WP2 DPP-ENRICHED CIRCULAR ECONOMY

T2.2. REGULATORY FOUNDATIONS OF THE DPP

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Executive summary

The Digital Product Passport (DPP) represents a cornerstone of the European Union's strategy to operationalize the circular economy through data-driven governance. Anchored in the Ecodesign for Sustainable Products Regulation (ESPR), the DPP establishes a standardized, digital framework for collecting, verifying, and exchanging product-specific information throughout the entire life cycle—from design and production to use, repair, and recycling. Eleven major regulatory instruments collectively define this architecture, specifying which data must be recorded, how it must be structured, and for which stakeholders it should be made accessible. Together, they move EU product governance from a compliance-based approach to a dynamic information ecosystem, in which sustainability, safety, and transparency are encoded directly into the product itself.

Within this ecosystem, the identified frameworks can be grouped into three complementary clusters. The Product and Information Governance cluster (ESPR, GPSR, Right to Repair, Energy Efficiency Directive) establishes the foundational data and procedural standards that enable interoperability and transparency. The Substance, Material, and Environmental Regulation cluster (REACH, RoHS, WEEE, ELV, Basel Convention) defines the chemical and material information essential for safe use, recycling, and environmental compliance. The Resource, Supply Chain, and Sustainability Governance cluster (EUDR, CRM Act, Battery Regulation) embeds geopolitical and ecological traceability, linking the DPP to global resource management and responsible sourcing. Together, these clusters form a coherent legal ecosystem that enables the DPP to function as both a compliance mechanism and a strategic policy instrument for industrial resilience and sustainability. The purpose of this document is to present an analytical overview of a relevant subset of the regulatory framework, highlighting aspects that are particularly significant for the DPP.

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Introduction

The Digital Product Passport (DPP) is a holistic policy concept designed to digitally represent the entire life cycle of a product in accordance with European Union (EP & EC: ESPR, 2024)

This overview concentrates on those regulations that correspond to the product categories defined in the delegated acts, as they delineate the practical scope of the Digital Product Passport (DPP). Although the instrument is designed to encompass all products placed in the EU market, it must be stressed that numerous additional regulatory frameworks such as the EUDR remain equally relevant for its future development and application (EP & EC: Deforestation Regulation, 2023). Figure 1 illustrates the initial Working Plan, which prioritizes certain products for the implementation of the DPP and indicates the timeline of entry into force of the corresponding Delegated Acts. At the uppermost level, specific product groups are enumerated, thereby defining the primary scope of application. Energy-related products are disaggregated at the lowest tier, reflecting their regulatory significance. Positioned between these levels, the horizontal requirements indicate cross-cutting obligations that apply across product categories (EP & EC: ESPR, 2024; EC, 2025).

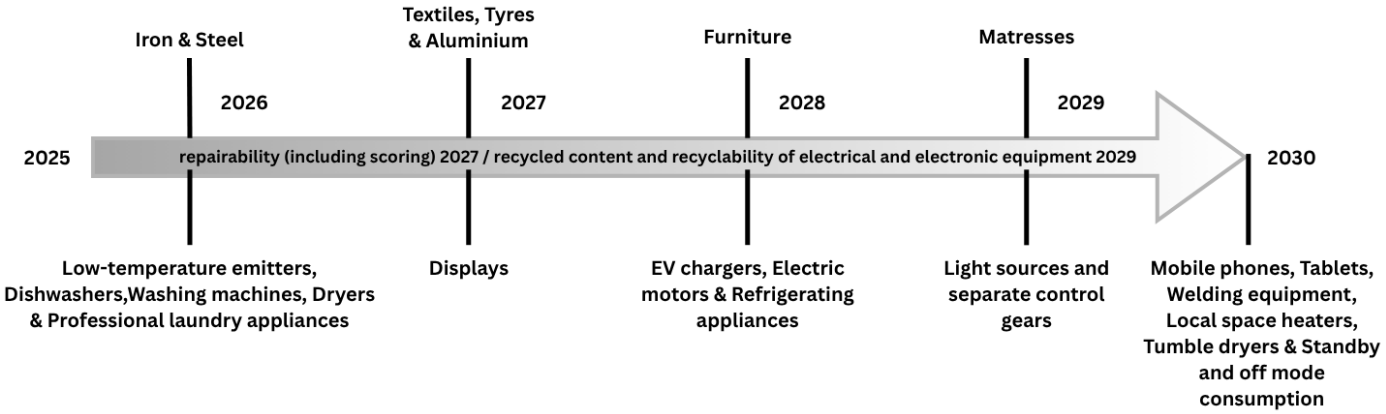

Figure 1: Timeline of Prioritized Product Groups for the Implementation of the Digital Product Passport (2025–2030)

