plan to make the EU climate-neutral by 2050, safeguard biodiversity, establish a circular economy and eliminate pollution, while boosting the competitiveness of the European industry and ensuring a just transition for the regions and workers affected.

Circular Economy Action Plan

Initiative promoting the sustainable use of resources, especially in resource-intensive sectors with high environmental impact.

Provisional agreement

Ecodesign for Sustainable Product Regulation

- Proposed in Mar 2022, as central part to the Commission's strategy for eco-friendly and circular products
- Extends beyond current Ecodesign Directive, which exclusively addresses energy-related products
- Aims to promote environmental sustainability across a broader range of products

Introduces **digital product passports** as a general concept

Entered into force

Battery Regulation

- Initially proposed in 2020 complementing the Strategic Action Plan for Batteries
- Entered into force in Aug 2023 replacing the EU Battery Directive
- Provides a legal framework aiming to promote sustainability, circularity, safety and transparency

Mandates a **battery passport** for all EV, LMT, and industrial (>2kWh) batteries starting Feb 2027

Proposal

End-of-Life Vehicle Regulation

- Proposed in Jul 2023, as result of the review of the End-of-life Vehicle Directive
- Will replace the End-of-life Vehicle Directive as well as the Type-approval Directive
- Governs the entire vehicle lifecycle, from design to end-of-life treatment

Mandates a **circularity vehicle passport** starting 7 years after entry into force of the regulation

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The purpose of the battery passport is to provide transparency and awareness, enable the shift to a circular economy, and create a level playing field

Purpose of the battery passport

Enable the shift from linear to circular economies

- Provide the required “situational awareness” for batteries including, for example a “product-as-a-service” mode, instead of considering a product a consumable only
- Keep products within the system to save resources and minimize the amount of actual waste
- Leverage data for optimizing circularity processes

Provide transparency to impact decisions

- Enable informed decisions based on comprehensive data being provided digitally
- Bridge information gaps in the battery value chain to maximize lifetime value
- Leverage new insights from use and fate for design and production

Create a battery level playing field

- Build the future battery value chain on multi-stakeholder responsibilities
- Move stakeholders to compete on sustainable innovation
- Develop business models that operate on value creation, value capture, and value conservation

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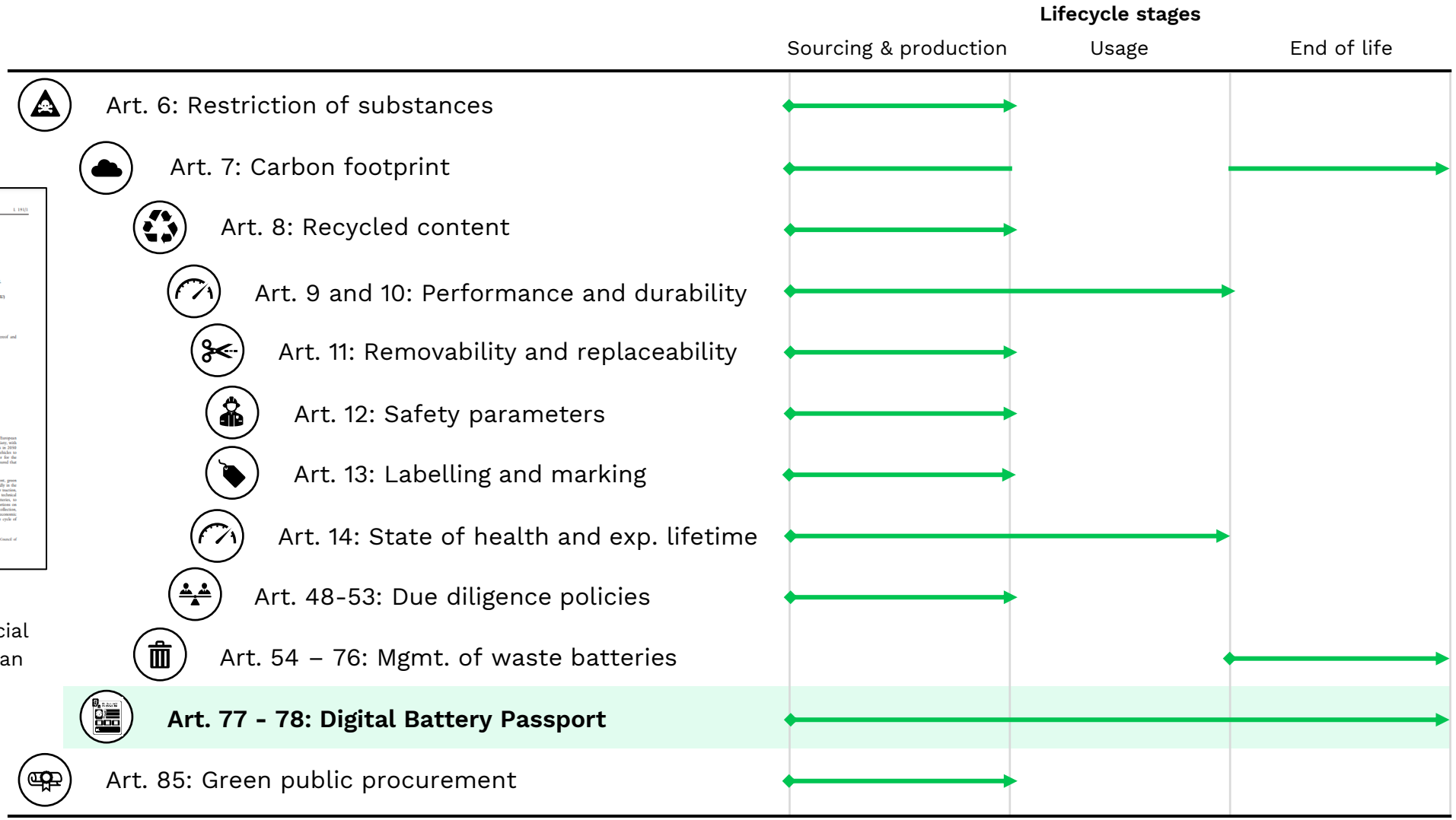
The Battery Passport is defined in Article 77 of the Battery Regulation and encompasses reporting requirements covering the entire battery life cycle

Not exhaustive

REGULATIONS

REGULATION (EU) 2023/1542 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 July 2023 concerning batteries and waste batteries, amending Directive 2009/98/EC and Regulation (EU) 2019/1020 and repealing Directive 2006/66/EC

Battery Regulation publication in the Official Journal of the European Commission



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The battery passport will be required for EV, LMT and industrial batteries > 2 kWh from February 2027 with the main responsibility lying with the “economic operator”

Specifications for the battery passport

Timeline	The battery passport will be required from 18 February 2027
Scope	• Batteries in light means of transport (LMT) • Industrial batteries with a capacity greater than 2 kWh • Electric vehicle (EV) batteries
Responsibility	The responsibility lies with the economic operator (or an authorized representative) placing the battery on the market
Stakeholder Groups	1) The “general public” 2) “Notified bodies, market surveillance authorities and the Commission” 3) “Any natural or legal person with a legitimate interest in accessing and processing that information”

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The scope of information to be made available via the battery passport is extensive with up to 90 data attributes which can be clustered into seven categories

Not exhaustive

Data categories for the battery passport (select data attributes shown below)

Battery Pass

Battery ID: 0101010
Battery passport ID: 1111010
Responsible economic operator

General information

- Manufacturing info (identity, place, date)
- Battery category
- Battery weight
- Battery status

Labels and certifications[1]

- Symbols and labels
- Meaning of labels & symbols
- Declaration of conformity
- Compliance of test results

Carbon footprint

- Carbon footprint (5 metrics)
- Weblink to CF study
- CF performance class

Supply chain due diligence

- Due diligence report

Materials and composition

- Hazardous substances
- Battery chemistry
- Critical raw materials
- Materials used in cathode, anode, electrolyte

Circularity & resource efficiency

- Recycled content shares
- Manuals for removal, disassembly, dismantling
- Component part numbers & spare parts information
- Safety measures/instructions

Performance & durability

- Capacity, energy, power, SoH
- Expected lifetime
- Negative events

1) Labels and symbols are covered in section 5. „Battery materials and composition“ in the following. Information on compliance can be found in the main Guidance Document.

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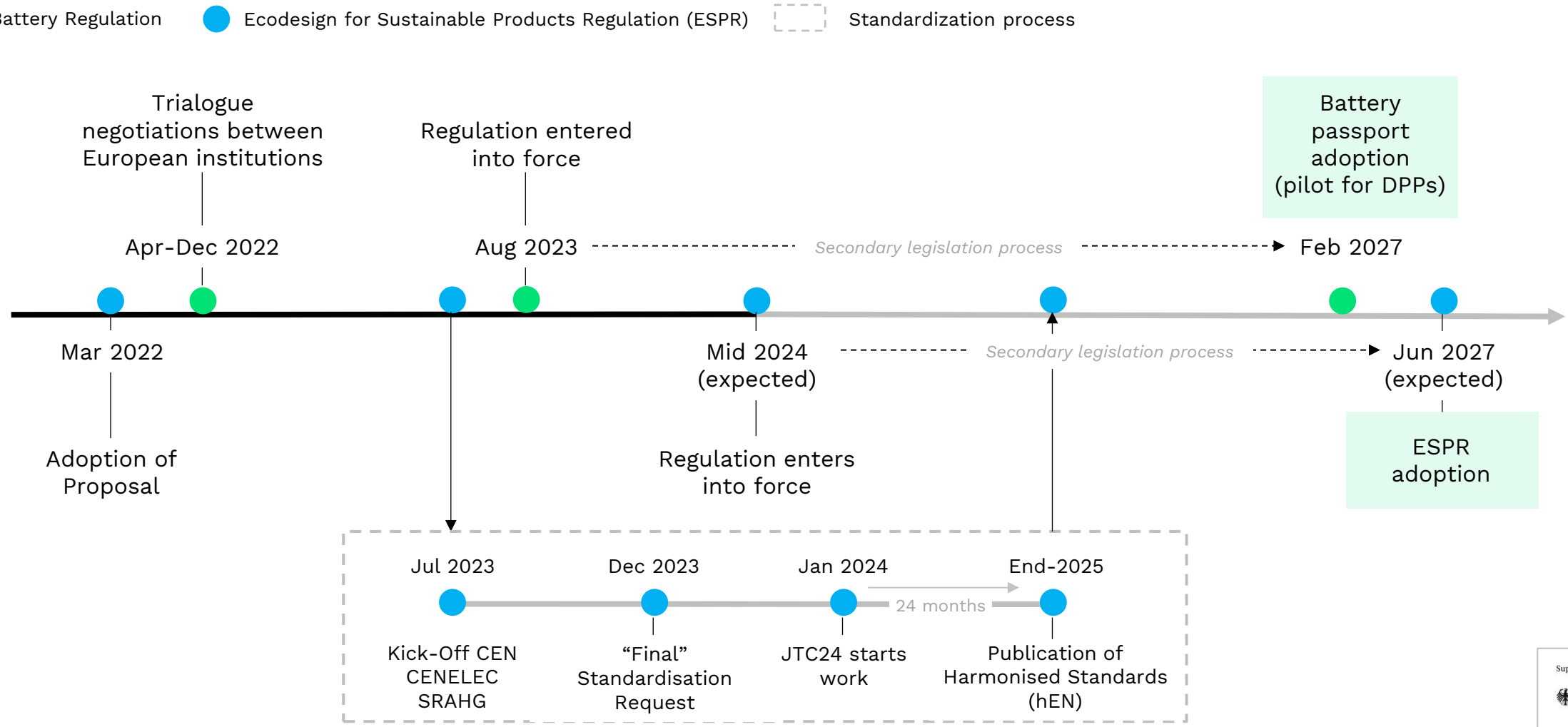
The regulatory frameworks for the battery passport are the EU Battery Regulation and Ecodesign for Sustainable Products Regulation (ESPR)



