Conformity Assessment for Battery Passport Data – Principles and Options

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The Battery Pass consortium

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Co-funded by the German Federal Ministry for Economic Affairs and Climate Action (BMWK), the Battery Pass consortium project aims to advance the implementation of the battery passport based on requirements of the EU Battery Regulation and beyond. Led by system change company Systemiq GmbH, the consortium comprises eleven partners and a broad network of associated and supporting organisations to draft content and technical standards for a digital battery passport, demonstrate them in a pilot application and assess its potential value.

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Table of contents

List of abbreviations

Abbreviation	Definition
BMS	Battery Management System
EV	Electric vehicle
GBA	Global Battery Alliance
JRC	Joint research centre
LMT	Light means of transportation
NLF	New legislative framework

List of figures

List of tables

Terminology

This document uses different terms to differentiate between regulatory requirements, recommendations, and permissible or allowable options:

Table 1: Terminology

Term	Expressed intention
Shall (not)	Requirement as per the Battery Regulation or other relevant legislation
Should (not)	Recommendation made by the Battery Pass consortium
May (not)	Option that is permissible
Mandatory	Requirement as per EU Battery Regulation or other relevant legislation (see “shall”)
Voluntary	Recommendation made by the Battery Pass consortium (see “should”)

1 Introduction to trustworthy battery passports

The EU Battery Regulation mandates that batteries in light means of transport (LMT), industrial batteries with a capacity above 2 kWh, and electric vehicle (EV) batteries placed or put into service on the EU market, must be accompanied by a battery passport from February 2027 onwards. The primary goal of this regulation is to support a circular economy, by storage and exchange of data along the battery life. To have an impact on the sustainability of batteries, it is crucial that the data stored in the battery passport is **trustworthy**.

On the one hand there is a **technical aspect** to this trustworthiness. The correct entity should write the data at the correct time into the battery passport. The technical system should also ensure that data is not tampered with. Details with regard to this can be found in the technical guidance already published by the consortium.

On the other hand, to be trustworthy, data stored in the battery passport needs to be **correct**. Regulation formulates this as well as information needs to be "accurate, complete and up to date" (Article 77, 4). To show data is accurate or correct, it first needs to be specified what the requirement is, e.g. how the value or the claim can be determined, for a specific attribute. Everything within a predefined margin of the expected real value or fulfilling the requirements of the claim can then be defined as correct. To create trust some kind of assurance or proof of this correctness is beneficial. Here is where conformity assessment comes into play. Additionally, the completeness of data will be checked by the technical battery passport system (see technical guidance chapter 3.3.2 for more details). The up-to-dateness is mainly relevant for the use phase of the battery and discussed in chapter 5.3 in more detail.

This document lays out requirements and principles of the topic of data trustworthiness created by conformity assessments and presents potential options for implementation by economic operators.

There are several naming conventions around the topic. We refer to the established standards around conformity assessment of the ISO 17000 series. According to DIN EN ISO/IEC 17000 conformity assessment is defined as "demonstration that specified requirements [...] are fulfilled". Regulation prescribes one specific form of conformity assessment (Article 17) when a battery is placed on the market, which depending on the modules is covering design and production. In the following this is referred to as **EU conformity assessment**.

Besides this specifically defined form of conformity assessment there are **other forms** of conformity assessment, e.g. testing, inspection or audit (DIN EN ISO/IEC 17000). Regulation prescribes a further form of conformity assessment. According to Article 51, due diligence needs to undergo third-party verification, which can be seen as a form of conformity assessment as well.

Here regulation differentiates based on who conducts the conformity assessment. This can also be found in DIN EN ISO/IEC 17000, which differentiates between **first-, second-, and third-party** conformity assessment. Additionally, the standard introduces verification and validation, where validation can be used to confirm claims on future use while verification is to be used for claims where the result is already obtained.

We extend the scope beyond the “core” battery passport system of data exchange of economic operator and central services, like registry and web portal (see Figure 1), and also include considerations necessary which are not directly part of the battery passport system, e.g. how data is collected by the economic operator. It is important to note that there are assessments in place due to legal provision and those being in place due to e.g. requirements by market participants. We intend to show both possible options of conformity assessment and their accompanying considerations to ensure data in the battery passport is trustworthy. The EU conformity assessment and respective processes remain as such and form the basis for any additional considerations, which, from our point of view could be helpful to ensure trust in battery passport data.

Based on the previously published content guidance, chapter 2 summarizes the characteristics of the data to be assessed. Chapter 3 outlines the regulatory requirements. Using these two chapters as a foundation, chapter 4 introduces the building blocks for conformity assessment options. Finally, chapter 5 discusses these options in light of practical considerations.

2 Requirements based on the characteristics of data

The content guidance published by the consortium elaborates data attributes to be included in the battery passport, and the technical guidance describes the technical battery passport system. Possible mechanisms of ensuring trust depend on the data attributes, the technical system behind and their respective characteristics. These characteristics as well as the consequences for conformity assessment procedures are to be discussed in the following. We refer to categories (e.g. performance and durability) and classifications (e.g. dynamic and static) already established in the content guidance; see there (chapter 5.1.1) for further explanations.

From a company perspective, it is imperative that any assessment ensures security and confidentiality. Furthermore, it is essential that the implementation reduces additional burdens, e.g. financial efforts, of participants. Additionally, the assessment system should be built to be highly adaptable, allowing for swift adjustments and modifications to keep pace with the rapidly evolving market dynamics and legislative requirements.

2.1 Value stream data and accountability

Data attributes such as carbon footprint, recycled content or information needed for supply chain due diligence need to be collected along the value stream (see Figure 1). This data is then processed, e.g. by performing additional calculations. The manufacturer, who is responsible to issue the battery passport, writes the data attributes to the battery passport as static attributes. These data attributes thus include information of other value steam partners which are passed along the value stream as well as data collected or created by the economic operator itself. This results in different accountability over the collected data, while the responsibility for the battery passport solely remains with the economic operator. An economic operator may want to ensure the accuracy of data received from value stream partners.

Towards the end of the battery's (first) life, additional actors come into play, as the battery may be subject to repair, remanufacturing, or repurposing. This again results in different accountability over the data.