Review of Frameworks

The Digital Product Passport (DPP) is situated within a rapidly evolving network of European and international regulatory frameworks that collectively aim to operationalize the principles of the circular economy, product safety, and sustainable resource management. Eleven key instruments form the legal and conceptual foundation for the DPP, ranging from horizontal frameworks such as the Ecodesign for Sustainable Products Regulation (ESPR), REACH, the General Product Safety Regulation (GPSR) and all data related regulations to sector-specific or thematic acts including the Battery Regulation, Critical Raw Materials Act (CRM Act) and EU Deforestation Regulation (EUDR). Together, these regulations define the informational architecture and compliance logic of the DPP: what data must be captured, how it should be structured, and for whom it must be accessible. Their combined implementation transforms sustainability governance into a data-driven system, embedding transparency, traceability, and lifecycle accountability across all product categories and value chains. The following subsections review each framework in detail, outlining their objectives, relevance, and implications for the design and operation of the Digital Product Passport.

Cluster 1: Product and Information Governance

The first cluster comprises frameworks that establish the structural and informational foundations of the Digital Product Passport (DPP). The Ecodesign for Sustainable Products Regulation (ESPR), General Product Safety Regulation (GPSR), Right to Repair Directive, and the Energy Efficiency Directive define how product information must be generated, verified, and made accessible throughout the lifecycle. These instruments move the EU regulatory regime from static documentation toward dynamic, data-based product governance. The ESPR introduces harmonized sustainability criteria and life-cycle transparency, while the GPSR links these data requirements to consumer protection and market surveillance. The Right to Repair Directive embeds reparability and accessibility information within the DPP architecture, granting consumers and repairers differentiated data access. In parallel, the Energy Efficiency Directive anchors the collection of energy performance data as a prerequisite for both regulatory reporting and market comparability. Collectively, these frameworks position the DPP as a universal information infrastructure that merges sustainability, safety, and consumer rights into a single, interoperable data environment.

Ecodesign for Sustainable Products Regulation (ESPR)

Entering into force on 18 July 2024, the Ecodesign for Sustainable Products Regulation (ESPR) serves as the primary legal framework for the Digital Product Passport (DPP) and builds upon the Ecodesign Directive of 2009 by significantly broadening its scope. It establishes general ecodesign requirements for nearly all physical products placed on the EU market, with implementation beginning with the categories defined in the delegated acts, namely iron and steel, aluminum, textiles, furniture, tyres, detergents, paints, lubricants, chemicals, energy-related products subject to ecodesign requirements, and information and communication technology (ICT) products as well as other electronic devices. The overarching objective of this regulation is to integrate sustainability across the entire product life cycle by mandating that products are designed for durability, reparability, recyclability, as well as for overall energy and resource efficiency (EP & EC: ESPR, 2024). Importantly, the ESPR extends sustainability criteria beyond energy consumption, encompassing product longevity, ease of repair, and broader environmental impacts, all of which are essential for the functioning of the DPP.

The key requirements of the ESPR for the DPP can be summarized in six categories. First, products must achieve high standards of energy efficiency, resource efficiency, and environmental performance, ensuring minimized energy consumption, reduced life-cycle emissions, and delayed depletion of raw materials. Second, the regulation introduces harmonized standards across the EU to enhance consumer understanding and support continuous improvements in product design. Third, it mandates comprehensive data collection, requiring the DPP to digitally capture core product data, company-specific information, technical performance indicators, real-use data, and end-of-life details.

Fourth, the regulation emphasizes granular and hierarchical information, meaning that product data should be available at different levels—model, batch, and item—thus facilitating traceability and targeted sustainability improvements. Fifth, it establishes differentiated access rights to ensure that diverse stakeholders, such as regulators, consumers, and repairers, can access tailored information relevant to their roles. Sixth, the ESPR promotes transparency and continuous improvement, as standardized data collection and reporting within the DPP provide visibility throughout the product life cycle and enable ongoing efforts to reduce environmental impacts in alignment with the EU Green Deal and circular economy objectives (EP & EC: ESPR, 2024; EC: Green Deal, 2019).

General Product Safety Regulation (GPSR) (EU 2023/988)

The General Product Safety Regulation (GPSR), which entered into force on 13 December 2024, modernizes and strengthens the EU framework for ensuring that all consumer products placed on the market are safe. It establishes harmonized obligations for manufacturers, importers, distributors, and online marketplaces to improve traceability, risk assessment, and market surveillance. The regulation also introduces requirements for clearer consumer information and rapid alert mechanisms for unsafe products, thereby enhancing overall product safety within the single market (EP & EC: GPSR, 2023).

The DPP can play an essential role in supporting the implementation of the GPSR by serving as a digital repository for safety-related data. It could include information on product-specific safety standards, potential hazards, recall notices, and risk mitigation measures, while also enabling real-time updates accessible to regulators, businesses, and consumers. By integrating safety-related information into a standardized digital format, the DPP increases transparency, strengthens trust in the European product safety framework, and complements the GPSR's goal of ensuring a high level of consumer protection across the EU (EP & EC: GPSR, 2023).