SRAHG: Standardization Request – Ad-hoc Group; **JTC:** Joint Technical Committee; **hEN:** harmonised Standard

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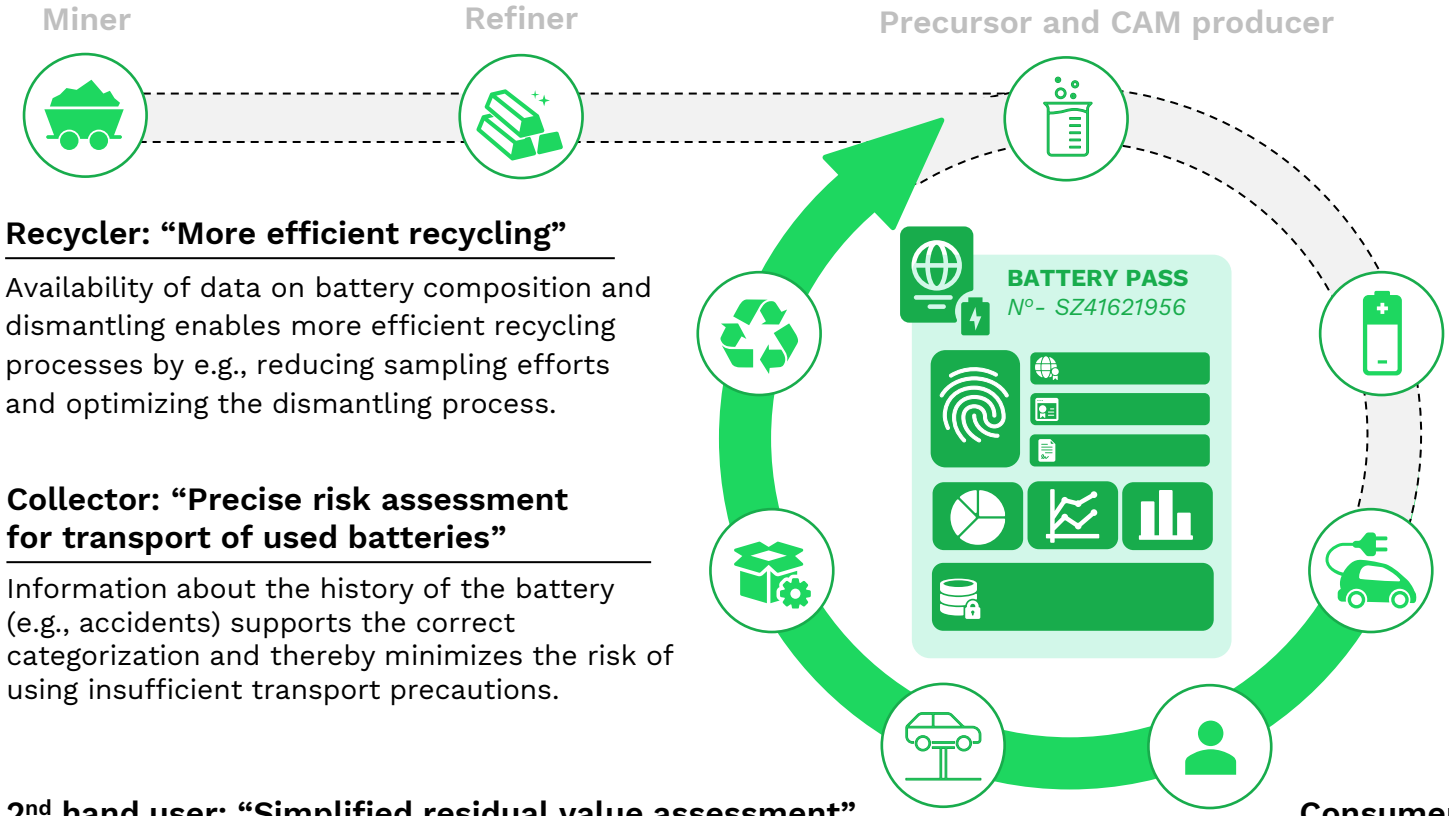
The battery passport will unlock major value along the value chain

Value of the passport: Regulatory compliance and potential additional value pending conditions beyond regulatory requirements

Direct value add along several dimensions (environmental, social and economic)

Select examples



Recycler: “More efficient recycling”

Availability of data on battery composition and dismantling enables more efficient recycling processes by e.g., reducing sampling efforts and optimizing the dismantling process.

Collector: “Precise risk assessment for transport of used batteries”

Information about the history of the battery (e.g., accidents) supports the correct categorization and thereby minimizes the risk of using insufficient transport precautions.

2nd hand user: “Simplified residual value assessment”

Performance and durability data (e.g., remaining capacity) enable downstream businesses and private users to better assess the residual value of the battery to decide between recycling or 2nd life and its specific 2nd life application.

Authorities: “Informed policy design”

Aggregated battery passport data can provide information for fact-based policy design and implementation.

OEM: “Reliable communication of ESG data”

Economic operators excelling on ESG performance (e.g., due diligence report, carbon footprint) can leverage the battery passport for product differentiation.

Consumer: “Informed purchasing decisions”

Access to reliable and comparable information about the battery (e.g., carbon footprint) facilitates well-informed purchasing decisions. .

The value of the battery passport is assessed in detail in a distinct work package, the first publication can be expected in Spring 2024.

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The Battery Pass Consortium

The Battery Pass is a consortium of 11 partners from industry, science, technology and beyond, co-funded by BMWK aiming to provide guidance on the EU battery passport

Key facts on the Battery Pass Consortium

- Evolved from the Circular Economy Initiative Germany (CEID)
- 11 consortium partners from industry, science, technology and beyond
- Co-funded by the German Federal Ministry for Economic Affairs and Climate Action (BMWK) with EUR 8.2 mn
- Aiming to advance the implementation of and provide guidance on the EU Battery Passport
- Five work packages including:
  - Project coordination and stakeholder engagement
  - Guidance on content requirements
  - Guidance on technical battery passport system
  - Development of a physical and software demonstrator
  - Value assessment of individual use cases and overall
- 3-year timeframe from April 2022 to April 2025

CONSORTIUM LEAD

SYSTEMIQ

CONSORTIUM PARTNERS

acatech · Audi · BASF We create chemistry · BMW GROUP · Circulor · FIWARE FOUNDATION · Fraunhofer IPK · TWAICE · umicore · VDE RENEWABLES

*under subcontract

Kick-off event of the Battery Pass Consortium in Berlin in April 2022

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The Battery Pass draws upon a network of associated and supporting partners and guidance of its Advisory Council

The Battery Pass partner network

Associated Partners

Global Battery Alliance · GS1 in Europe · Mercedes-Benz · RWE · SAP

Supporting Partners

AIT Austrian Institute of Technology · Alpha Ventures · Battery Associates · Battery Damage Service · batwoman · betteries · CATL · cidetec energy storage · Circular Cars Initiative · Daimler Truck · Denso Crafting the Core · DEKRA · DIN · DKE · DMT · energy web · Henkel · Honda R&D Europe (Deutschland) · INOBAT AUTO · Jungheinrich · LG Energy Solution · LiBCycle · Li-Cycle · LogBATT · LRP Autorecycling · Morrow · NIO · northvolt · PEM Motion · RockTech Lithium · SINE · sonnen · SPHERITY · Stiftung GRS Batterien · StoreDot · TÜV Verband · We work for tomorrow · UNI GRAZ · volytica diagnostics · wbcsd · zvei electrifying ideas

Advisory Council

European Battery Alliance EBA250 · DIN · Federal Ministry for Economic Affairs and Climate Action · Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection · KLiB Kompetenznetzwerk Lithium-Ionen-Batterien · Transport & Environment · VDE · Wuppertal Institut · zvei electrifying ideas

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The Battery Pass supports and collaborates with other major initiatives active in the digital product passport space

CIRPASS Digital Product Passport

- European Commission “Digital-2021-Trust-01-DIGIPASS” winner
- Kicked off in October 2022 lasting 18 months (March 2024)
- Funding volume: EUR 2 mn
- Partners: 31 organisations
- Objective: build a common understanding of a cross-sectoral DPP
- Focus: Batteries, Textiles, Electronics

Global Battery Alliance

- Leading global voluntary passport initiative
- Objective: enabling transparency and accountability for risks and ESG impacts in EV battery value chains by creating a digital twin of the battery and aggregating data in a battery passport
- 3 early-stage proof of concepts were launched at WEF 2023
- Release of first set of ESG metrics (GHG Rulebook, Child Labour and Human Rights Indices) with additional metrics to follow

Catena-X Automotive Network

- Developing a comprehensive data ecosystem with standardized global data exchange for data-driven value chain in the automotive industry
- Based on GAIA-X data space technology to support data sovereignty with distributed data management and sophisticated identity and access management
- Focusing on several use cases including decarbonization and ESG reporting, circularity & battery passport and others

CircuBAT · SAE International · batwoman · NAATBatt International · And many more... · zvei electrifying ideas · DIN · CE-RISE · IDTA · DKE