Any conformity assessment must consider that the value stream involves many different actors. It needs to recognize that data collection across all actors might not always be feasible. Additionally, it should take into account that the value stream is highly interconnected and, although depicted as a stream, it more accurately resembles a network of various suppliers and sub-suppliers who provide parts to create the final product.

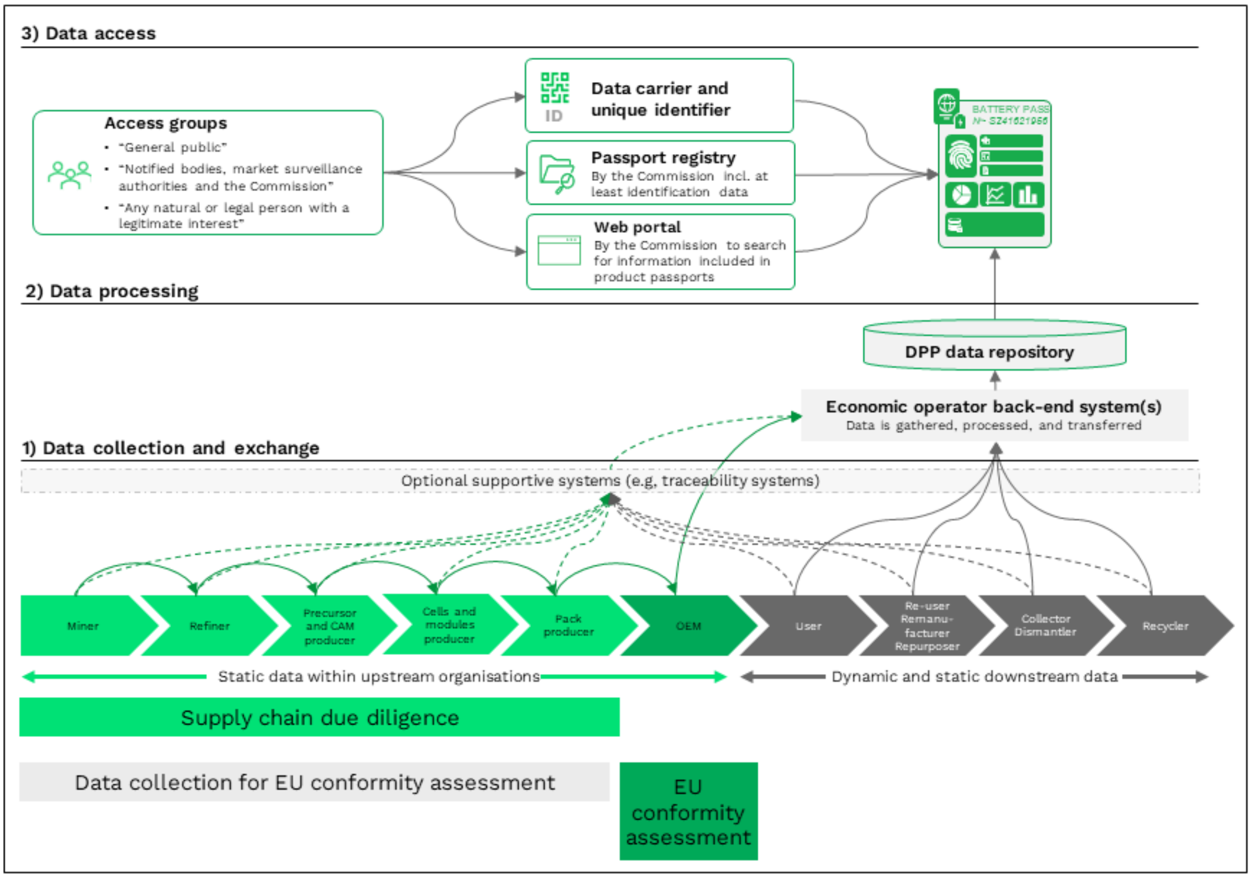

Figure 1: The EV battery value stream (Assumption in this figure: OEM is the battery manufacturer)

2.2 Dynamic data collection during the use phase

Data attributes in the category performance and durability of the content guidance, e.g. remaining capacity, can only be collected once the battery is used. Data attributes like this, which are collected along the battery life, constitute dynamic data which needs to be updated continuously during the life cycle. This raises questions such as how often these attributes need to be updated and how this can be technically achieved. Additionally, it presents challenges for conformity assessment of that data. For example, is a conformity assessment conducted every time the data is updated and who is responsible for that?

The EU conformity assessment is conducted only once, when the battery is placed on the market. If a notified body is involved in the conformity assessment, the certificate is valid for a certain period and surveillance by the notified body is required at least once a year. However, from our point of view current EU conformity assessment procedures do not sufficiently account for dynamic data generated during the use phase.

Therefore, conformity assessment activities need to account for dynamic data that is collected only during the use phase. This data is specific for a single battery rather than a batch or type of batteries. The possibilities for generating and transferring data greatly depend on the battery type; for instance, EV batteries are often “online” via the car’s system, whereas this may not be the case for LMT batteries. Conformity assessment needs to take this into account.

2.3 Criticality of data based on intended use

The data attributes can be used for various purposes. This in turn has an influence on how critical the correctness of some data attributes may be evaluated. As a non-exhaustive example from the consortium perspective: Information on performance and durability data are of high relevance whenever batteries are traded or decisions on repair, refurbishing or remanufacturing are made by partners in the value stream. In light of the target of the Battery Regulation to spur a circular economy, one could argue that this information is more critical compared to other data attributes, e.g. battery category.

Conformity assessment should account for this and might use different trust levels for different attributes or groups of attributes.

3 Regulatory framework

The Battery Regulation employs the **new legislative framework** (NLF) established by regulation (EC) 765/2008, decision 768/2008 and regulation (EU) 2019/1020. The NLF strengthens the market surveillance and implements rules to protect market participants from unsafe products. It introduces transparent guidelines for accreditation of conformity assessment bodies and enhances the reliability of EU conformity assessments. Additionally, it clarifies the significance of CE marking and increases its reliability, and creates a common legal framework for industrial products.