Repair Directive ("Right to Repair") (EU 2024/1799)

The EU Directive on the Repair of Goods, commonly referred to as the "Right to Repair," entered into force on 30 July 2024 and requires Member States to transpose its provisions into national law by July 2026. It introduces additional requirements for product categories that are already subject to reparability provisions under EU legislation. While the directive allows manufacturers to decide whether the required information is communicated through the Digital Product Passport (DPP) or via alternative channels, the inclusion of such information in the DPP could substantially support the directive's objectives (EC: Directive Repair of Goods).

Specifically, the DPP could provide details from manufacturers regarding their repair offerings. It could also include a link to the joint online interface or national online platforms—or directly embed this information—enabling search functions for goods and repair services, cross-border service provision, repair conditions (such as turnaround times, availability of replacement goods, and delivery options), as well as supplementary services and quality standards for repair. In addition, the DPP could contain repair manuals and information on modularity and interchangeability, thereby enabling consumers to

undertake independent repair activities. Furthermore, the DPP could offer consumers the option to request the European Repair Information Form, alongside product-specific details on compliance with reparability requirements established in EU law. Finally, the directive emphasizes accessibility for persons with disabilities, which means the DPP should ensure inclusive communication while also providing clear consumer information on rights under the repair directive (EC: Directive Repair of Goods).

European Energy Efficiency ACT (EED) (2023/1791/EU)

The Energy Efficiency Directive entered into force on 10 October 2023 and constitutes the central legal framework for enhancing energy efficiency within the European Union. Its primary objective is to significantly reduce primary and final energy consumption, increase energy productivity, and thereby make a substantial contribution to achieving the Union's climate and energy targets for 2030 as well as climate neutrality by 2050. The directive establishes binding energy-saving targets for the Member States, sets specific requirements for companies with high energy consumption, and introduces efficiency standards for data centres. In doing so, it seeks not only to reduce overall energy demand but also to decrease dependence on fossil fuels and strengthen energy security across the Union (EP & EC: EED, 2023).

In relation to the Digital Product Passport (DPP)**,** the Energy Efficiency Directive is particularly relevant as it emphasises the collection, documentation, and transparent provision of energy consumption data and efficiency indicators. The DPP can serve as a key instrument in this regard by systematically recording product-specific energy consumption, lifecycle-related information, and details on applied efficiency technologies, while ensuring interoperability. In this way, the DPP supports companies in meeting regulatory reporting and verification obligations, provides a basis for the comparability of products with respect to their energy efficiency, and contributes to the implementation of the Union's broader energy and climate objectives (EP & EC: EED, 2023).

Data-related Regulations

The digital governance of the Digital Product Passport (DPP) depends not only on product-oriented legislation but also on the coherent regulation of data access, sharing, and trust across the European Single Market. Four key legislative acts—the Data Act, Data Governance Act (DGA), General Data Protection Regulation (GDPR), and the revised eIDAS 2.0 Regulation—together establish the foundational rules for the secure and

interoperable exchange of product and lifecycle data within the DPP ecosystem. These instruments collectively ensure that information embedded in the DPP can circulate between public authorities, industry actors, and consumers under conditions of legal certainty, privacy protection, and digital trust.

The Data Act (EU) 2023/2854), adopted on 27 November 2023, constitutes a central pillar of the EU's strategy to foster a fair and innovative data economy. It introduces harmonised rules for access to and use of data generated by connected products and related services. Its objectives include strengthening user rights over data they help generate, ensuring fair contractual relations between data holders and data users, and facilitating data sharing across sectors while safeguarding trade secrets and cybersecurity (EP & EC: Data Act, 2023).

For the DPP, the Data Act provides the overarching legal framework that enables data interoperability and portability. By defining conditions under which manufacturers must grant product users and authorised third parties access to product-generated data, it ensures that DPP-related datasets—such as lifecycle information, environmental metrics, and repair histories—can be shared across supply chains in a transparent yet secure manner. The regulation thus reinforces the DPP's role as a dynamic data space instrument, aligning product-level information governance with the principles of the European Data Strategy.

The Data Governance Act (DGA) (EU) 2022/868), applicable since 24 September 2023, complements the Data Act by creating a trust-based framework for data sharing among private and public entities. It establishes mechanisms for data altruism, data intermediation services, and re-use of public-sector data that is subject to confidentiality restrictions (EP & EC: Data Governance Act, 2022).

In the context of the DPP, the DGA provides the institutional and procedural scaffolding for the exchange of product-related information beyond bilateral commercial relationships. It enables neutral data intermediaries to manage access to DPP data in a legally compliant way, facilitates cross-sectoral data pooling, and introduces transparency obligations for organisations handling sensitive datasets. These provisions are crucial for building trust among manufacturers, recyclers, and authorities, thereby supporting the creation of the European Data Space for Circular Economy where DPP data is securely shared and reused for regulatory, scientific, and market purposes.