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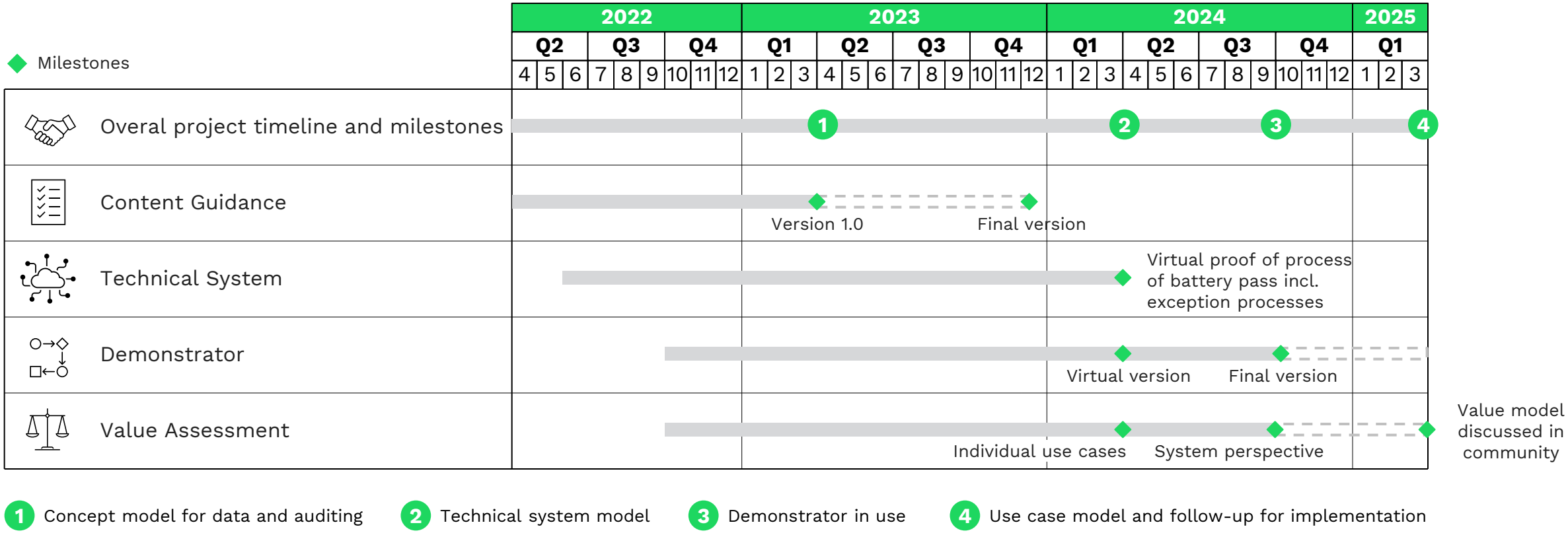
The Battery Pass project runs 3 years: starting with content requirements, the technical system will be analysed, a demonstrator built, and a value assessment conducted



1 Concept model for data and auditing

2 Technical system model

3 Demonstrator in use

4 Use case model and follow-up for implementation

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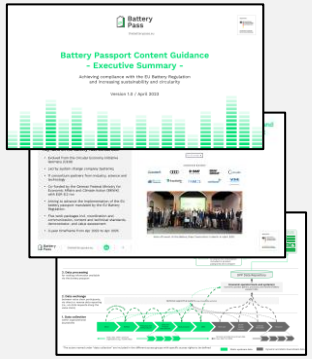
The Battery Pass reached its first milestone at Hannover Messe in April 2023 with the handover of its Battery Passport Content Guidance to State Secretary Kellner

Handover of Content Guidance at Hannover Messe

Battery Passport Content Guidance

Comprehensive report
PDF report (200 pages)



Executive Summary
Slide deck

Data attribute longlist
Excel file

Position Paper to EC
PDF report

Carbon Footprint Documents

Carbon Footprint Rules
PDF report

Carbon Footprint EOL Analysis
PDF report

All documents available on the Battery Pass website

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Sneak Peek: In a world's first detailed assessment of use cases of Battery Passports, we quantify several ways the system could add value

Micro perspective: Baseline procurement incl. technical testing costs for three different battery sourcing scenarios and reduction enabled by the battery passport

Inhouse sourcing

e.g. first life OEM same as second-life operator (All information available)

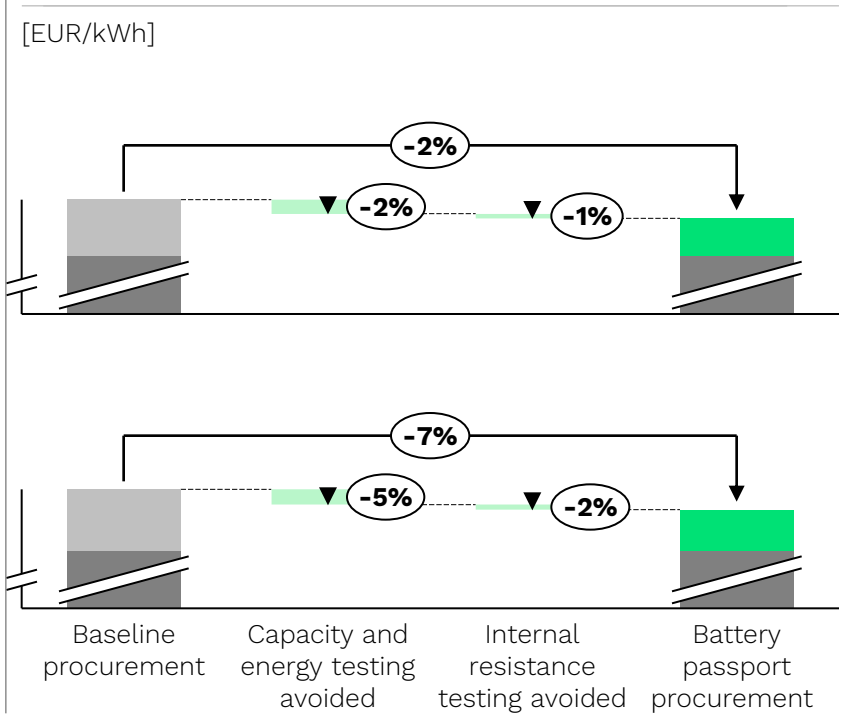
- Share of modules tested[1]: 0%

No testing costs, therefore, no improvement potential

Direct sourcing

e.g. partnership of second-life operator with OEM (Information partially available)

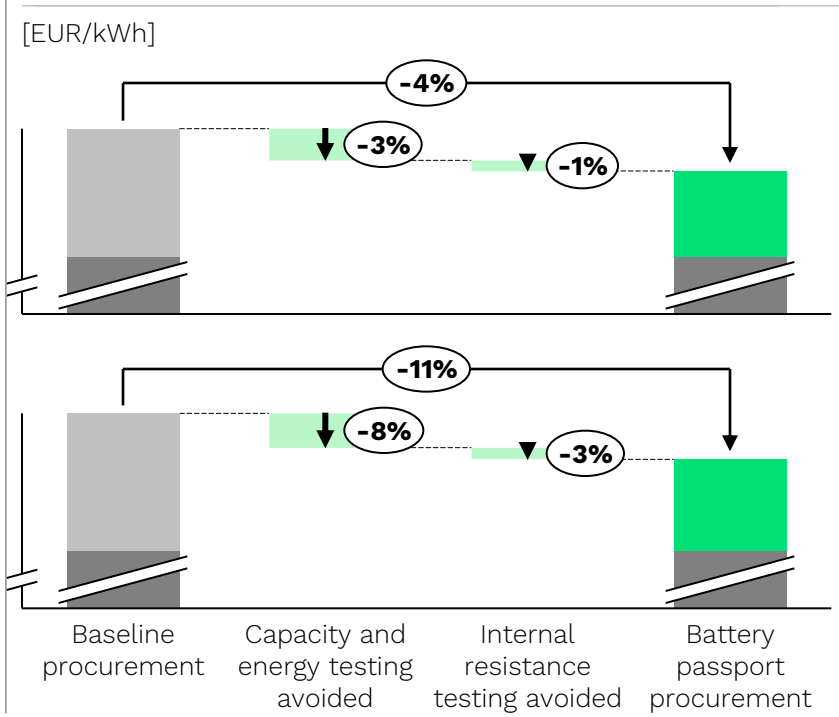
- Share of modules tested[1]: 1%



Indirect sourcing

e.g. open marketplace (No (reliable) information available)

- Share of modules tested[1]: 2%



Interactive visualisation

- Technical testing costs
- Avoided technical testing costs
- Price of second life battery

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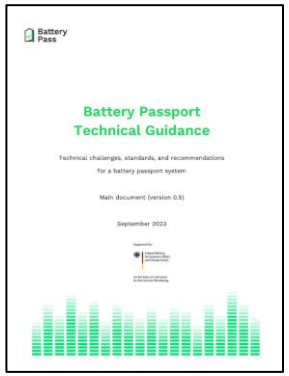
1. From acquired EOL batteries
2. Min refers to minimum testing costs with one temperature tested, max refers to maximum testing costs with three temperatures tested

Source: Systemiq analysis (2024) based on expert interviews and Global Sustainable Electricity Partnership (2021) see technical annex on slides 133-135 for main assumptions and their sources

Results of the Content Guidance have been building the foundation for further Battery Pass publications which will soon be released

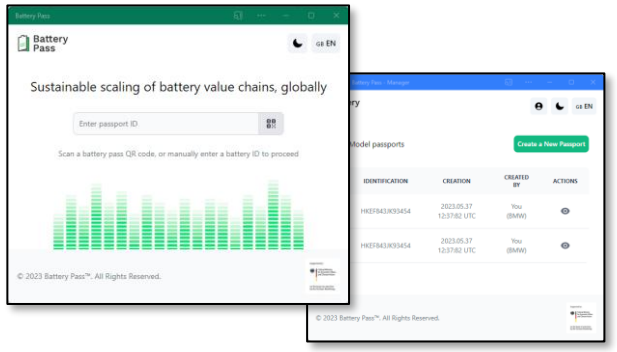
Technical Guidance

- Objective: provide an overview on how the technical battery passport system could look like and which required technical standards it must support
- Scope: Technical Standard Stack incl. mapping of existing standards as well as key challenges and recommendations



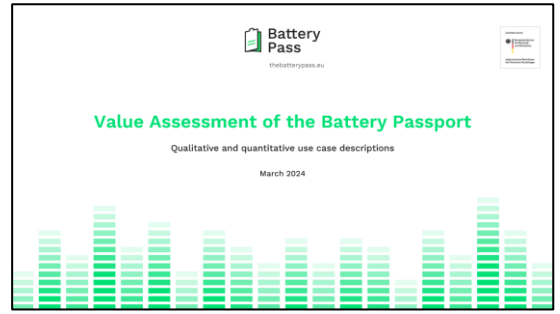
Demonstrator

- Objective: provide a platform which integrates results on battery passport data and system and verifies technological feasibility of the passport
- Scope: software prototype (TRL 5) covering exemplary real-world data



Value Assessment

- Objective: Provide an analytical study to motivate stakeholders to use the battery passport proactively and leverage its full potential.
- Scope: benefit modelling of individual use cases as well as the battery passport overall (incl. a qualitative-conceptual evaluation and exemplary quantification)



Launch at Hannover Fair April 22, via hand-over to State Secretary for Economy and Climate Action

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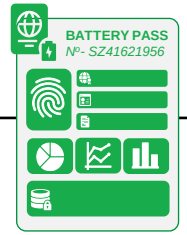
The Digital Battery Passport System

Outlined by the Battery Pass Project

A digital product passport (DPP) consists of data and a system



DPP Data

DPP data sector specific for:

- Batteries
- Electronics
- Textiles
- Construction Materials

→ Defined in different regulations
(e.g., the Battery Regulation with further information available in the Battery Passport Content Guidance)

DPP System

Harmonized technical system for all DPPs:

- Data Storage
- Data Carrier Identifier
- Trust / Security / Sovereignty / Access
- Data Exchange
- IT Services / APIs
- Workflows and Data Processing

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A digital product passport (DPP) is a novel concept making available comprehensive lifecycle information of a physical product in digital format