However, the battery passport is the **first digital tool** that contains supply chain data as well as data from the entire life cycle of the battery. Consequently, several significant challenges need to be overcome. This chapter discusses the relevant requirements as formulated by regulation. As mentioned in the introduction, while we expand on these requirements later on, they remain unchanged as legislative mandates for all participants.

Market surveillance is defined by regulation (EU) 2019/1020 as “the activities carried out and measures taken by market surveillance authorities to ensure that products comply with the requirements set out in the applicable Union harmonisation legislation and to ensure protection of the public interest covered by that legislation”. Recital 123 of the Battery Regulation specifies further that the battery passport should support “market surveillance authorities in carrying out their tasks under this Regulation, but it should not replace or modify the responsibilities of market surveillance authorities, which should, in line with Regulation (EU) 2019/1020, check the information provided in battery passports.” Chapter X of the regulation defines market surveillance procedures. While the procedures aim to protect participants, it is still the sole responsibility of the manufacturer to ensure conformity of its batteries, which also includes its monitoring of the market.

EU conformity assessment will be required for all batteries placed on the market. Depending on the type of the battery and whether it is manufactured in series or not, the manufacturer has to apply the relevant EU conformity assessment procedures laid out in the different modules (see Figure 2). Module D1 or G as described in Annex VIII of the Battery Regulation must be used to process the requirements outlined in Article 7 and 8, which pertain to carbon footprint and recycled content. These two modules necessitate the involvement of a notified body. For requirements laid out in Article 6, 9, 10, 12, 13 and 14 the manufacturer can also choose to use Module A which does not directly involve a notified body. Module A is also prescribed for these articles for batteries that are “subject to preparation for re-use, preparation for repurposing, repurposing or remanufacturing” (Article 17, 3). These different conformity assessment procedures are due to the different risk and safety level (recital 52).

Additionally, within chapter VII, there are requirements related to **due diligence**, which form a different type of conformity assessment and is necessary alongside the EU conformity assessment shown in Figure 2. However, certain products are exempted from undergoing due diligence (a more detailed discussion can be found in the content guidance chapter 6.4).

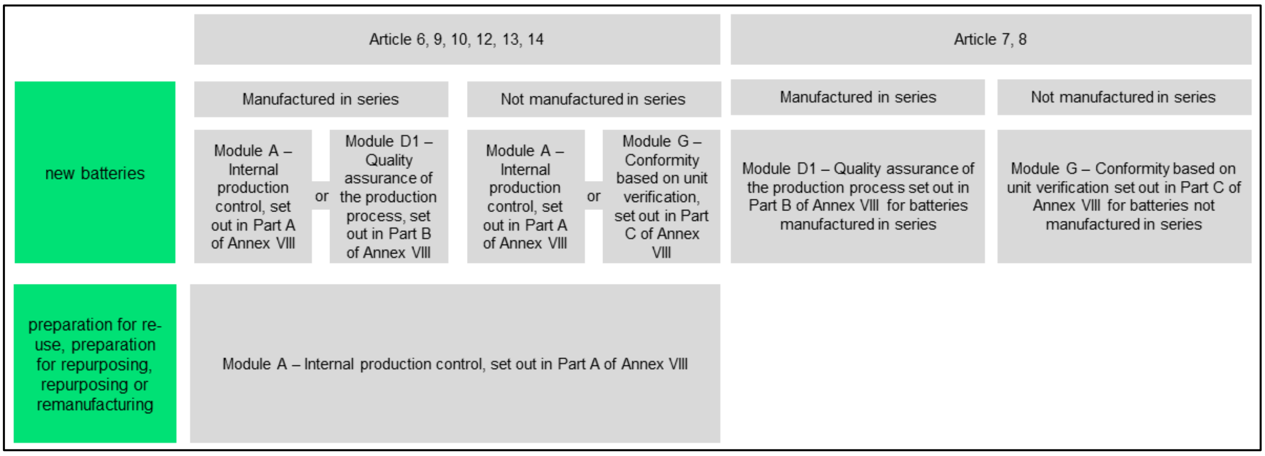

Figure 2: Modules for EU conformity assessment according to Article 17

The content of the articles is as follows:

- Article 6: Restriction on substances
- Article 7: Carbon footprint
- Article 8: Recycled content
- Article 9: Performance and durability requirements for portable batteries of general use
- Article 10: Performance and durability requirements for industrial, LMT and EV batteries
- Article 12: Safety of stationary battery energy storage system
- Article 13: Labelling and marking of batteries
- Article 14: Information on the state of health and expected lifetime of batteries.

Article 17 prescribes an EU conformity assessment for these articles directly. Neither in Article 17 nor in Article 77 where the battery passport is introduced there is a mention that EU conformity assessment explicitly includes the assessment of the battery passport itself.

However, with the EU declaration of conformity, the manufacturer states the compliance with the requirements of the EU Battery Regulation (Article 18).

The **ESPR** specifies that the product passport shall "facilitate the verification of product compliance by competent national authorities;" (ESPR Article 9, (3b)). The product passport registry shall "allow for the verification of authenticity of the product passport" (ESPR Article 13 (2a)). Processes according to delegated acts (ESPR recital 78, 82) or reference to standards (ESPR recital 80) may be required in the future to verify such compliance. Furthermore, the "Commission shall identify appropriate means of verification for specific ecodesign requirements, including direct checks of the product or on the basis of the technical documentation" (ESPR Article 5 (12)). However, it is already further defined that supply chain actors need to support the verification of ecodesign requirements either by supplying information, allowing assessment through the manufacturer or enable verification by notified bodies and competent national authorities (ESPR Article 38). The ESPR also includes custom authorities to check whether a product passport exists as well as consistency of digitally stored data and customs declaration (ESPR Article 15).

Besides Battery Regulation and ESPR there is also a proposal for a **new green claim directive**. While we acknowledge that the goal is a different one we still see parallels as it prescribes that environmental claims need to be backed and substantiated. Potentially the carbon footprint and the recycled content could qualify as such environmental claims. This would result in the need for a verification of these attributes. The Commission should clarify whether an EU conformity assessment by a notified body already suffices as such a verification when progressing with the proposal.

4 Conformity assessment building blocks

The legislative requirements form the minimal requirements to ensure trust in data contained in the battery passport. However, other building blocks can support this trustworthiness. The foundation is rooted in a set of principles that govern all activities. Furthermore, the building blocks can be divided into three distinct levels: entity, scope, and method. Each of these levels will now be described in detail.