The General Data Protection Regulation (GDPR) (EU) 2016/679), applicable since 25 May 2018, defines the fundamental rights and obligations concerning the processing of personal data in the European Union. Its central principles—lawfulness, fairness, transparency, data minimisation, and accountability—govern all data operations involving identifiable natural persons (EP & EC: GDPR, 2016).

Although the DPP primarily manages technical and environmental data, personal information can be indirectly involved, for example in user registration, repair traceability, or product ownership documentation. The GDPR therefore ensures that such processing respects privacy by design and by default. Integration of GDPR-compliant safeguards within the DPP architecture—including pseudonymisation, purpose limitation, and explicit consent mechanisms—preserves individual rights while enabling lawful data exchange. Consequently, the GDPR forms the ethical and legal foundation for trustworthy digital product information systems.

The eIDAS 2.0 Regulation (EU) 2024/1183), adopted on 29 February 2024, revises the original electronic Identification, Authentication and Trust Services framework to introduce the European Digital Identity Wallet. This regulation enables secure cross-border authentication and verification of entities and datasets across the Union's digital infrastructures. Its objective is to guarantee the integrity, authenticity, and non-repudiation of digital transactions and attestations within both public and private domains (EP & EC: eIDAS 2.0, 2024).

Within the DPP framework, eIDAS 2.0 underpins the trust infrastructure necessary for verifying product data sources, digital signatures, and organisational identities. By linking DPP records to verifiable credentials, it ensures that data on product composition, lifecycle performance, or sustainability claims originates from authenticated sources. This strengthens both regulatory enforcement and consumer confidence, establishing a trustworthy digital environment for circular-economy data exchange.

Collectively, these four data-related regulations extend the DPP's reach beyond material and product governance into the domain of data sovereignty. They operationalise the principles of access, trust, and privacy, ensuring that digital product information becomes a reliable asset for sustainable, competitive, and transparent European markets.

Cluster 2: Substance, Material, and Environmental Regulation

The second cluster groups regulatory instruments that govern the material and chemical dimensions of the circular economy. It includes the REACH Regulation, Restriction of Hazardous Substances Directive (RoHS), Waste Electrical and Electronic Equipment Directive (WEEE), End-of-Life Vehicles Directive (ELV), and the Basel Convention. These acts define how hazardous substances, waste, and recyclable materials are identified, documented, and processed across global value chains. In the context of the DPP, they determine the content layer of sustainability information – specifying which substances, compositions, and recovery data must be recorded and transmitted. Through REACH and RoHS, chemical safety is made digitally traceable, while the WEEE and ELV Directives extend these requirements to the end-of-life phase, linking product data to collection, disassembly, and recycling processes. The Basel Convention, operating at the international level, complements these EU regulations by providing a legal framework for documenting hazardous waste movements. Together, these instruments transform the DPP into a compliance and traceability mechanism for material flows, ensuring that chemical, environmental, and waste-management obligations are met in a transparent, machine-readable manner.

Registration, Evaluation, Authorization and Restriction of Chemicals Regulation (REACH) (EC No 1907/2006)

The REACH Regulation, entering into force on 1 June 2007, ensures the safe management of chemicals by requiring companies to register, evaluate, and authorize substances placed on the European market. Its primary objective is to protect human health and the environment from potential risks posed by hazardous chemicals. Article 33 specifically mandates communication within the supply chain regarding substances subject to authorization or listed as candidates for authorization. Accordingly, any supplier of an article containing such a substance at a concentration above 0.1% weight by weight (w/w) is obligated to provide consumers with sufficient information for the safe use of the article, which must include, at a minimum, the name of the substance (EP & EC: REACH , 2006).

In this context, the Digital Product Passport (DPP) could function as a central repository for essential compliance data. It may include the names of substances of very high concern (SVHCs) subject to authorization, along with guidance for the safe handling, use, and disposal of the article. By embedding these details in a structured and accessible digital

format, the DPP facilitates both regulatory compliance and informed decision-making for stakeholders across the supply chain (EP & EC: REACH , 2006).

Restriction of Hazardous Substances Directive (RoHS) (2011/65/EU)

The Restriction of Hazardous Substances (RoHS) Directive, which came into force on 21 July 2011, limits the use of certain hazardous substances—such as lead, mercury, and cadmium—in electrical and electronic equipment (EEE) marketed within the European Union. Its primary objective is to safeguard human health and the environment while simultaneously promoting safer recycling and disposal practices. All products containing electrical or electronic components must comply with these restrictions, unless explicitly exempted under the directive (EP & EC: RHOS Directive, 2011).