Core elements and functioning of the battery passport system

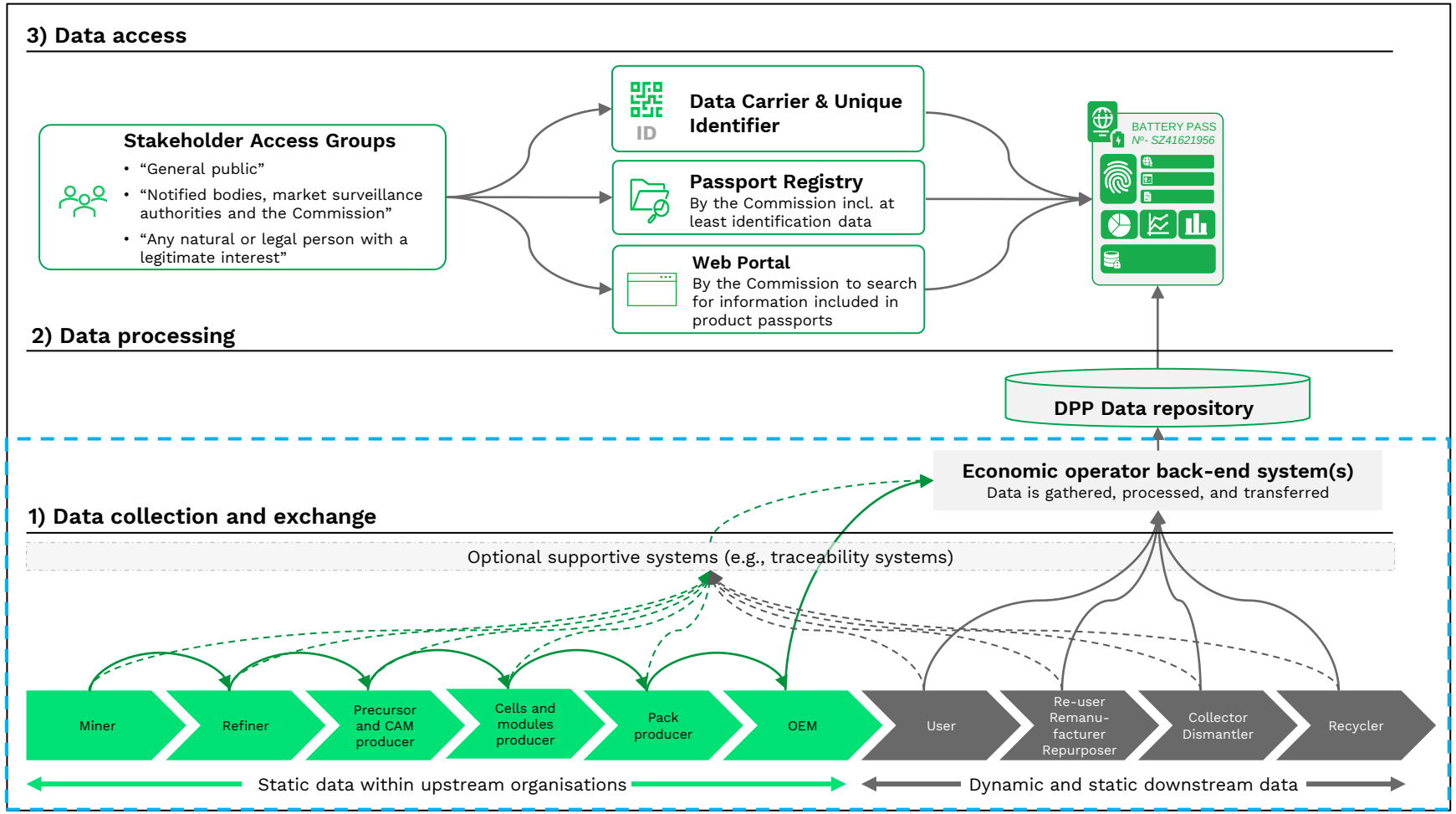
DPP definition

The European Commission defines a digital product passport (DPP) as:

> *A structured collection of product related data with predefined scope and agreed data ownership and access rights conveyed through a unique identifier.*[1)]

DPP functioning

1) Data is collected within organizations and exchanged between value chain players
2) Data is gathered, processed and transferred for product passport by the economic operator
3) Data is accessed from product passport by pre-defined groups based on respective access rights



Not specified by regulatory DPP system requirements, but under the responsibility of the economic operators.

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1) Galatola, M. Digital Product Passport (DPP). Circular Economy Europe. [Online] [Cited: 20 03 2023.] https://circulareconomy.europa.eu/platform/sites/default/files/michele-galatola-european-commission.pdf

Overview on regulatory references by passport system process steps

Regulatory references (ESPR and Battery Regulation)

1 Data collection and exchange

The **responsibility for collecting and processing** this battery passport **information lies with the economic operator** placing the battery on the market (Battery Regulation, Article 77(4)).

While the regulation requires an **interoperable data exchange network "without vender lock-in"** (Battery Regulation, Article 77(5)) for battery passport data provision, the technology of data collection and processing is not further specified.

2 Data processing

The battery passport should be based on a **decentralized data system**, set up and maintained by economic operators (ESPR (6), Recital 32; Battery Regulation, Recital 126).

Economic operators can authorise other operators to act on their behalf and store the data being accessible via the battery passport (ESPR (6), Article 10(c)).

3 Data access

Product passport registry:

The European Commission will also aggregate and store selected data of the battery passport in the **product passport registry**. This registry, to be set up and maintained by the Commission, should be **accessible to competent national authorities, customs authorities, and the Commission** itself (ESPR (6), Recital 32, Article 12).

The responsibility for uploading the required information to the registry lies with the economic operator placing the product on the market or putting it into service (ESPR, Article 12).

Data carrier:

Access to DPPs shall be provided via a data carrier (ESPR (6), Recital 31), defined as a "linear bar code symbol, a two-dimensional symbol or other automatic identification data capture medium that can be read by a device" (ESPR (6), Article 2(30)).

For the battery passport, this data carrier shall be a QR code (Battery Regulation, Article 77(3)), whereas delegated acts can be adopted by the European Commission to "provide for alternative types of smart labels instead of or in addition to the QR code, in view of technical and scientific progress" (Battery Regulation, Article 13(6, 8)).

Stakeholder groups:

(Article 77(2), Battery Regulation)

- "General public" (Recital 123)
- "Notified bodies, market surveillance authorities and the Commission" (Recital 123)
- Any natural or legal person with a legitimate interest in accessing and processing that information" (Annex XIII (2 and 4))

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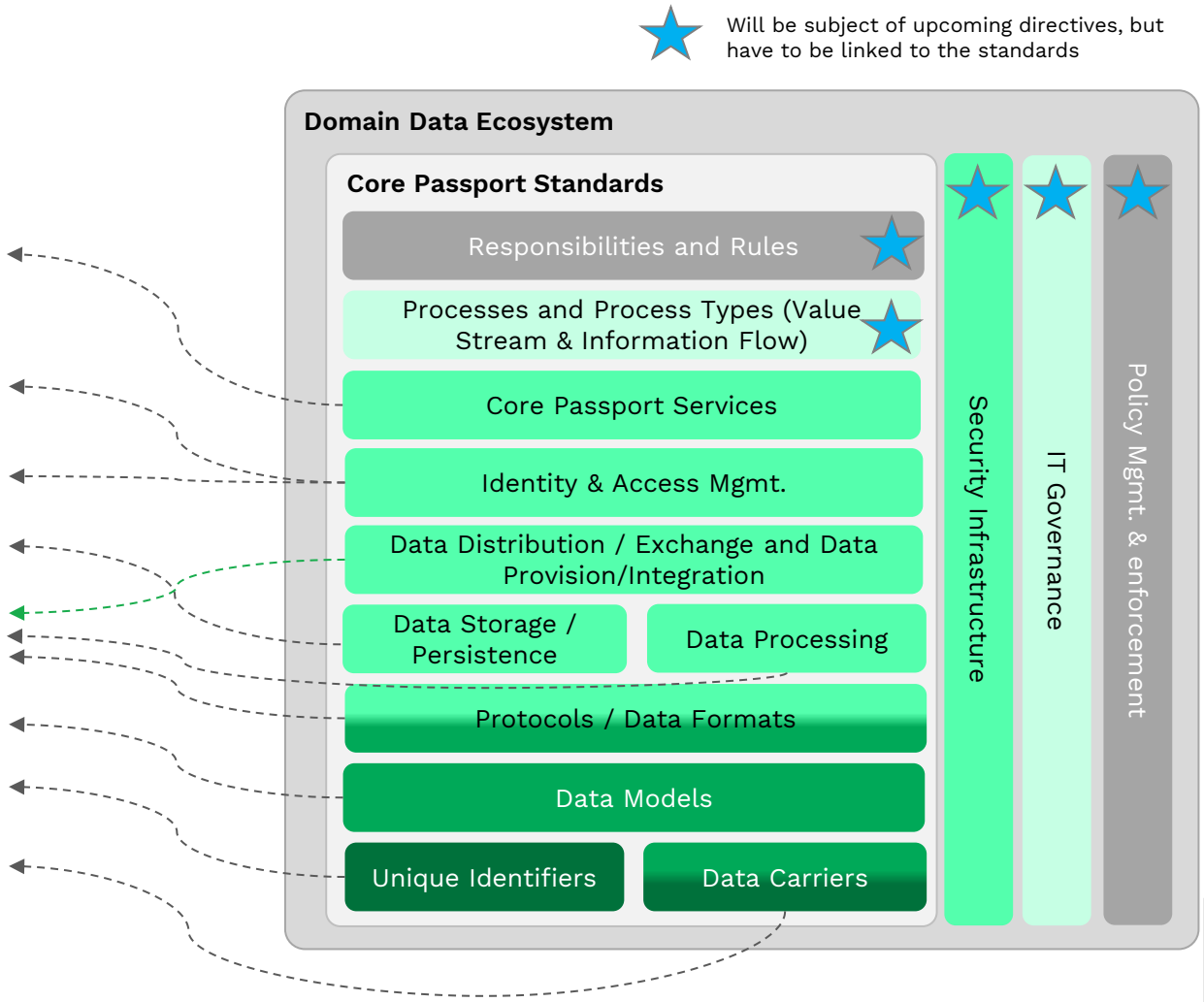
The Standard Stack contributes to the elaboration of harmonised Standards to implement the ESPR

Current standardisation request harmonised standard(s) on:

- APIs for the DPP lifecycle management and searchability
- Access rights management, information, system security, and business confidentiality
- Data authentication, reliability, integrity
- Data storage, archiving, and data persistence
- Data processing, data exchange protocols and data formats
- Interoperability
- Unique identifiers
- Data carriers and links between physical product and digital representation



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Via a top-down approach an initial longlist of standards for each element of the Technical Standard Stack has been identified and evaluated afterwards

Standards origin and hierarchy	Select examples
1 Global standards	ISO, IEC
2 European standards	CEN, CENELEC, ETSI
3 German standards	DIN, DKE
4 Standard setters	IETF, W3C
5 Associations	Catena-X Automotive Network, Global Battery Alliance, gaia-x