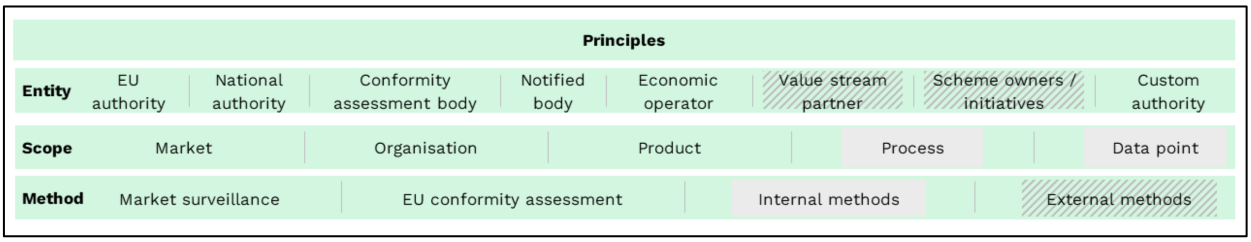

Figure 3: Building blocks to ensure trust (grey = additions of consortium, striped = only partially included in legislation)

4.1 Principles

All measures conducted to ensure the correctness should follow the basic principles. These principles are derived from requirements formulated for notified bodies in the Battery Regulation (Article 25), DIN EN ISO/IEC 17000 series, DIN EN ISO 19011 as well as guidelines for financial audits:

- Independence
- Impartiality
- Integrity
- Fair presentation
- Due professional care
- Confidentiality
- Evidence-based approach
- Competence
- Transparency on processes
- Risk-based approach.

Within financial auditing and the auditing of ESG criteria, principles of reasonable and limited assurance are used. While both follow the same methods, limited assurance is not as comprehensive and therefore the level of assurance is lower. Potentially similar assessments on battery passport data could use the same approach of different data levels.

4.2 Entity

Entity describes all actors that play a role within the assessment system. In implementing new rules and regulations, **EU authorities** play a crucial role at the European level. **National authorities** act at the Member State level and are defined as "an approval authority or any other authority involved in and responsible for market surveillance in a Member State in respect of batteries;" (Article 3, 62).

A "'**conformity assessment body**' means a body that performs conformity assessment activities including calibration, testing, certification and inspection;" (Article 3, 40).

A "'**notified body**' means a conformity assessment body that has been notified in accordance with Chapter V;" (Article 3, 41).

An **economic operator** is making a battery available or placing the battery on the market or putting it into service (Article 3, 22). For a detailed description on responsibilities of the economic operator see content guidance chapter 5.2.

As shown, the user is not involved, as they have no active tasks. However, the data of the use phase also needs to be checked. This is discussed in chapter 5.

Partners along the value stream, e.g. suppliers and waste operators, are summarised as **value stream partner**. Downstream suppliers might deliver data which is crucial to determine certain attributes in the value stream. The waste operator, which we also summarise in this category, has a crucial role as they ensure a battery passport will cease to exist and therefore ensure that it cannot be misused e.g. on other batteries. Entities performing re-use, repurposing or remanufacturing are not explicitly mentioned as when a battery is placed on the market again, a second conformity assessment needs to be carried out as the organisation is turning into an economic operator (Article 45).

The ESPR adds **custom authorities** as well, which will access the passport to verify if a product fulfills the requirements (recital 103, ESPR). However, from a viewpoint of the consortium this can only include a verification of formal requirements and not whether the claims and values are correct.

Regulation defines **scheme owners** as “governments, industry associations and groupings of interested organisations [sic] that have developed and oversee due diligence schemes” (Article 53, 1). We extend this to not only refer to due diligence schemes but potentially also other schemes or initiatives that organisations might use to show adherence to said schemes.

4.3 Scope

Conformity can be assessed on different objects (DIN EN ISO/IEC 17000). Similarly, we introduce the scope as the level at which an assessment is conducted. The broadest scope is at the **market level**, where national authorities are involved. At this level, assessments such as the recycling rate on a national scale can be understood. The next level pertains to assessments conducted at the **organisational level**, such as financial audits or audits of management systems. Following this is the **product level**, with the EU conformity assessment being one example. Additionally, assessments can be performed at the **process level**, examining specific operational procedures within organisations. The most granular level of scope concerns individual **data points**, involving the assessment of singular entries in the battery passport.

4.4 Method

Methods describe how to conduct an assessment. Based on definitions in DIN EN ISO/IEC 17000, a differentiation is made between internal methods (first-party, second-party) and external methods (third-party), depending on who conducts the assessment. Since market surveillance and EU conformity assessment are regulatory requirements and always take place, they are grouped separately. The methods are explained in more detail below.

4.4.1 EU conformity assessment and market surveillance

EU conformity assessment is carried out according to the procedures in Annex VIII, which are shown in Table 2. As it can be seen, it can either be conducted with or without a third-party involvement depending on the module. The manufacturer is responsible to conduct an EU conformity assessment when placing the battery on the market. There is on one side an "EU declaration of conformity", issued by the manufacturer, and, if a notified body is involved in the EU conformity assessment, then this notified body issues a certificate and / or a statement. The manufacturer attaches a CE marking, which serves to declare that all applicable legislative requirements are fulfilled. The EU declaration of conformity is to be included in the battery passport itself (see longlist of data attributes already published by consortium).