In this regulatory context, the Digital Product Passport (DPP) can serve as a valuable tool for documenting RoHS compliance. It may include a binary indication of whether a product is RoHS-compliant (Yes/No). In cases of non-compliance, the DPP could also provide justification for a valid exemption as well as detailed information to ensure proper handling and environmentally sound disposal (EP & EC: RHOS Directive, 2011).

Waste Electrical and Electronic Equipment Directive (WEEE) (2012/19/EU)

The Waste Electrical and Electronic Equipment (WEEE) Directive aims to reduce electronic waste by establishing requirements for the collection, recycling, and recovery of electrical and electronic equipment (EEE). The directive, enacted on 13 August 2012 and has applicable since February 2014, aims to minimize environmental impacts and combat illegal waste exports, while assigning manufacturers primary responsibility for the disposal and recycling of their products (EP & EC: WEEE Directive, 2012).

Within this regulatory framework, the Digital Product Passport (DPP) could provide relevant information tailored to different stakeholder groups. For users, the DPP may include information on whether the product is classified as EEE, the associated costs for collection, treatment, and disposal, the obligation of separate collection, and the availability of return and collection systems. It may further provide guidance on how consumers contribute to reuse and recycling, as well as details on potential environmental and health risks posed by hazardous substances contained in EEE. For treatment facilities (one year after the product has entered the market), the DPP could supply information relevant to preparation for reuse and treatment, including data on EEE components and materials, and the precise location of hazardous substances and mixtures within the product. For national product registers,

the DPP may also serve as a repository of essential reporting data (EP & EC: WEEE Directive, 2012).

End-of-Life Vehicles Directive (ELV) (2000/53/EC)

The End-of-Life Vehicles Directive (ELV), which entered into force on 21 October 2000, constitutes a cornerstone of EU policy to reduce the environmental impact of vehicles once they reach the end of their life cycle. The directive restricts the use of hazardous substances such as lead, cadmium, mercury, and hexavalent chromium, while obliging manufacturers to ensure vehicle designs that enable dismantling, reuse, and high levels of material recovery. It also requires Member States to establish collection systems and sets mandatory reuse and recycling targets for automotive components and materials (EP, ELV Directive , 2000).

The DPP could significantly enhance the implementation of the ELV Directive by providing structured digital documentation on vehicle composition, hazardous substances, and component ownership. It would increase transparency by supplying recyclers with detailed information on materials and substances, thereby facilitating safer and more efficient treatment processes. At the same time, it would support compliance with substance restrictions by digitally recording hazardous materials and enabling authorities to verify conformity in real time. Moreover, the inclusion of modularity data, interchangeability details, and disassembly instructions would improve dismantling practices and promote the reuse of components. Finally, by offering standardized digital datasets, the DPP would strengthen monitoring and traceability, allowing authorities to track recycling rates and enforce ELV targets more effectively. In this way, the DPP can serve as both a compliance tool and a driver of circularity in the automotive sector, thereby reinforcing the overarching goals of the ELV Directive (EP, ELV Directive , 2000).

Basel Convention (Document 21993A0216(02))

The Basel Convention, enacted on 5 May 1992, is an international treaty designed to reduce the transboundary movement of hazardous waste, particularly from developed to less developed countries. Its primary objective is to safeguard human health and the environment from the risks associated with hazardous waste (Basel Convention, n.d.).

Within this framework, the Digital Product Passport (DPP) could serve as a practical tool for supporting compliance and transparency. It may indicate whether a product is classified as “hazardous waste” or not, thereby enabling stakeholders to clearly identify regulatory

obligations. In addition, the DPP could provide information on appropriate disposal pathways and authorized facilities for hazardous waste, ensuring that end-of-life management is conducted in accordance with international standards (Basel Convention, n.d.).

Cluster 3: Resource, Supply Chain, and Sustainability Governance

The third cluster addresses the geopolitical and ecological dimensions of resource management, encompassing the EU Deforestation Regulation (EUDR), Critical Raw Materials Act (CRM Act), and the Battery Regulation. These frameworks link the DPP to global supply-chain governance and industrial resilience strategies. The EUDR establishes georeferenced traceability obligations for high-risk commodities, requiring digital documentation of origin and deforestation-free production. The CRM Act mandates the disclosure of critical material content and removability, particularly for permanent magnets, thereby integrating strategic resource data into the DPP structure. The Battery Regulation, serving as the first large-scale implementation of a digital passport, operationalizes lifecycle reporting on carbon footprint, recycling content, and raw material sourcing. Collectively, these instruments transform the DPP into a strategic policy tool that extends beyond environmental compliance: it becomes a mechanism for supply-chain transparency, responsible sourcing, and industrial competitiveness. By embedding provenance and resource-security data, this cluster situates the DPP at the intersection of sustainability policy, trade governance, and technological sovereignty.