Evaluation criteria

- ☑ Cross-sector suitability
- ☑ Open, non-proprietary and independent of specific technical implementation
- ☑ Co-existence of standards
- ☑ Consideration of requirements of all stakeholders

→ **Existing mature international standards**
→ **New and innovative approaches**

... according to the standardisation request

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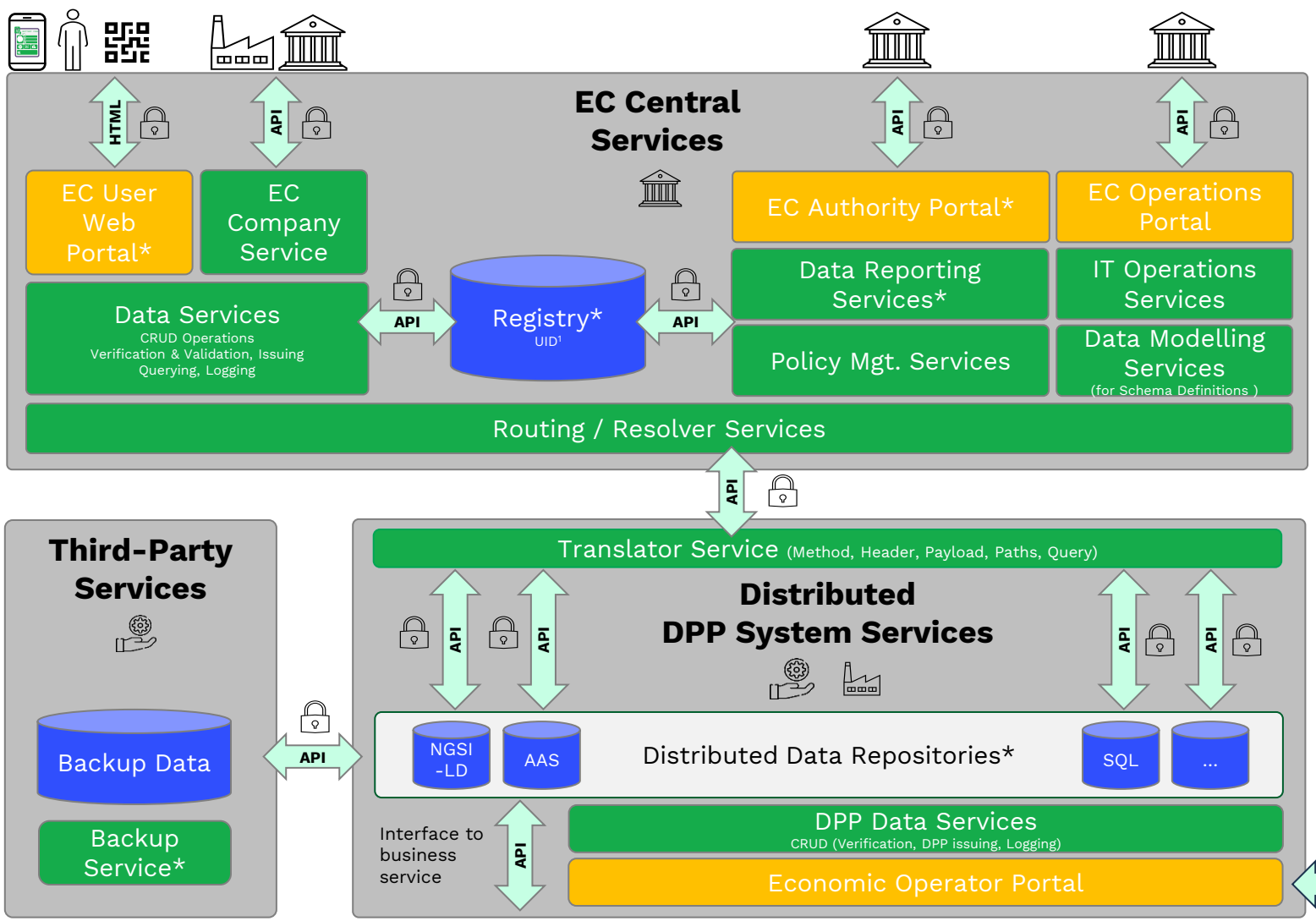
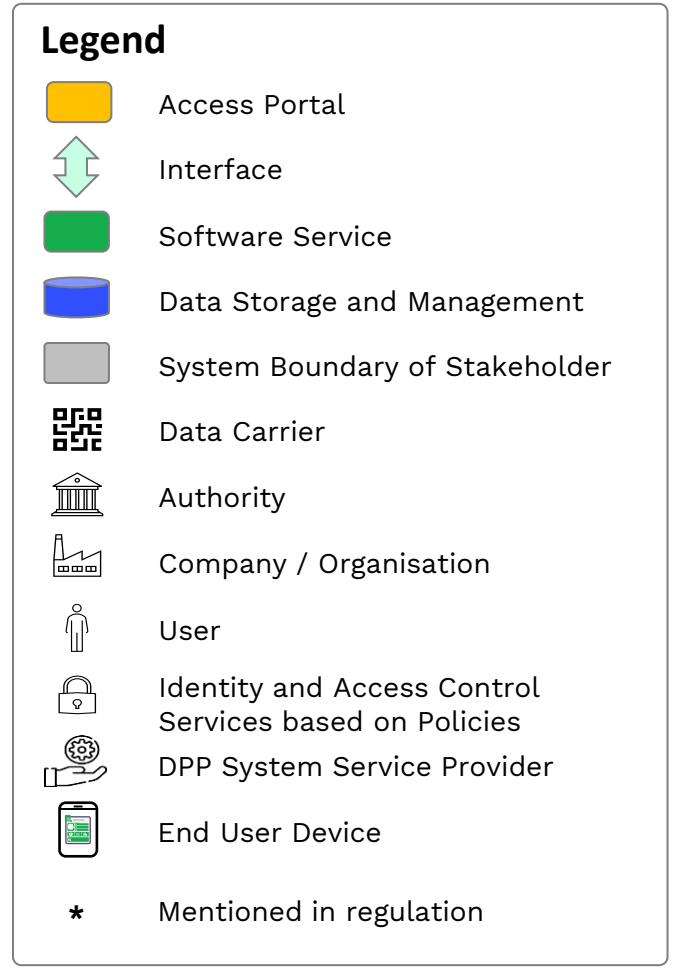
A variety of building blocks beyond the regulation are needed for an operational system





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A variety of interoperability challenges need to be solved

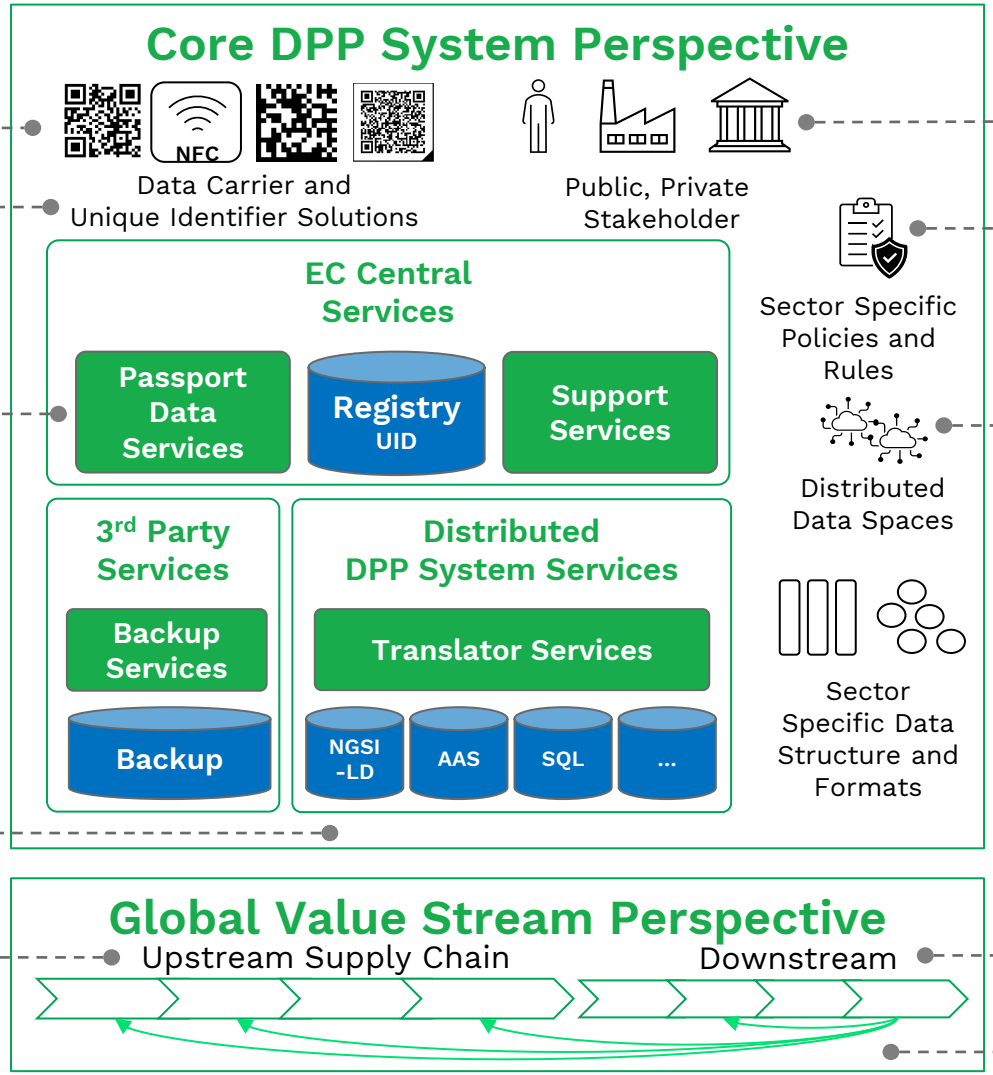
Application of different Data Carriers

Allow different principles of Unique Identifiers

Routing to different distributed DPP Systems

Application of different data management technologies

Secure and reliable supply chain data acquisition and exchange



Seamless and secure provision of access to different stakeholder groups with sector specific policies and rules

Cross-domain interoperability across different data spaces

Realise connectivity to products for dynamic data acquisition in use and r-phases

How to align with global DPP initiatives (sector, country)