Table 2: Overview of requirements of the conformity assessment modules (according to Annex VIII)

	Module A	**Module D1**	**Module G**
Technical documentation	(a) a general description of the battery and its intended use;		
	(b) the conceptual design and manufacturing drawings and schemes of components, sub-assemblies and circuits;		
	(c) the descriptions and explanations necessary for the understanding of the drawings and schemes referred to in point (b) and the operation of the battery;		
	(d) a specimen of the label required in accordance with Article 13;		
	(e) a list of the harmonised standards referred to in Article 15, applied in full or in part, including an indication of which parts have been applied, a list of the common specifications referred to in Article 16, applied in full or in part, including an indication of which parts have been applied, and a list of other relevant technical specifications used for measurement or calculation purposes;	(e) a list of the harmonised standards referred to in Article 15, the common specifications referred to in Article 16, or of both, applied, and, in the event of partly applied harmonised standards, common specifications, or both, an indication of which parts have been applied;	(e) a list of the harmonised standards referred to in Article 15, the common specifications referred to in Article 16, or of both, applied, and, in the event of partly applied harmonised standards, common specifications, or both, an indication of which parts have been applied;
	(f) where the harmonised standards and the common specifications referred to in point (e) have not been applied or are not available, a description of the solutions adopted to meet the applicable requirements laid down in Articles 6, 9, 10, 12, 13 and 14 or to verify the compliance of batteries with those requirements;	(f) a list of other relevant technical specifications used for measurement or calculation purposes and descriptions of the solutions adopted to meet the applicable requirements laid down in Articles 6 to 10 and Articles 12, 13 and 14 or to verify the compliance of batteries with those requirements, where harmonised standards, common specifications, or both, have not been applied or are not available;	(f) a list of other relevant technical specifications used for measurement or calculation purposes and descriptions of the solutions adopted to meet the applicable requirements referred to in point 1 or to verify the conformity of batteries with those requirements, where harmonised standards, common specifications, or both, have not been applied or are not available;

	(g) the results of design calculations made and the examinations carried out, and the technical or documentary evidence used;		
	-	(h) a study supporting the carbon footprint values referred to in Article 7(1) and the carbon footprint class referred to in Article 7(2), containing the calculations made in accordance with the methodology set out in the delegated act adopted pursuant to Article 7(1), fourth subparagraph, point (a), and the evidence and information determining the input data for those calculations;	(h) a study supporting the carbon footprint values and class referred to in Article 7, containing the calculations made in accordance with the methodology set out in the delegated act adopted pursuant to Article 7(1), fourth subparagraph, point (a), and the evidence and information determining the input data for those calculations;
	-	(i) a study supporting the recycled content share referred to in Article 8, containing the calculations made in accordance with the methodology set out in the delegated act adopted pursuant to Article 8(1), second subparagraph, and the evidence and information determining the input data for those calculations;	(i) a study supporting the recycled content share referred to in Article 8, containing the calculations made in accordance with the methodology set out in the delegated act adopted pursuant to Article 8(1), second subparagraph, and the evidence and information determining the input data for those calculations;
	(h) the test reports.	(j) the test reports.	(j) the test reports.
Manufacturing	The manufacturer shall take all measures necessary so that the manufacturing process and the monitoring thereof ensure the batteries comply with the technical documentation referred to in point 2 and with the applicable	The manufacturer shall operate an approved quality system for production, final product inspection and testing of the batteries concerned as specified in point 5, and shall be subject to surveillance as specified in point 6.	The manufacturer shall take all measures necessary so that the manufacturing process and the monitoring thereof ensure that the manufactured battery is in conformity with the applicable requirements referred to in point 1.

	requirements referred to in point 1.		
Quality System*	-	Yes, assessed by notified body	-
Verification*	-	-	Yes, carried out by notified body

* Quality System and Verification are two additional conformity assessment procedures required as part of EU conformity assessment. Additional information and steps for these can be found in Annex VIII of the Battery Regulation.

Market surveillance will be conducted by the member states or their respective authorities. There will be checks conducted. The results will be communicated, however not in the battery passport, but rather by the respective authority.

The biggest advantage is that there is no additional effort. However, as it is based on the assumption of conformity, in the past there have been incidents where violations of conformity were discovered later on as part of surveillance activities. Additionally, the regulation currently only covers the placing on the market. The consequent updates during the use phase need to be clarified.

4.4.2 Internal methods

This group of methods involves any assessments of the data made by participants in the value stream (first- and second-party according to DIN EN ISO/IEC 17000). Generally, two sub-methods are possible: automated or manual assessments, conducted as either first-party or second-party assessments.

Inevitably there will be an exchange of data by value stream partners and between the economic operator and the central registry. These data streams could undergo an **automated assessment**. A simple example is checking the format and range of data points. Challenges arise as those rules need to be up to date and the technology is evolving fast. More sophisticated examples, already applied by track and trace providers, include using geographical data to confirm the origin of materials. Within automated assessment we differentiate between **singular data points** which only refer to one attribute from one organisation and **summarised data**, which refers to any calculation which was made on the basis of multiple data points. Both singular data points and summarised data, or a combination of both, can be evaluated. An example for a data point could be the carbon footprint of one organisation in the value stream, while an example for summarised data could be the same carbon footprint, but instead of one organisation it is already summarised across multiple organisations in the value stream. Furthermore, there is **aggregated data**, which refers to data aggregated across multiple battery passports. On the one hand this enables the assessment of market trends (see publication on value assessment for more details), which from our view is a benefit, but does not add to the trustworthiness of a single battery passport. However, if aggregated data is to be compared to the data of a single battery passport, a certain level of trust would be built as well, as it would generate a base for comparison, e.g. to detect outliers in a fleet of EVs. When assessing data, a differentiation between **primary and secondary** data should be made. Secondary data is generally seen as less accurate but can be used in an initial step if primary data is not yet available. Considerations regarding data quality should be made accordingly (see for example Catena-X Product Carbon Footprint Rulebook Version 2). The main advantage is, that automated methods present an efficient way for assessment. However, it is important that these not only rely on data but instead always assess whether the digital data is correct, in the sense of depicting the reality.

Additionally, the correctness of data can be checked through **manual first-party** and **second-party** assessments, e.g. in the form of internal or supplier audit. The advantage of these methods is that they are already widely implemented in many organisations and supplier-buyer relationships. But they are only ensuring one supplier-buyer relationship, therefore every buyer needs to conduct his own assessment resulting in higher efforts.

4.4.3 External methods

External methods are any **third-party** conformity assessments, which are carried out "by a person or organization [sic] that is independent of the provider of the object of conformity assessment [...] and has no user interest in the object" (DIN EN ISO/IEC 17000). One example where regulation demands this form of assessment is due diligence (Article 48). Others, not included in regulation, would be certifications according to standards like DIN/EN ISO 9001 or TISAX.