European Union Deforestation Regulation (EUDR) (EU 2023/1115)

The European Union Deforestation Regulation (EUDR) entered into force on 29 June 2023, with application commencing at the end of 2026 for large and medium-sized enterprises, while it is unknown when small and micro enterprises will be required to comply. It repeals the European Union Timber Regulation (EUTR), which had entered into force in 2013. Representing a paradigm shift in sustainable sourcing, the EUDR introduces strict traceability and due diligence mechanisms for selected high-risk commodities such as cocoa, beef, palm oil, coffee, rubber, soy, and timber, along with their derivatives. Its overarching aim is to reduce the EU's global ecological footprint, mitigate greenhouse gas emissions, and halt biodiversity loss. To achieve these objectives, the regulation requires that these raw materials be traceable to their precise geographical origins, including time-

stamped production data and evidence of compliance with local environmental legislation (EP & EC: Deforestation Regulation, 2023).

The Digital Product Passport (DPP) serves as a critical compliance instrument for the EUDR. By enabling the structured, digital documentation and verification of supply chain data, the DPP facilitates both risk assessments and automated compliance checks by regulatory authorities. Through the consolidation and harmonization of product-related information using standardized identifiers and machine-readable formats, the DPP ensures traceability, authenticity, and accessibility across all stakeholders. Moreover, the integration of georeferenced data, chronological production records, and stakeholder identities into a unified digital system not only strengthens legal compliance but also advances broader sustainability goals. These include enabling informed consumer decision-making, fostering responsible sourcing practices, and reducing the prevalence of illegal deforestation (EP & EC: Deforestation Regulation, 2023).

Critical Raw Materials Act (CRM Act) (EU 2024/1252)

The Critical Raw Materials Act (CRM Act), which came into force on 23 May 2024, represents a comprehensive policy framework designed to secure a stable and sustainable supply of essential raw materials for European industry. It identifies key raw materials and promotes strategies aimed at reducing import dependence, enhancing recycling processes, and fostering the development of alternative sources. Within this context, relevant information for the Digital Product Passport (DPP) may include the recorded weight of critical and strategic raw materials, the proportion of recycled critical and strategic materials, as well as specific instructions for disassembling or otherwise separating these substances (EC: CRM Act, n.d.).

Beyond the possibilities already outlined, Article 28 of the CRM Act requires specific mandatory provisions for the DPP regarding products containing permanent magnets. First, the DPP must specify the name, registered trade name or brand, and postal address of the responsible entity, along with electronic contact details. Second, it must include information on the weight, location, and chemical composition of each permanent magnet incorporated in the product, as well as details concerning the presence and type of magnet coatings, adhesives, and additives used. Third, it must provide information facilitating both access to and the safe removal of all permanent magnets contained in the product (EC: CRM Act, n.d.).

Battery Regulation (EU 2023/1542)

The Battery Regulation, which entered into force on 17 August 2023 and has applied since 18 February 2024, aims to minimize the environmental impacts of batteries throughout their entire life cycle. In doing so, it maintains existing restrictions on hazardous substances such as mercury and cadmium while also introducing new limitations on the use of lead in portable batteries (EP & EC: EU-Battery Regulation, 2023).

A key feature of the regulation is the requirement for comprehensive data collection concerning the energy consumption, chemical composition, and recyclability of batteries. These data points are essential for integration into the Digital Product Passport (DPP), as they ensure transparency regarding the ecological footprint of batteries and enable stakeholders to make informed decisions. By embedding such information in the DPP, the regulation supports not only regulatory compliance but also the transition to a circular economy, where resources are conserved, and waste is minimized (EP & EC: EU-Battery Regulation, 2023).

An important development within this regulatory framework is the Battery Passport, which functions as a proof of concept for the broader DPP. As one of the first sector-specific implementations, it demonstrates the practical feasibility of digitally documenting product data in a standardized, machine-readable format. This pilot initiative thus provides valuable insights into the technical, regulatory, and market-related challenges of deploying the DPP at scale across multiple product categories (EP & EC: EU-Battery Regulation, 2023).

Discussion

The evolving European regulatory landscape forms an intricate but increasingly coherent foundation for the Digital Product Passport (DPP). Table 1 presents the objectives of regulations and their relevance for the Digital Product Passport. At its center, the Ecodesign for Sustainable Products Regulation (ESPR, EU 2024/1781) serves as the legal cornerstone, embedding sustainability into the design phase of all physical products. By mandating lifecycle transparency—on durability, reparability, recyclability, and resource efficiency—it provides the structural and procedural logic for DPP implementation. The ESPR transforms sustainability reporting from a declarative into a data-based obligation, requiring harmonized product information accessible across supply chains. In this sense, it functions as the "constitutional layer" of the DPP ecosystem: all other frameworks derive operational specificity from it.