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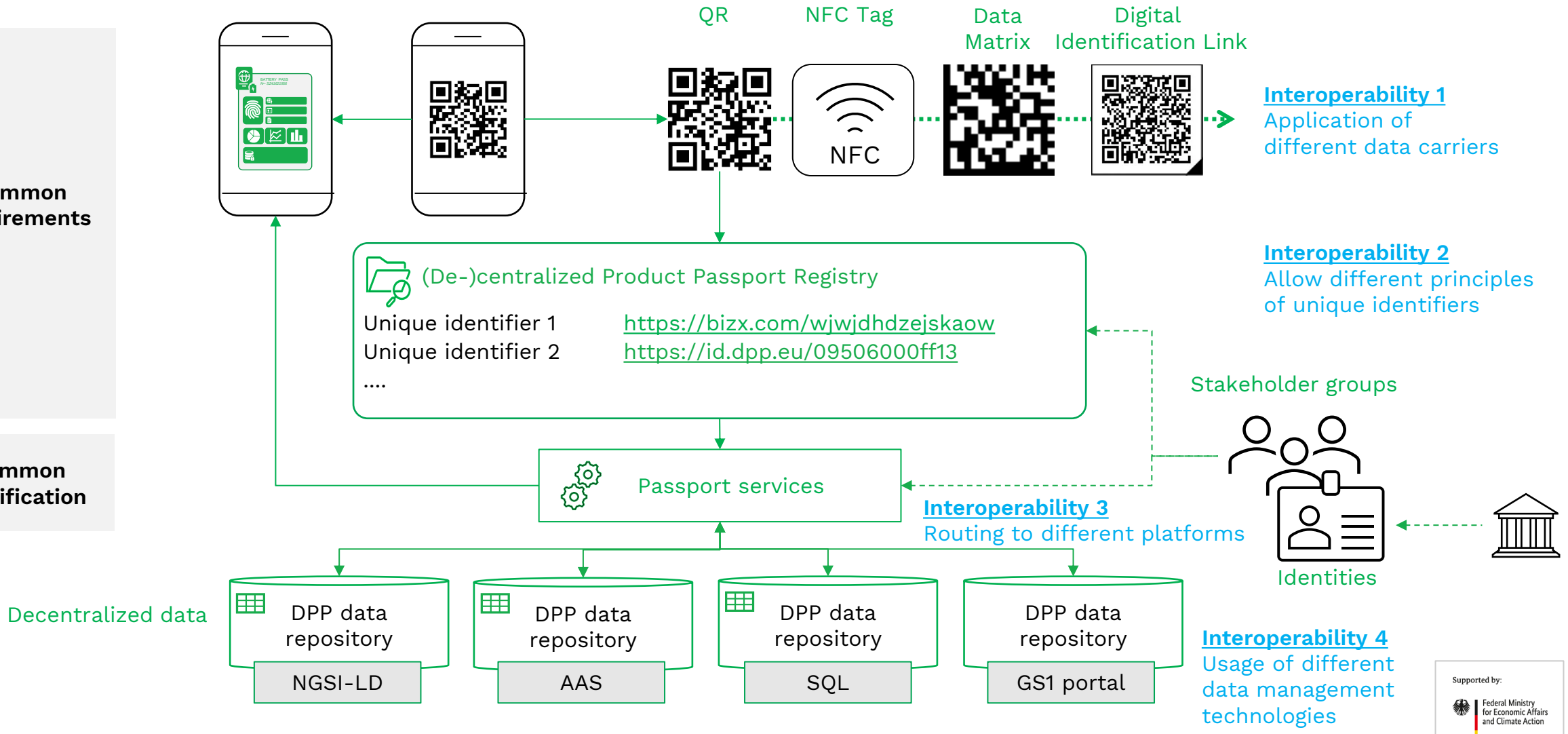
The interoperability requirements are numerous – a selection

Common requirements

Common specification



Interoperability 1
Application of different data carriers

Interoperability 2
Allow different principles of unique identifiers

Interoperability 3
Routing to different platforms

Interoperability 4
Usage of different data management technologies

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Why common data models are important for interoperability

Technical Standard Stack

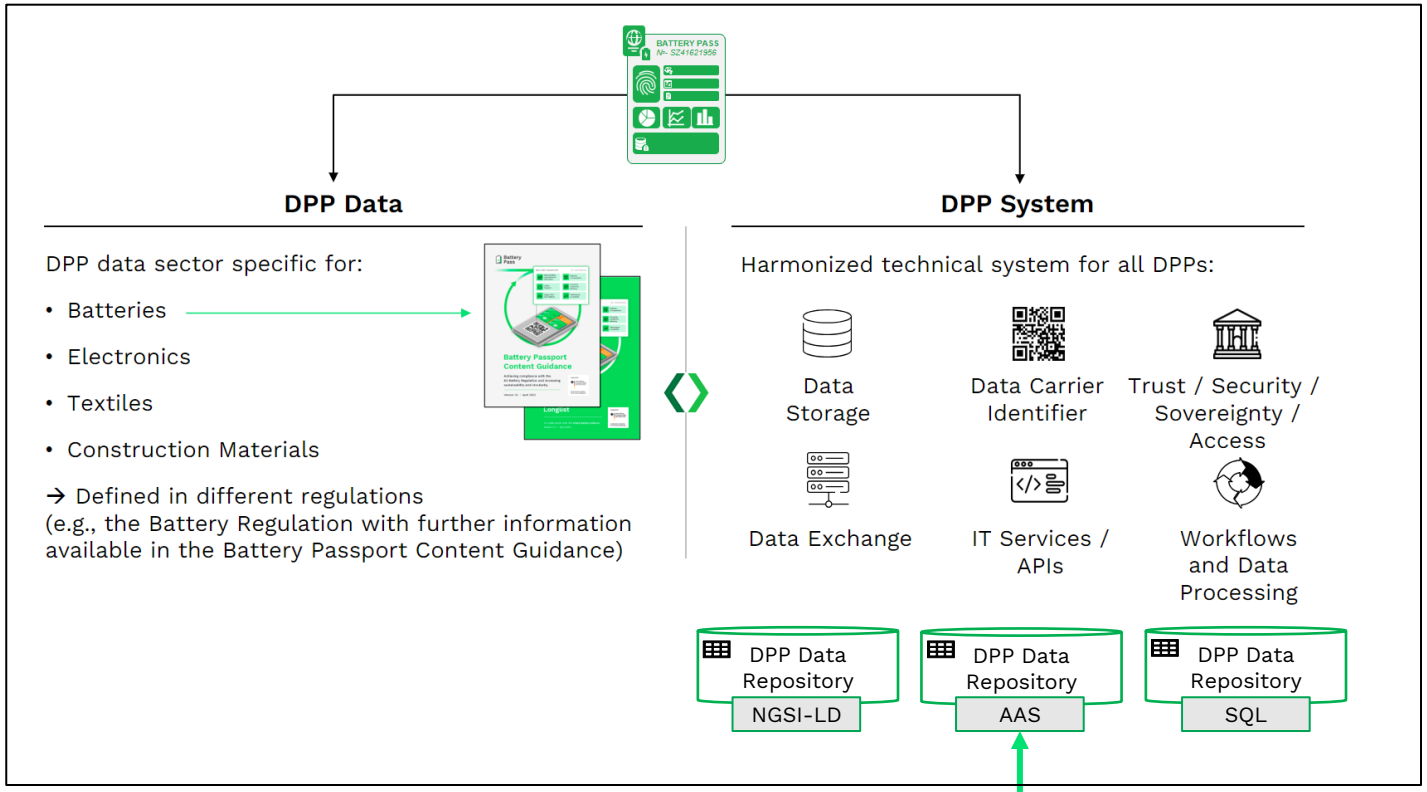
- Data models
- Data distribution / exchange and data provision/ integration
- Protocols / data formats

Regulatory requirements

The product passports should be as uniform as possible across products, industry sectors and relevant EU legislations (standardisation request based on ESPR)

One DPP system applicable for different product sectors in the future

Seamless data exchange between product sector specific DPP



(Semi-) Automatic sector specific data mapping of DPP system

(Re-) Use existing implementation standards and solutions

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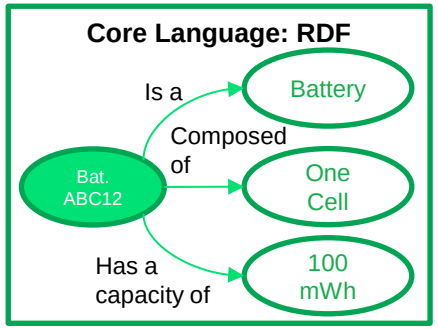
Data points are mapped into interoperable semantic models based on RDF

Standardised common meta model based on RDF, defining core data model elements (e.g., entities, properties, data types, physical units, etc.)



Product-agnostic semantic data models to compose the battery passport data model

- General product information
- Compliance, labels and certifications
- Materials and composition
- Carbon footprint
- Performance and durability
- Circularity and resource efficiency
- Supply chain due diligence

- Extensibility for individual data and updated legislative requirements
- Technology agnostic application in other sectors

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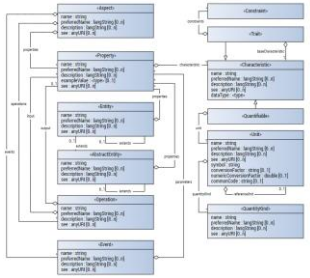
How DPP Data is represented and transformed in a DPP System

Meta Model

Core Data Model



Standardised common meta model based on RDF

Semantic Data Model

Platform Independent Model

```
:batteryCarbonFootprint a samm:Property ;
   samm:description "The carbon footprint of the battery, calculated as kg of carbon dioxide equivalent per one
   samm:characteristic :BatteryCarbonFootprint .

:carbonFootprintPerLifecycleStage a samm:Property ;
   samm:description "The carbon footprint of the battery as share of total Battery Carbon Footprint, differenti
   samm:characteristic :CarbonFootprints .

:carbonFootprintPerformanceClass a samm:Property ;
   samm:description "The carbon footprint performance class that the relevant battery model per manufacturing p
   samm:characteristic :CarbonFootprintPerformanceClass .

:carbonFootprintStudy a samm:Property ;
   samm:description "A web link to get access to a public version of the study supporting the carbon footprint
   samm:characteristic samm-c:ResourcePath .

:BatteryCarbonFootprint a samm-c:Measurement ;
   samm:description "The battery carbon footprint is an aggregation of the carbon footprint of the individual l
   samm:dataType xsd:double ;
   samm-c:unit :kilogramperkilowatthour .
```

PCF Model (RDF) CO_2

Platform Specific Model

```
{
  "$schema": "http://json-schema.org/draft-04/schema",
  "type": "object",
  "components": {
    "schemas": {
      "urn_samm_BatteryPass_1.0.0_BatteryCarbonFootprint": {
        "type": "number",
        "description": "The battery carbon footprint is an aggregation of the carbon footprint of the individual lifecycl
      },
      "urn_samm_BatteryPass_1.0.0_LifecycleStage": {
        "type": "string",
        "enum": [
          "RawMaterialExtraction",
          "MainProduction",
          "Distribution",
          "Recycling"
        ]
      },
      "urn_samm_BatteryPass_1.0.0_CarbonFootprintValue": {
        "type": "number"
      },
      "urn_samm_BatteryPass_1.0.0_CarbonFootprintPerLifecycleStageEntity": {
        "description": "The carbon footprint of the battery as share of total Battery Carbon Footprint, differentiated pe
        "type": "object",
        "properties": {
          "lifecycleStage": {
            "description": "The description of the life cycle stage ",
            "$ref": "#/components/schemas/urn_samm_BatteryPass_1.0.0_LifecycleStage"
```