These assessments can be specifically carried out to prove correctness of data included in the battery passport. Often existing assessment results, like the above-mentioned ISO 9001, could also be used for some aspects. The process is conducted against well-defined standards. One advantage is that many companies already have established systems in place to facilitate these assessments. These can take the form of management systems or financial audits. Since these assessments are conducted by a third party, they are generally recognised and accepted by other parties in the market. This eliminates the need for multiple assessments and promotes efficiency in the process. To reduce the disadvantages of a high effort for these assessments, existing standards should be used and seen as equivalent to each other according to rules (to be defined). Potentially a third party could also automate those assessments as described in the previous section, which would also reduce effort needed, but at the same time might trigger new confidentiality considerations as data needs to be transferred to a third party.

5 Practical considerations

With the basic concept, principles and options introduced, this chapter discusses what needs to be considered when implementing the methods.

5.1 Evaluation of methods

Within the project we do not prescribe one method over the other, but rather conduct a comparison to help economic operators choose a suitable method for their needs. The evaluation is only qualitative and compares each method with the other ones in the same category (see Table 3). The categories are:

- Reliability: How trusted is the method considered?
- Cost: How much additional financial expense is needed for introducing and maintaining?
- Coverage/specificity: How specific is the method assessing the data attributes?

- Flexibility: How fast and how much effort is it to react to new circumstances, e.g. changes in the supply chain or changed requirements?
- Resource availability: Are standards defined, are there organisations to conduct the assessment, etc.?
- Automation capability: Is it possible to reduce manual efforts?

In general, when economic operators choose assessment mechanisms they should consider a risk-based approach for cost-efficiency and effectiveness reasons.

The highest level of **reliability** can be attained through an external assessment carried out by an independent organisation, e.g. a notified body, in the form of third-party conformity assessments. Internal methods are considered to be less reliable, as while the parties should be independent, they still have some form of interest in the object of conformity assessment. Among these, the greatest reliability can be achieved when the evaluation is automatically conducted based on defined rules using specific data points. However, this is only the case when mechanisms ensure that digital data and reality match up and are up to date. Reliability decreases further with second- and reaches a low point with manual first-party assessment.

A dedicated assessment proves a high reliability; however, it also comes with the highest **cost**. This is not the case for existing certificates as there is no additional cost. First- and second-party assessments are seen to have a similar cost effort necessary. Automated methods, while probably having a higher cost to implement, are seen as cost-effective once implemented and maintained continuously, and therefore have the best evaluation with regard to cost.

All methods show a high **coverage** of the assessed data. When using existing certificates there needs to be a definition of which existing certificate can be used to prove the correctness of which battery passport attribute. When aggregated or secondary data is used the coverage is seen as generally lower as the data is less specific.

Assessments based on data are characterised by a high level of **flexibility**, as the requirements against which the data is checked can easily be modified and any assessments conducted then use the new requirements. Additionally, changes in the value stream can be assessed quickly based on the data. Second-party assessments and dedicated assessments show the least flexibility as the assessments need to be manually carried out again and multiple parties are involved. Therefore, internal assessments albeit also manual are seen as more flexible. External assessments still offer a certain level of flexibility if they are based on existing certificates. Similarly, internal assessments are considered somewhat flexible, as fewer parties are involved.

Resource availability considers the availability of a defined standard for conducting the checks as it defines the requirement against which conformity is to be checked, as well as the resources such as notified bodies that perform these checks. As neither standards nor notified bodies have yet been defined for all aspects (see chapter 5.7), there is a shortage of resources. Furthermore, even after the standards are in place, it is likely to take some time for services of notified bodies according to these standards to become available in the market, which is why the availability is considered to be reduced compared to internal methods or automated methods where requirements need to be defined as well, but resources performing assessments are assumed to be available faster.

Automation capability is only present when tests are based on data, as all other forms rely mainly on manual assessment tasks.

Table 3 Evaluation of methods (● = excellent, ○ = poor)

Method		Reliability	Cost	Coverage / Specificity	Flexibility	Resource availability	Automation capability
internal	First-party assessment	◔	◔	●	◑	◕	○
internal	Second-party assessment	◑	◔	●	○	◕	○
internal / external	Single data point / Summarised data / Primary data	◕	●	●	●	◑	●
internal / external	Aggregated data / Secondary data	◕	●	◑	●	◑	●
external	Existing certificates based on third-party assessment	●	◔	●	◑	◑	○
external	Dedicated third-party assessment	●	○	●	○	◑	○

5.2 Options for assessments along the Value Stream

As battery passport data contains data along the whole value stream, several challenges with regard to conformity assessment exchange arise (UNECE 2023). Two challenges will be addressed as follows: How is data summarised across multiple partners in the value stream? How is conformity ensured without compromising confidentiality?

With regards to **summarising** we suggest following the principles of **chain of custody** for assessments. The chain of custody outlines how information about materials can be traced in supply chains and includes four models: identity preservation, mass balance, segregation, book and claim. These models describe the relationship between input and output of processes (EMF white paper on circular economy):

- Identity preservation: This model is applicable when individual components can be identified separately.
- Segregation: This model can be used if components cannot be individually identified but meet the same standards and material categories, and are kept physically separate.
- Mass balance: When materials cannot be stored or processed separately, this approach tracks the materials and allocates them to the finished goods.

- Book and claim: This model applies when there is no physical connection between the input and output.

If, for example, one value stream partner is providing 70% of the input and is using third-party assessments, and two are using first-party assessment, this should be communicated along the value stream conserving the balance of those assessments.

With regard to **confidentiality** aspects there are several general options possible. Four data exchange options along the value stream are shown in Figure 4 and explained below.

Option 1: One-Up-One-Down

Within this option the only exchange of information is within the two directly engaging participants of the supply chain. Therefore, the possibilities for any data checks along the supply chain are limited to the two engaging value stream partners as well. The next value stream partner needs to ensure that data collected from the previous partner is trustworthy. First- and second- as well as third-party assessments could be used. However, a challenge is to ensure the completeness of all assessments, as no value stream partner has a complete overview of the value stream.

Option 2: Back-end of economic operator

In this option the economic operator collects all necessary data and, in this context, also ensures the necessary assessments took place. All methods described in the previous chapter can be used. As the economic operator this way has an overview of the whole value stream the completeness can be ensured.