Complementing this core, several sectoral and thematic regulations define the data domains to be integrated within the DPP. The Battery Regulation (EU 2023/1542) remains the most advanced application, establishing a fully digital passport for industrial and electric vehicle batteries that records carbon footprint, recycled content, and material sourcing. The Waste Electrical and Electronic Equipment Directive (WEEE, EU 2012/19) and the End-of-Life Vehicles Directive (ELV, 2000/53/EC) extend this logic by introducing obligations for tracking materials and hazardous substances throughout use and recovery phases. The Restriction of Hazardous Substances Directive (RoHS, EU 2011/65) and the REACH Regulation (EC No 1907/2006) reinforce chemical safety and environmental protection, ensuring that DPP data reflects compliance with limits on toxins and substances of very high concern (SVHCs). Together, these instruments embed environmental risk governance into digital traceability systems, linking material safety with product transparency.

Table 1: Overview of the Regulatory Landscape of the First Cluster

LAW / REGULATION	***OBJECTIVE***	***RELEVANCE FOR DPP***
Ecodesign for Sustainable Products Regulation (ESPR) (EU 2024)	Establishes a unified framework for sustainable product design across the EU, promoting durability, reparability, recyclability, and	Serves as the legal foundation of the DPP, mandating digital documentation of product, performance, and lifecycle data to ensure traceability, transparency, and sustainability assessment.

	resource efficiency throughout the life cycle.	
General Product Safety Regulation (GPSR) (EU 2023/988)	Modernizes EU product safety rules to enhance traceability, risk management, and consumer protection.	Positions the DPP as a digital safety database, integrating real-time information on standards, hazards, and recalls to strengthen market surveillance and consumer trust.
Repair Directive ("Right to Repair") (EU 2024/1799)	Promotes repairability and consumer access to repair information, parts, and services.	Enables the DPP to provide repair data and manuals, supporting independent repair, transparency, and alignment with EU reparability objectives.
Energy Efficiency Directive (EU 2023/1791)	Sets binding energy-saving targets to enhance efficiency and achieve EU climate neutrality.	Uses the DPP to record and disclose energy performance data, supporting compliance, comparability, and climate policy implementation.

A second cluster of frameworks addresses resource security, biodiversity, and material provenance, broadening the DPP's geopolitical and ecological dimensions. The EU Deforestation Regulation (EUDR, EU 2023/1115) mandates georeferenced traceability for high-risk commodities such as timber, palm oil, and cocoa. Integrating these datasets into the DPP enables automated due diligence and risk screening against deforestation footprints. Similarly, the Critical Raw Materials Act (CRM Act, EU 2024/1252) ties the DPP to Europe's industrial resilience strategy by requiring disclosure of critical material content and removability, especially for permanent magnets and rare earths. These frameworks extend the DPP beyond environmental compliance to questions of strategic autonomy and supply chain security, turning the passport into a data instrument for both sustainability and industrial policy.

Table 2: Overview of the Regulatory Landscape of the Second Cluster

LAW / REGULATION	***OBJECTIVE***	***RELEVANCE FOR DPP***
REACH Regulation (EC No 1907/2006)	Ensures the safe management of chemicals by requiring registration, evaluation, authorization, and restriction of substances, thereby protecting	Positions the DPP as a central compliance repository for substances of very high concern (SVHCs), including safe-use instructions and handling information to

	human health and the environment.	support supply-chain transparency and regulatory conformity.
Restriction of Hazardous Substances Directive (RoHS) (2011/65/EU)	Limits the use of specific hazardous substances (e.g., lead, mercury, cadmium) in electrical and electronic equipment to promote environmental and human health protection.	Enables the DPP to document RoHS compliance status, exemptions, and handling requirements, ensuring clear communication and environmentally sound disposal.
Waste Electrical and Electronic Equipment Directive (WEEE) (2012/19/EU)	Reduces electronic waste through improved collection, recycling, and recovery of electrical and electronic equipment, while assigning producers extended responsibility.	Allows the DPP to provide tailored lifecycle and recycling information, including collection obligations, treatment data, and hazardous material locations, enhancing traceability and resource recovery.
End-of-Life Vehicles Directive (ELV) (2000/53/EC)	Reduces environmental impact of end-of-life vehicles by restricting hazardous substances and promoting dismantling, reuse, and high recycling rates.	Uses the DPP to digitally document vehicle composition and hazardous materials, support safe disassembly, and enable real-time compliance verification and circularity tracking.
Basel Convention (Document 21993A0216(02))	Prevents transboundary movement of hazardous waste and promotes environmentally sound management to protect human health and ecosystems.	Employs the DPP to classify hazardous waste, specify disposal routes, and identify authorized facilities, ensuring compliance with international waste management standards.

The General Product Safety Regulation (GPSR, EU 2023/988), the Basel Convention (1992), and the Right to Repair Directive (EU 2024/1799) further expand the functional scope of the DPP toward consumer empowerment and post-market accountability. Under the GPSR, DPPs can store safety warnings, conformity data, and recall information, allowing regulators to monitor products dynamically. The Basel Convention, though international and

predating the DPP concept, provides the normative foundation for documenting hazardous waste transfers—an obligation that can be operationalized through passport-based waste classification and disposal guidance. Finally, the Right to Repair Directive strengthens consumer sovereignty by mandating access to repair information and modularity data through digital means, positioning the DPP as the interface between producers, repairers, and users. Collectively, these instruments redefine the DPP as a multi-stakeholder information infrastructure, not merely a compliance database.

