DPP4Plastics

A Digital Product Passport for Plastics

Programm / Ausschreibung	Digitale Technologien, Digitale Technologien, Digitale Schlüsseltechnologien: Ausschreibung 2023	**Status**	abgeschlossen
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Keywords	Plactics, Circular Economy, Intermediate Products, Digital Product Passport, Life Cycle Management		

Projektbeschreibung

DPP4PLASTICS untersucht die technischen, rechtlichen und organisatorischen Implikationen eines digitalen Produktpasses (DPP) für kunststofferzeugende und -verarbeitende Unternehmen. Das Projekt zielt darauf ab, den F&E-Bedarf für verfahrens- und prozessbezogene Defizite und Notwendigkeiten zu identifizieren, um die kommenden Ökodesign-Anforderungen zu erfüllen und Hindernisse, Risiken und Chancen des Übergangs zu einer zirkulären Kunststoffindustrie abzuleiten.

Um die Kreislaufwirtschaft zu nutzen, benötigt der Abfallverarbeiter/Recycler genaue Informationen über die Art des Kunststoffs und seine Zusammensetzung, wenn die Verarbeitung zu Recyclaten führen soll, die mit Neuware konkurrenzfähig sind. Dies erfordert sauber getrennte Materialströme. Außerdem müssen die Rezyklate in ausreichender Menge und Qualität zu einem angemessenen Preis auf dem Markt verfügbar sein, insbesondere wenn es darum geht, die gesetzlich vorgeschriebenen Rezyklatquoten zu erfüllen. Die Hersteller/Vertreiber von Kunststoffprodukten werden verpflichtet, alle notwendigen Daten im Produktpass zu erfassen und diese entlang ihrer Lieferkette abzufragen (müssen).

Für kunststoffherstellende und -verarbeitende Unternehmen stellen die neuen gesetzlichen Anforderungen eine Herausforderung auf mehreren Ebenen dar:

Die bestehenden Dokumentationsvorschriften für Kunststoffe müssen an die neuen Anforderungen angepasst und zum Teil überarbeitet und erweitert werden, um den neuen Vorgaben zu entsprechen. Dies kann die Bereitstellung der notwendigen Informationen, die Schaffung neuer Prozesse und Schnittstellen sowie die Festlegung von Verantwortlichkeiten im Unternehmen beinhalten. Angst vor übermäßigen Dokumentationspflichten.

Verschärfte Offenlegungs- und Dokumentationspflichten, insbesondere im Hinblick auf die Materialzusammensetzung und -verarbeitung, lassen Rückschlüsse auf sensible oder heikle Produkteigenschaften und Herstellungsverfahren zu. Dies kann zu Konflikten mit Betriebsgeheimnissen, Geschäftsmodellen und Gewährleistungspflichten führen.

Die Umstellung auf durchgängig digitale Dokumentationsprozesse erfordert neue digitale Kompetenzen und - wenn diese nicht im eigenen Haus aufgebaut werden können - niedrigschwellige Tools und Services, die Unternehmen helfen, Produktdaten rechtssicher bereitzustellen, aber auch DPP-Daten gewinnbringend zu nutzen.

Hinzu kommen die wirtschaftlichen Auswirkungen von recyclingfähigen und DPP-konformen Kunststoffen und ergänzende Regelungen, wie z.B. das Recht auf Reparatur oder Rücknahmeverpflichtungen (erweiterte Herstellerverantwortung), die mittelfristig zu neuen Wertschöpfungsprozessen und Geschäftsmodellen führen werden (z.B. Plastics as a Service).

Die Finanzierung ermöglicht es dem Konsortium, die für die Durchführung der Forschung erforderlichen Ressourcen zu mobilisieren, das bereits vorhandene Fachwissen zu vertiefen und weitere Forschungsaktivitäten durchzuführen.

Abstract

DPP4PLASTICS is investigating the technical, legal and organizational implications of a digital product passport (DPP) for plastics producing and processing companies. The project aims to identify R&D needs for procedural and process-related deficiencies and needs to comply with the upcoming eco-design requirements and to derive obstacles, risks and opportunities of transition towards circular plastics industry.

To leverage circularity, the waste processor/recycling company needs precise information about the type of plastic and its composition if the processing is to result in recyclates that are competitive with virgin material. This requires cleanly separated material flows. In addition, recyclates must be available on the market in sufficient quantity and quality at an appropriate price, especially when it comes to meeting legally prescribed recyclate quotas. The manufacturer/distributor of plastic products will be obliged to ensure that all necessary data is recorded in the product passport, and they will (have to) request this data along their supply chain.