Option 3: Traceability app

Within a value stream a traceability app, also referred to as “track & trace”, could be used to track information along the supply chain, collecting data from each participant along the way. Within such a system, information of assessments conducted could also be exchanged, for example certification. This system could also enable the automatic check of data. As the traceability app has an overview of the whole value stream the completeness can be ensured.

Option 4: Blockchain

This option, often referred to in the context of digital product passports, employs a blockchain mechanism to build a consensus driven and tamper-proof chain of assessments along the value stream. The results of the checks conducted could be stored in the ledger and the completeness can be checked as all aspects are stored in the chain.

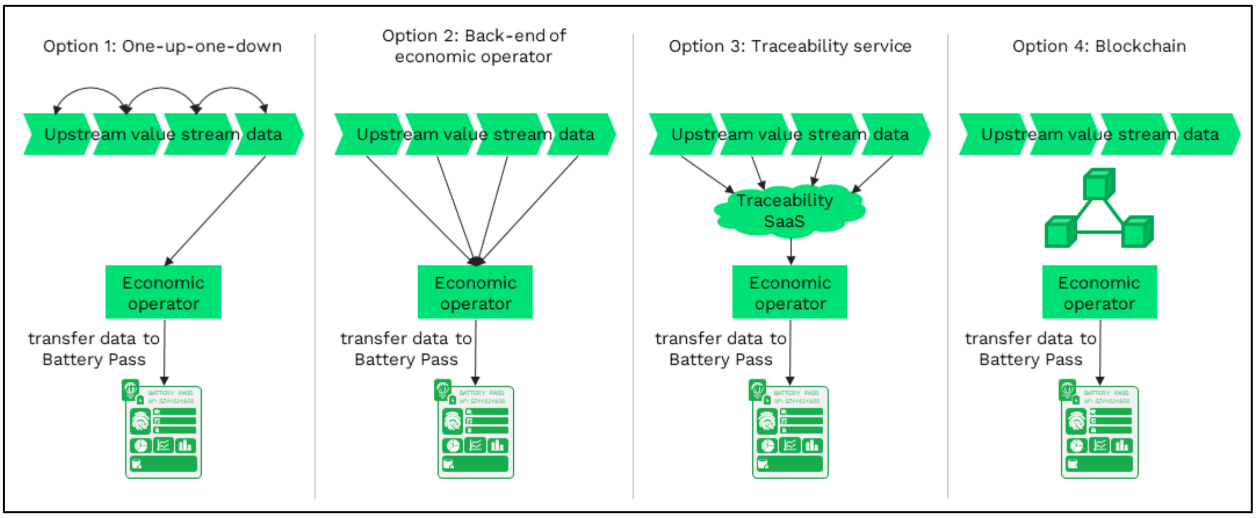

Figure 4: Options of value stream data tracking

5.3 Options for assessment of use phase data

Among other data attributes, the battery passport also contains those which are related to the use phase. This results in challenges as such data needs to be updated along the life cycle and therefore also continuously assessed to improve trustworthiness. In contrast static data points remain static once entered in the battery passport and therefore also only need to be checked once (assuming the technical system ensures data can only be written once).

Conformity assessment is conducted when the battery is placed on the market. Therefore, it can, by design, only assess the static data points of a battery. Routines that exist as part of the approval process, e.g. for energy consumption, test according to a defined procedure and attest a range for all products of that type. Those tests are already in place for e.g. for in-vehicle Battery Durability for EV with GTR-22.

While we acknowledge that these rely on averages and not on the specific use of one battery, similar mechanisms could be used for other battery types and values as well, e.g. by measuring values in a defined test procedure. These values could be then compared with the data measured e.g. by the BMS of the economic operator and transferred to the battery passport as part of the update of dynamic values. If these are reasonably similar for a certain number of tests, one could assume that the BMS measures the correct value in all cases which would then allow to certify the BMS regarding the battery health status. This process then closer resembles an assessment of a management system than a product.

However, a second challenge arises as not all battery types have the same technical systems embedded. Some may be equipped with a BMS and connected to the internet, while others don’t even contain a BMS, which in turn means that the values stored in the battery passport cannot be updated regularly. For those batteries secondary legislation could prescribe certain checks, either interval or event based, where data stored in the battery passport is compared to data measured at the specific battery according to defined test procedures.

All in all the question of trustworthiness, especially of dynamic data, is closely related to the up-to-dateness. It needs to be defined, e.g. by standards or secondary legislation, at which intervals data needs to be updated. When this is defined, assessment methods can be defined as well. If the trigger is a certain interval, automated mechanisms could be used to check whether an update was conducted. Then, in a second step, the methods could check whether the new value is correct. If the trigger is an event in a first step, the process of recording the event should be assessed to then, in a second step, check the value for correctness.

5.4 Transfer cases along the battery lifetime

As described in the content guidance (chapter 5.2.1) there are two transfer cases. The first transfer case occurs when the battery has been subject to preparation for re-use, repurpose or remanufacturing. For these cases a new conformity assessment has to be carried out by the (new) economic operator. The options for second-party assessments are limited as there might be additional vendors involved and therefore no supplier-customer relationship between the old and the new economic operator. The new economic operator could prove that data is correct by internal first-party assessments as well third-party assessments. Furthermore, there could be an automated data check of the old vs. the new battery passport. This would require some linkage between the two passports as suggested by the consortium in the content guidance (chapter 5.2.2).

The second transfer case occurs when the battery is declared waste. In these cases, the battery passport ceases to exist if the status is changed. Here first- and third-party assessments as well as automated assessments based on data are possible.

Besides these cases there is also the case of transfer of ownership of battery as a result of a sale. While this doesn't mean there is a new battery passport, it could imply actions to check for correctness of data. The correctness of data at this point is crucial for several reasons. Firstly, it influences the value of a battery. Secondly, it greatly influences the decision of a potential buyer on how to use the battery and therefore influences the ecological impact of the battery. If data e.g. related to battery health is incorrect, the decision it informs may not the one that fits the specific battery best. Thirdly, it also implies safety risks when the battery is used under wrong conditions or undergoes replacement/repair actions.