The interaction among all eleven frameworks reveals a distinct regulatory pattern: progressive convergence toward a unified, data-centric model of product governance. Each regulation delineates a specific thematic pillar—safety, environment, materials, repair, or trade—while collectively reinforcing a shared digital backbone. The DPP thus becomes the integrative node linking horizontal sustainability legislation (ESPR, REACH, EUDR) with vertical sectoral regimes (Batteries, WEEE, ELV). Its systemic impact is transformative: it enables regulators to operationalize environmental goals through verifiable data, industries to meet compliance through interoperable digital architectures, and consumers to access transparent, trustworthy information. However, this integration also exposes tensions—particularly around data ownership, interoperability, and the administrative burden for SMEs—requiring coherent governance under the upcoming European Data Space for Circular Economy.

Table 3: Overview of the Regulatory Landscape of the Third Cluster

LAW / REGULATION	***OBJECTIVE***	***RELEVANCE FOR DPP***
European Union Deforestation Regulation (EUDR) (EU 2023/1115)	Establishes strict due diligence and traceability requirements for high-risk commodities (e.g., cocoa, coffee, soy, palm oil, timber) to prevent deforestation, reduce emissions, and protect biodiversity.	Positions the DPP as a key compliance and traceability instrument, enabling digital documentation of georeferenced production data, supply-chain verification, and automated compliance checks to ensure sustainable sourcing and transparency.
Critical Raw Materials Act (CRM Act) (EU 2024/1252)	Secures a sustainable and resilient supply of critical and strategic raw materials by	Mandates DPP integration for products containing permanent magnets, including data on material composition, weight, location,

	promoting recycling, diversification, and reduced import dependency.	coatings, and safe removal, as well as information on recycled and critical material content.
Battery Regulation (EU 2023/1542)	Reduces the environmental impact of batteries across their lifecycle through material restrictions, enhanced recyclability, and transparency requirements.	Establishes the Battery Passport as a prototype of the DPP, digitally recording battery composition, energy performance, and recyclability data to support circularity, compliance, and informed decision-making.

In conclusion, the regulatory ecosystem surrounding the DPP embodies a paradigm shift from product-level regulation to data-level governance. The eleven frameworks together construct the legal and operational scaffolding for a European circular economy that is digitally measurable, traceable, and enforceable. Their combined impact extends beyond environmental performance: they institutionalize sustainability through information symmetry, embedding circularity, safety, and accountability into the very architecture of market exchange. The DPP is, therefore, not a single instrument but the materialization of a broader regulatory intelligence system—one that fuses environmental law, industrial policy, and digital transformation into a unified European governance model.

Conclusion

The analysis of European Union legislation in relation to the DPP demonstrates that the instrument is embedded within a multi-layered regulatory framework. At its foundation lies the ESPR, which provides the overarching legal basis for the DPP. Building on this framework, sectoral regulations such as the EUDR, CRM Act, the Basel Convention, and GPSR introduce targeted requirements for specific value chains or risk areas. In addition, product-specific instruments including RoHS, WEEE, REACH, the Right to Repair Directive, the Battery Regulation, and ELV define concrete obligations at the level of individual product groups. Complementary to these, data-centric and reporting frameworks—namely the CSRD, the EU Taxonomy Regulation, the SFDR, the Data Act, and the (DAG)—function as enablers by establishing principles of transparency, interoperability, and accountability. Together, these categories highlight the dual role of the DPP. It is both a compliance tool for product- and sector-specific legislation and a data infrastructure that strengthens corporate sustainability reporting and financial market transparency.

The scope of this document, however, has been deliberately selective. The regulations addressed here are not the only ones relevant to the DPP but were chosen because the delegated acts under the ESPR prioritize certain product categories where the DPP is expected to be applied first. Other legal instruments, for example the Packaging and Packaging Waste Regulation or the Construction Products Regulation, could also influence the evolution of the DPP. Their exclusion in this study does not imply a lack of significance but reflects the methodological decision to focus on those frameworks that are either prioritized in delegated acts or provide a clear enabling environment for the passport's initial implementation.

In sum, the DPP must be understood as a dynamic instrument situated at the intersection of product policy, sustainability regulation, and data governance. Its effectiveness will depend not only on the technical design of the passport itself but also on the coherence and coordination of the surrounding regulatory frameworks. By bridging product-specific requirements with sectoral and cross-cutting data frameworks, the DPP exemplifies the EU's integrated approach to advancing the Green Deal objectives and moving towards a circular, transparent, and sustainable single market.

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