PCF Model (JSON-Schema) CO_2

Data

Application Data

```
{
  "carbonFootprintperLifecycleStage": [
    {
      "lifeCycleStage": "RawMaterialExtraction",
      "carbonFootprintPerLifecycleStage": 45
    },
    {
      "lifeCycleStage": "MainProduction",
      "carbonFootprintPerLifecycleStage": 15
    },
    {
      "lifeCycleStage": "Distribution",
      "carbonFootprintPerLifecycleStage": 5
    },
    {
      "lifeCycleStage": "Recycling",
      "carbonFootprintPerLifecycleStage": 5
    }
  ],
  "carbonFoortPrintStudy": "https://car.oem.com/carbonFoortPrintStudy",
  "batteryCarbonFootprint": 70,
  "carbonFootPrintPerFormanceClass": "classA"
}
```

JSON, JSON-LD CO_2

Technology Independent Machine Readable	Technology Dependent e.g., AAS, NGSI-LD	System Dependent but accessible by Standards

(Semi) – Automatic Transformation

- **Description without implementation technology dependency**
- **Open technology progress at implementation level**
- **Less time and effort for data updates**

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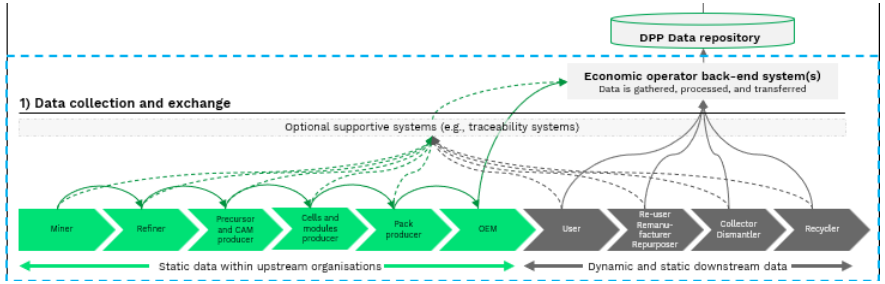
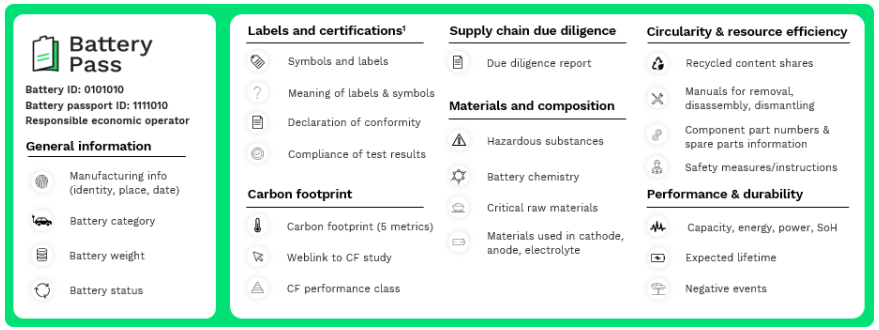
The Battery Pass Demonstrator

Pilot implementation of a mean viable Battery Passport System

Covered user stories / functions in the Battery Passport Demonstrator

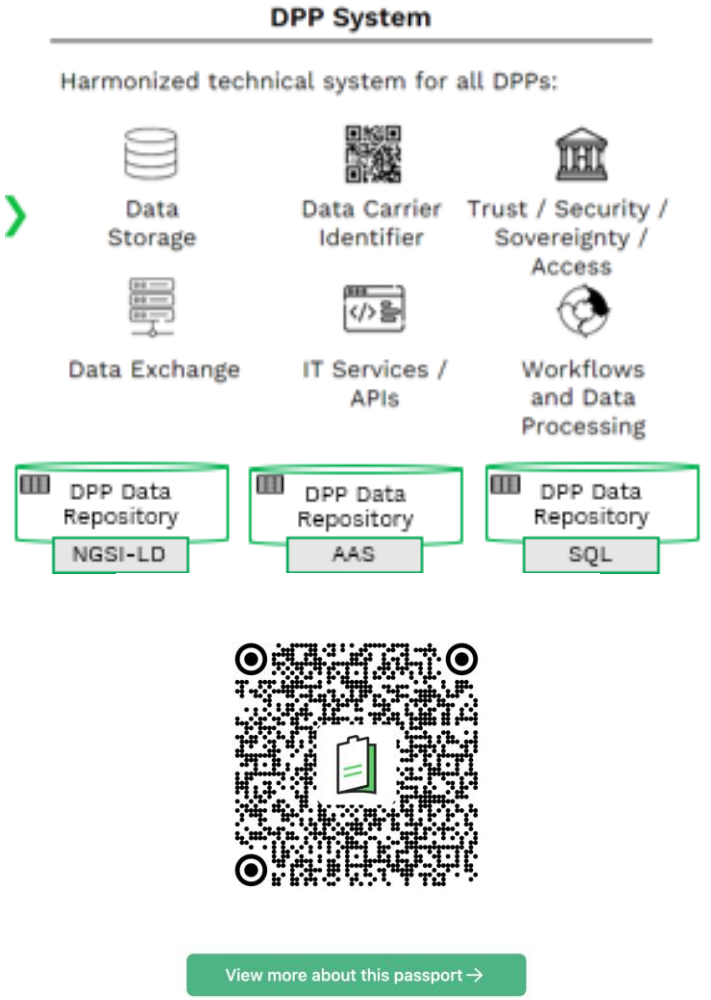
- Collect and process data for the Battery Passport from economic operator back-end systems
  - Collect data from backend systems
  - Map data to common battery pass data model
  - Manage Battery Passport in Economic Operator local Battery Passport Data Repository
- Issue a Battery Passport
  - Create unique Battery Pass Identification based on URN notation scheme, which allows multiple identification standard adoption e.g. DID



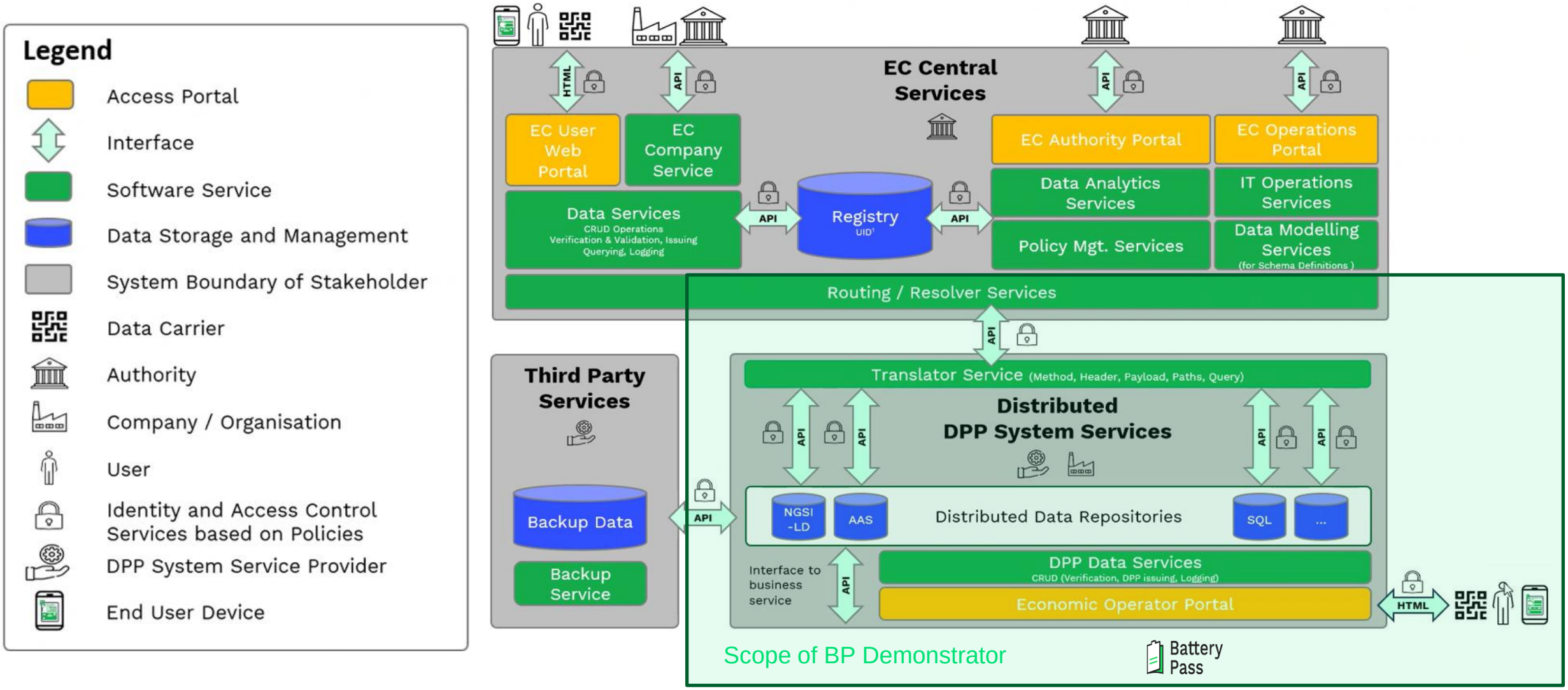


Covered user stories / functions in the Battery Passport Demonstrator

- Distributed management of Battery Passport data at each Economic Operator
  - Common access to Battery Pass through Battery Passport IDs via resolver mechanism in central registry
  - Verify different data representation based on common semantic model (NoSQL, NGSI-LD, AAS) for verification of technology-open implementation approach
- Accessing and viewing of Battery Passport
  - Scan QR Code or enter Battery Passport ID
  - Access to public/restricted Battery Passport Data without/with authorisation