To solve this challenge, we see two potential options. There is the "market solution" which means that the market requires an (independent) assessment of the correctness of the data stored in the battery passport. A new owner might not buy a battery or device with a battery included without having the important parameters checked by a third-party. There could also be a "regulatory solution" where secondary legislation requires an independent check of the data contained in the battery passport in such cases.

5.5 Aggregation levels (cell, module, pack, type)

The data stored in the battery passport can refer to different aggregation levels. Most of the data is related to the individual battery on a pack level (see content guidance chapter 4.1.2 for an explanation of the different level). The assessment mechanisms need to accommodate these different levels.

For example, EU conformity assessment of the carbon footprint needs to consider the specific facility where the product is produced rather than an assessment of a general battery of that type, as the same product on different production lines or using differently sourced raw material can have a different carbon footprint. Note that the EU Commission will draft a delegated act on the methodology and values of the carbon footprint and these might also specify this aspect.

Another challenge arises for batteries which are subject to remanufacturing and repair as these procedures might change battery specific aspects. EU conformity assessment, which needs to take place again in these cases, must ensure that it is conducted for that specific battery and not a general battery of that type.

Furthermore, the battery passport, from a consortium perspective, requires not only product specific tests. The "backbone" (database, API, connection to central services, ways of communication in the value chain, etc.) of the battery passport should also be checked to ensure data is handled correctly. Potentially there could be an audit of the battery passport itself. Currently we see little added value in such an audit; however, there should be systems in place for checking the "backbone" of the battery passport, e.g. by using existing certificates for quality management or information security management systems.

5.6 Communication of results

The method used to check a battery passport data attribute should be attached to every attribute itself. This way it increases transparency (see Table 4), although it might result in multiple attributes having the same assessment applied, e.g. the recycled content share is probably using the same method independent of the material. When the attribute itself is calculated, e.g. based on value stream data, assessment information could also be summarized (always per attribute not across multiple attributes). Here, an indication of which assessments have been used along the value stream, potentially also as percentage (e.g. 90 % third-party assessment, 10% first-party assessment), could be used. The level of assurance (reasonable or limited assurance) should be indicated.

Table 4: Example for communication of results (data for illustrative purposes only)

Attribute	Value	Assessment mechanism applied
	...	
Battery Serial Number	992356610548948	Automated self-assessment
Battery carbon footprint	137.00 gCO_2e/kWh	EU conformity assessment; 90 % Third-party assessment / 10% first-party assessment
	...	

Within the content guidance access rights were addressed based on the Battery Regulation. The access to information on the used assessment mechanisms should follow these. This would enable all roles with access to the attribute itself to also access data with regard to the assessments made.

5.7 Choosing the right standard

While conformity assessment procedures are laid out in regulation, for the other methods the process is not defined in detail. Here standards play an important role as they define test procedures and therefore enable comparison of results. Currently there are efforts to close gaps in standardisation underway within standardisation request M/579.

For some aspects there might also be secondary legislation in the form of delegated and implementing acts which could specify methods on calculation and therefore would also enable to be used to carry out checks. Examples are the methodology for carbon footprint or recycling efficiencies. The joint research centre (JRC) can be seen as preparatory for that, e.g. in the already published JRC guidelines on carbon footprint the methods for calculation are specified as well as details on how to verify that data. At the same time industry initiatives, like Catena-X or Global Battery Alliance (GBA), are working on rulebooks for calculation as well.

6 Conclusion and outlook

The EU Battery Regulation mandates a battery passport for certain batteries by February 2027. The document provides a comprehensive overview of the principles and options for conformity assessment of battery passport data, emphasising the critical role of trustworthy data in supporting a circular economy. Special considerations need to account for the different characteristics of the data attributes, presented in chapter 3, namely accountability across the value stream and dynamic data collection during the use phase.

The building blocks for conformity assessment presented in chapter 4 outline the fundamental principles, entities and their respective scope. Furthermore, the chapter discusses the distinction between internal and external assessment methods, offering insights into their respective advantages and challenges. As written before, the regulatory framework established by the EU remain as such and the options presented are to be seen as additional measures besides those already prescribed in legislation.

Chapter 5 delves into practical considerations for implementing these assessment methodologies, stressing the importance of a risk-based approach to ensure cost efficiency and effectiveness. The evaluation of different assessment methods indicates that while external third-party assessments provide the highest reliability, internal methods can offer flexibility and be more readily available to assess specific data attributes along the value stream. The document emphasises various assessment options available along the value stream. It highlights challenges related to summarising data across multiple partners, ensuring confidentiality, and addressing dynamic data collected during the use phase. Specific strategies such as using chain of custody principles and technological solutions like traceability apps and blockchain are proposed to enhance data integrity. The importance of context-specific assessments at the respective levels – cell, module, pack, and type – is highlighted. To provide transparency and build trust among stakeholders it is important that the result is communicated with the data attribute itself.

The successful implementation of the battery passport system hinges on the accuracy and reliability of the data it contains.

Therefore, Commission as well as standardisation efforts need to clarify how the data contained in the battery passport should be verified to ensure correctness especially with regard for dynamic data collected during the battery's use phase. Further development of standards should provide clarity and consistency in the assessment process across the industry. An ongoing dialogue among stakeholders, including regulatory bodies, manufacturers, and value stream partners, will be crucial for establishing standardised practices. All standardisation efforts need to consider that the assessment framework must remain flexible to adapt to evolving market dynamics and regulatory requirements, ensuring it can adequately address new challenges as they arise.

Furthermore, it needs to be clarified how this can then be technically implemented. One option to technically highlight conformity could be by using verifiable credentials. They can be used to cryptographically sign and verify claims, which prove that a trusted issuer has confirmed that claim. Within the Battery Pass project, we used the model of verifiable credentials to show how such a system could work. For more information on verifiable credentials see the technical guidance (chapter 4.5) already published and the online demonstrator.

In summary, the effectiveness of the battery passport system is relying upon the accurate and reliable data it holds. The suggestions laid out for future verification processes, including the potential use of verifiable credentials, represent a critical step towards enhancing the trustworthiness of battery passport data. As the regulatory landscape continues to evolve, ongoing collaboration among stakeholders will be essential to establish robust standards and ensure the successful implementation of the battery passport ultimately contributing to a more sustainable battery life cycle.

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