For plastics producing and processing companies, the new regulatory requirements pose a challenge on several levels:

The existing documentation regulations for plastics must be adapted to the new requirements and in some cases revised and expanded in order to meet the new specifications. This may involve providing the necessary information, creating new processes and interfaces and defining responsibilities within the company. Fear of excessive documentation requirements.

More stringent disclosure and documentation requirements, particularly with regard to material composition and processing, allow conclusions to be drawn about sensitive or sensitive product characteristics and manufacturing processes. This can lead to conflicts with trade secrets, business models and warranty obligations.

The switch to end-to-end digital documentation processes requires new digital skills and - if these cannot be establish in-house - low-threshold tools and services that help companies to provide product data in a legally compliant manner, but also allow them to use DPP data profitably.

Added to this are the economic effects of recyclable and DPP-compliant plastics and supplementary regulations, e.g. right to repair or take-back obligations (extended producer responsibilities), which will lead to new value creation processes and business models in the medium term (i.e. Plastics as a Service).

The funding allows the consortium to leverage the resources necessary for conducting the research, deepen already existing expertise and engage in subsequent research activities.

Endberichtkurzfassung

DPP4Plastics - Findings & Recommendations

Motivation and Research Questions

The introduction of Digital Product Passports (DPPs) as a facilitator towards a circular economy for plastics is a central objective of European sustainability policy, yet progress remains limited, especially for technical plastics used in electrical and electronic equipment (EEE) . While packaging plastics have received substantial regulatory and academic attention, plastics embedded in complex products such as electronics remain largely overlooked, despite their high material diversity, frequent use of hazardous additives, and poor recyclability. Fragmented value chains, insufficient transparency regarding material composition, and weak information flows across lifecycle stages continue to impede high-quality recycling and the broader uptake of secondary plastics.

The Digital Product Passport (DPP) , introduced under the Ecodesign for Sustainable Products Regulation (ESPR), has emerged as a key policy instrument intended to improve lifecycle transparency, enable traceability, and support circular material flows. However, the implementation of DPPs raises fundamental questions that extend beyond technical feasibility. It entails regulatory interpretation, data governance, organizational readiness, cost allocation, and coordination across heterogeneous actor landscapes.

The project was motivated by the need to better understand whether and how DPPs can effectively contribute to circularity in plastics-intensive value chains , with a specific focus on technical plastics in EEE. It aimed to bridge the gap between regulatory ambition and practical implementation by addressing the following core research questions:

What structural, regulatory, technological, and organizational barriers currently hinder circular pathways for technical plastics?
What data, system architectures, and governance mechanisms are required for effective DPP implementation in the plastics sector?
How well are value-chain actors prepared for DPP adoption, and what benefits and challenges do they anticipate?
What impacts, risks, and opportunities arise from DPP implementation across different actor groups?
Which policy, technical, and organizational measures are necessary to operationalize DPPs in a way that delivers real circularity outcomes?

Research Design

The project adopted a multi-method, interdisciplinary research design , combining regulatory analysis, sectoral assessment, qualitative empirical research, technological analysis, and impact-oriented evaluation.

First, a sectoral analysis examined the structure of the European plastics industry, with particular attention to technical plastics and EEE applications. This analysis highlighted the sector’s high heterogeneity, dominance of linear value chains, strong reliance on fossil-based virgin materials, and limited competitiveness of recyclates, especially for plastics containing hazardous additives.

Second, a regulatory analysis mapped the evolving EU policy landscape relevant to plastics and DPPs, including the ESPR, WEEE, RoHS, REACH, and Extended Producer Responsibility (EPR) frameworks. This revealed a complex and fragmented regulatory regime, with overlapping objectives but insufficient integration across product, chemical, and waste legislation.

Third, the project conducted a technological analysis of DPP architectures, content models, identifiers, data carriers, and standardization initiatives. Existing frameworks and standards were assessed regarding their suitability for plastics-specific requirements, such as material composition disclosure, additive traceability, and long-term data persistence.

Fourth, an adoption experiment combined a qualitative company survey with a material flow case study . Semi-structured interviews and workshops with actors across the plastics value chain explored preparedness, perceived benefits, implementation barriers, and organizational capabilities. In parallel, a demonstrator DPP was developed for a simplified product to simulate data flows across lifecycle stages and identify practical implementation challenges.

Finally, the project applied a double materiality analysis as an integrative impact assessment framework. This approach was used to identify potential environmental and social impacts (inside-out perspective) as well as financial risks and opportunities (outside-in perspective) associated with DPP implementation across upstream, downstream, and horizontal actors. The analysis was exploratory and primarily qualitative, with a focus on impact materiality; a comprehensive financial materiality assessment was beyond the project’s scope.