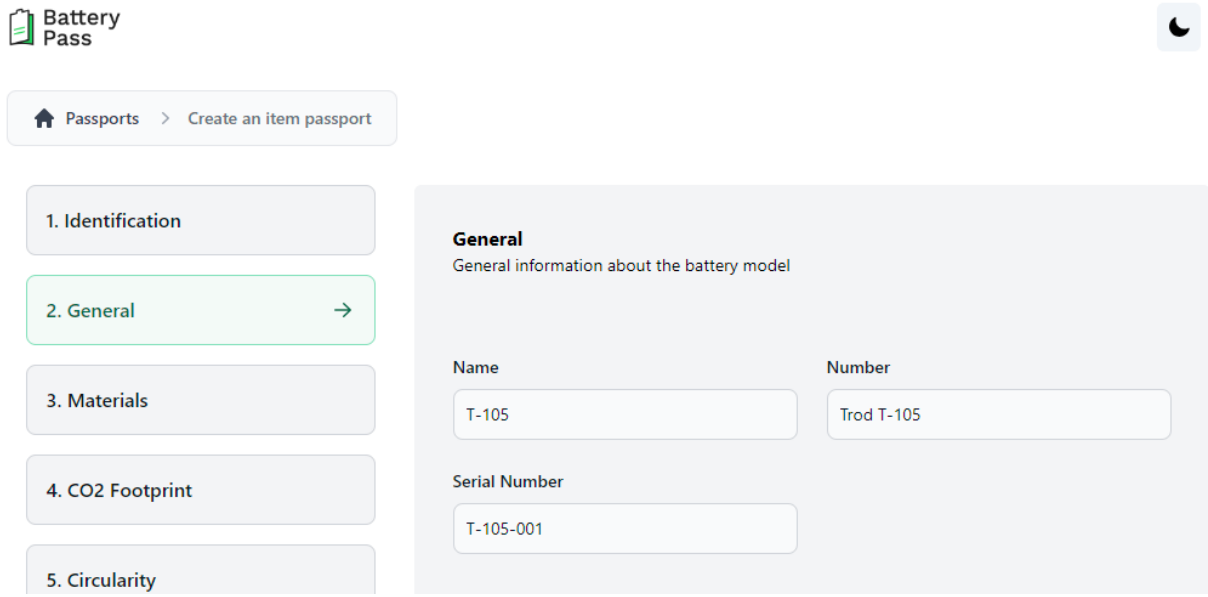


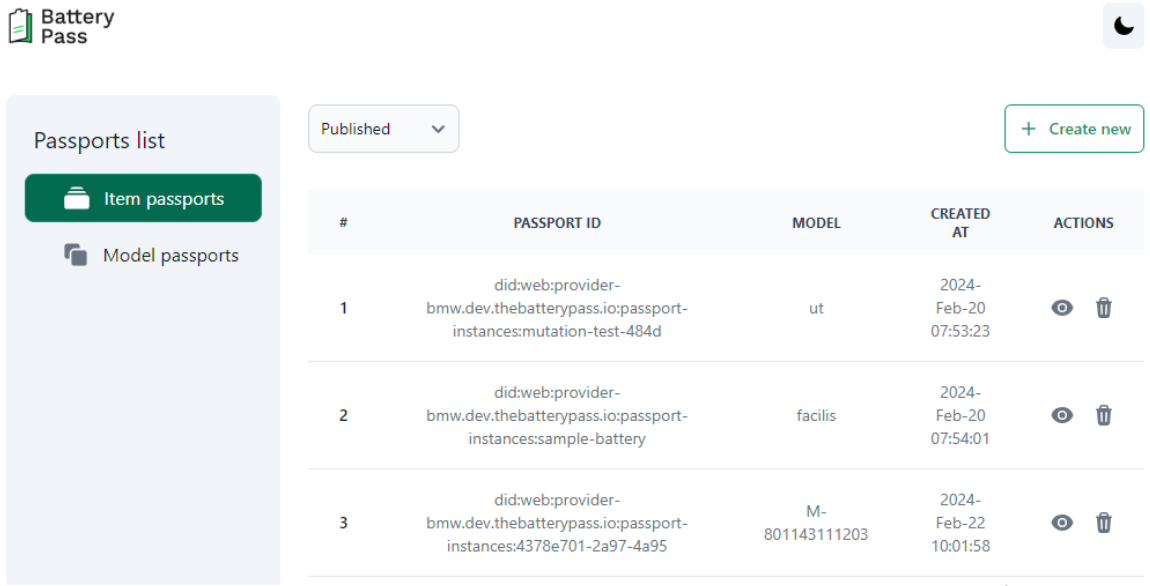
Scope of BP Demonstrator in DPP-System Architecture



Battery Pass Demonstrator Implementation

- Minimum viable Battery Passport System
  - Cloud-based infrastructure for distributed management
    - Currently Multiple instances of Battery Passport Data Repository (BPDR) have been setup to mimic a Battery Ecosystem with multiple Economic Operators
    - Economic operator portal with a dedicated URL for each EO
    - Access protected with additional authorization
    - Common API providing CRUD operations on BPDR
- Battery Passport Manager
  - Management tool for managing a local Battery Passports in Data Repository
    - Collect data from external source or from existing model passport
    - Store Battery Passport in EO specific BPDR
    - Publish Battery Passport via central registry

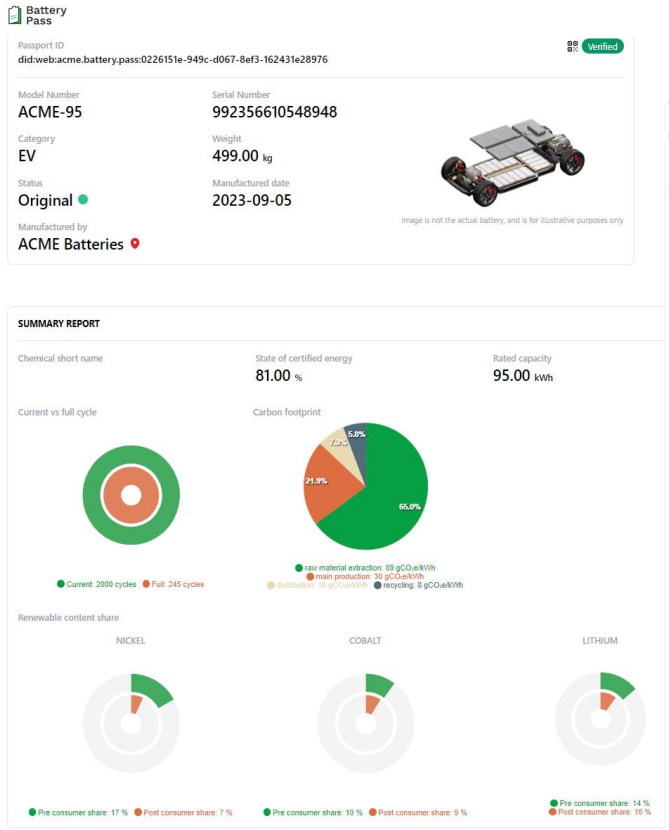


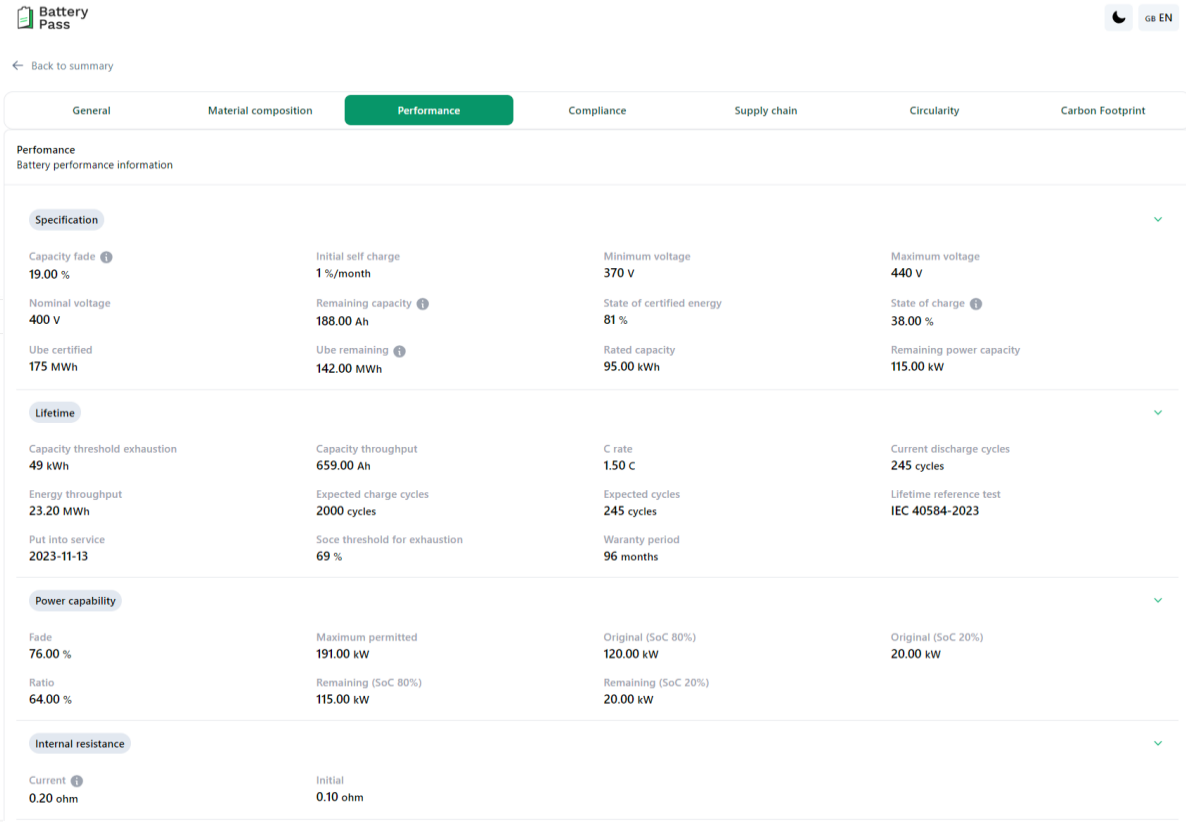


Battery Pass Demonstrator Implementation

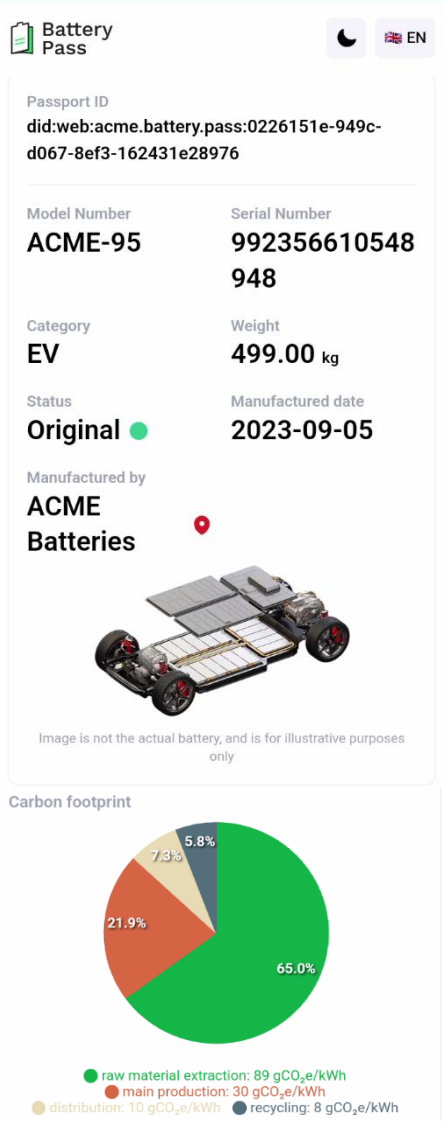
- Get Access with QR-Code or Battery Passport ID
- Landing page with most important data points, structured navigation through individual content clusters
- Dynamic UI for automatic adoption to mobile devices
- Multi-lingual and graphical representation of data points

QR-Code to Demo Battery Pass





Browser View



Mobile Device View

If you would like to learn more about the “Battery Pass”...

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Thank you

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Authors:

Niko D'Agostino, Circulor GmbH
Coenraad van Deventer, Circulor GmbH
Gernot Böge, FIWARE Foundation e.V.
Jason Fox, FIWARE Foundation e.V.
Patrick Gering, Fraunhofer IPK
Sven Jantzen Umicore AG & Co KG
Thomas Knothe, Fraunhofer IPK
Andreas Schlender, Circulor GmbH
Johannes Simböck acatech