Recommendations to Accelerate DPP Uptake in the Plastics Sector

To conclude, informed by both scholarly and industry perspectives, we outline a condensed set of recommendations.

Governance, Standards, and Regulatory Clarity

Codify minimum DPP data sets by product group, aligned with circular outcomes: polymer grade, additives of concern, joining methods, disassembly instructions, recycled content, and EoL routing. Harmonize semantics across EU and sectoral standards to ensure machine readability and cross-border use (WBCSD and BCG, 2023; Zhang and Seuring, 2024).
Resolve mass-balance accounting with EU-wide, auditable rules (calculation methods, flow diagrams, attribution limits, rolling averages) to prevent greenwashing and protect mechanical recycling competitiveness (BDE, bvse, VBS and VOEB, 2025; Ecopreneur, 2023; EuRIC, 2025).
Clarify liability and access rights: the actor placing the product on the EU market remains legally responsible for DPP data; define role-based access to protect IPR while ensuring recyclers and authorities receive the information they need (WBCSD and BCG, 2023).
Integrate DPP with EPR: make DPP data usable in fee modulation, performance benchmarking, and tendering rules that favor

high-quality sorting and recycling (Baxter et al., 2015).

Data Infrastructure and Interoperability

Adopt globally resolvable identifiers (e.g., GS1) at component level where feasible and pair them with trusted claims (e.g., verifiable credentials) for compliance and recycled-content declarations. Ensure persistent linkage via robust data carriers (QR, RFID, digital watermarks) appropriate to use conditions (WBCSD and BCG, 2023).
Mandate interoperable APIs and shared ontologies so that OEM PLM/ERP, converter MES, PRO/EPR systems, and recycler IT can write/read DPP data seamlessly. Prioritize machine-readable formats to reduce administrative burden (Zhang and Seuring, 2024).
Balance security and scalability in architectures: prefer hybrid models (off-chain data, on-chain proofs) only where they demonstrably add trust without undermining GDPR compliance or performance (Hsu et al., 2022).

Market Creation and Investment Signals

Create predictable demand via recycled-content targets in priority segments (packaging, selected EEE housings) and green public procurement criteria that reference DPP fields (Milios et al., 2018; European Investment Bank, 2023).
De-risk private investment: deploy framework loans and blended finance for sorting and advanced washing/extrusion capacity; tie concessional finance to verified DPP metrics (European Investment Bank, 2023).
Disincentivize leakage: consider time-bound restrictions on incineration of readily recyclable plastics, phased with capacity expansion, and require DPP-supported traceability for export streams (Milios et al., 2018; Amadei et al., 2025).

Upstream Design and Supplier Enablement

Make “Design for Circularity” measurable in the DPP: require disclosure of dismantlable joints, mono-material preference, and coating/adhesive choices that affect sortability and yield (Verein Deutscher Ingenieure, 2023; Van der Vegt et al., 2022).
Close composition data gaps with layered access: suppliers provide additive and formulation data as protected attributes while exposing hazard-relevant flags and disassembly guidance to recyclers (Hsu et al., 2022; WBCSD and BCG, 2023).
Support SMEs with templates and tooling (guided data entry, conformity checkers) and shared technical profiles per application (e.g., PC-ABS for small electronics), reducing cost and complexity (Zhang and Seuring, 2024).

Downstream Performance and EoL Integration

Operationalize DPP at EoL: equip sorting plants with readers and data services to ingest DPP fields; pilot DPP-informed “targeted dismantling” for EEE plastics with additives of concern to increase compliant yields (Verein Deutscher Ingenieure, 2023).
Standardize feedback loops: require recyclers to return quality and yield data (e.g., MFI, contamination, color drift) into the DPP, enabling upstream redesign and reliable sourcing of secondary feedstock (Van der Vegt et al., 2022).
Address export opacity: condition shipment permissions on DPP-based traceability and reporting, reducing leakage and mismanagement impacts (WBCSD and BCG, 2023; Amadei et al., 2025).

Organization-Wide Adoption and Human Capital

Treat DPP roll-out as a cross-functional program (design, procurement, manufacturing, IT, compliance, EHS, aftermarket). Define internal RACI, budget lines, and change-management plans; align PLM/ERP roadmaps with DPP data models (WBCSD and BCG, 2023).
Invest in skills and literacy: train designers in recyclability constraints, operators in data capture, and compliance teams in DPP governance; provide consumer-facing transparency that summarizes DPP content without exposing sensitive details (Hsu et al., 2022; Zhang and Seuring, 2024).

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