
# Achieving a circular economy: using data-sharing tools, like the Digital Product Passport

A system perspective on the barriers and opportunities of data-sharing tools in the chemicals, electronics, construction and apparel sectors

World Business Council for Sustainable Development

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# Contents

# Executive summary

**The concept of a circular economy has gained significant attention as an alternative to the traditional linear model of production and consumption. This is an economic model that is regenerative by design; it seeks to retain the value of circulating resources, products, parts and materials.[1] To achieve a circular economy, it is crucial to enable effective resource management and maximize the value of products and materials throughout their lifecycle.**

Data sharing tools, such as the European Commission's (EC) Digital Product Passport (DPP) as adopted in the Ecodesign for Sustainable Products Regulation, have emerged as promising solutions to facilitate the transition toward a circular economy. This insight report explores the potential of data-sharing tools like the DPP to enable various purposes (identified in the system maps) across the chemicals, textiles (apparel), construction, and electronics value chains - sectors of interest to the EC and the members of the World Business Council for Sustainable Development at the time of writing.

According to this study, sharing product information throughout its lifecycle can facilitate circular strategies for all stakeholders involved in the value chain. Harnessing the power of data has the potential to support value chain actors, such as manufacturers, suppliers, retailers, consumers, and recyclers, in making informed decisions, optimizing processes, and identifying opportunities for circularity.

Cross-sectoral insights identified in this research highlight the complexity of supply chain networks, extending beyond just European borders; opportunities for streamlining reporting operations; the need for the standardization of data, and the assurance of data security, accessibility, and compatibility. Sector-specific insights identify circularity trends from the flow of data through the supply chain. Focus areas for sectors as well as the opportunities created and barriers to be addressed for a data-sharing tool are also discussed on a per-sector basis.

Collaborative efforts among governments, businesses, and consumers to realize the full potential of data-sharing tools in driving circularity are recommended. The complexities of the multi-tiered supply network; the dominant structures of current reporting burdens; sector-specific leverage points for circular product systems; sector-transcending metrics and their order of priority; taking an iterative approach in the formalization of specific data points, and; consulting the IT industry on the technical requirements of developing data-sharing tools are recommended next steps to expedite further research, development, and rollout of a data-sharing tools like the DPP.

# 1 Introduction

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**The European Union has set a high ambition to transition to a modern, resource-efficient and more competitive economy in the next decade – including one that is more circular.[2] The circular economy is an economic model that is regenerative by design. With the goal of retaining the value of circulating resources, products, parts and materials, the circular economy creates a system of innovative business models that allow for renewability, long life, optimal (re) use and recycling, as well as various other circular strategies[3] and biodegradation. It is an approach that departs from current linear economic practices, which often result in negative impacts, such as the depletion of scarce, virgin resources, shorter product lifespans, and valuable materials seen as waste destined for the landfill. Instead, by applying circular principles organizations can collaborate to design out waste, increase resource productivity, and maintain resource use within planetary boundaries.[4]**

One of the enablers to mobilize a circular economy is having insight into the physical properties and movement of products and materials. All advanced circular economy strategies, from refurbishment to recycling, depend on the availability of reliable and up-to-date data, which is currently largely unavailable. One of the most prominent barriers to achieving circular economy goals in the European Union is the lack of sharing product information between value chain actors.[4] Using data-sharing tools, which communicate product and material information to actors along the supply chain, can enable this. As such, these tools can support the tracking and tracing of information along the supply chain, allowing actors to know where their materials come from as well as their properties. The announced implementation of the Digital Product Passport (DPP) by the European Commission under the new Ecodesign for Sustainable Products Regulation (ESPR) is an example of a data-sharing tool with the potential to unlock a circular economy.

New impetus regarding both the policy and implementation of DPPs stems from the European Green Deal and the Circular Economy Action Plan. In March 2022, the European Commission released a communication paper announcing the planned implementation of the new ESPR. It states DPPs will be mandatory for all products regulated by the ESPR entering the European Union (EU) market, coming into effect for the first product groups in 2026/2027.[6]

### What are Digital Product Passports?

A Digital Product Passport, as defined in the ESPR, is a structured collection of product-related data, conveyed through a unique identifier. Stakeholders in a supply chain can electronically access information related to sustainability, circularity and value retention for circular business models through pre-determined data ownership and access rights. This includes raw material producers/extractors, end-of-life actors, authorities and consumers. As denoted in the new ESP regulation, this data allows the DPP to support sustainable product production, encourages the implementation of services and repair business models, helps businesses and consumers make well-informed decisions, and aids compliance verification.[7] The DPP also has the potential to achieve goals outside of those included in the ESPR. By using and integrating many of the data points that organizations are currently collecting, such as greenhouse gas (GHG) emissions, life-cycle assessments (LCAs), corporate social responsibility reporting, the DPP has the potential to enable circularity by streamlining reporting operations across supply chains and overcoming the lack of transparency by facilitating the sharing of data. This can allow businesses, consumers and public procurers to make better-founded decisions for sustainable procurement.[8]

Different sectors have already initiated concepts similar to the European Commission's DPP. Organizations in the construction and building sector, for example, have proposed multiple digital passports that are in operation. These include material passports (which contain detailed information about materials used in a building or infrastructure, such as a bridge),[9] building renovation passports and energy performance certificates, as part of the Energy Performance of Buildings Directive.[10]

Other sectors that are paying increasing attention to similar initiatives are the electronics, textiles, automotive, packaging and plastics sectors. The battery sector has already developed the concept for an industry-wide battery product passport. As the first operable DPP – all industrial batteries with a capacity greater than 2kWh, electric vehicles batteries and light means of transport (LMT) batteries will require a QR code, giving access to a battery's product passport, by 2027.[11] With the first implementation scheduled for 2024, the battery passport promotes the development of a competitive sustainable battery industry, supporting Europe's clean energy transition and independence from fossil fuels, as well as its circular economy and zero-pollution ambitions.

While delegated acts will specify the product-specific or product-group details of the DDPs, organizations have yet to develop them for the majority of industries.
There are currently no specifications for the product-specific content of the DPPs, nor the technical specifications and the required systems and infrastructure to facilitate it, leaving uncertainties for value chain actors on how to best prepare for the regulation's implementation.[12] While different groups are currently working to answer the open questions associated with the DPP – such as the CIRPASS consortium, which is preparing the ground for the gradual piloting and deployment of the DPP – the European Commission has indicated that it will rely on industry input for the further shaping of the DPP and its implementation.[13]

## Purpose and structure of this report

This report provides insights to lawmakers, WBCSD members and stakeholders of the respective value chains addressed in the ongoing development of data-sharing tools, like the European Commission's Digital Product Passport.

This multidimensional report elaborates on how four investigated sectors would benefit from an effective and feasible data-sharing tool to transition to a circular economy. The sectors of interest in this research include: chemicals, electronics, construction and apparel.

The investigation identifies data points that help support sustainable production, provide new business opportunities to economic actors, support consumers in making sustainable choices, and allow authorities to verify compliance with legal obligations. We have created in-depth sector mappings to identify which actors in the value chain have specific information and which actors would require that information to enable various purposes. Clarity on the complete value chain dynamics of data sharing is beneficial in the eventual design of data-sharing tools and/or of the delegated acts of the upcoming DPP policy. Furthermore, key circular strategies link to sector-specific dynamics, focus areas, opportunities and barriers to implementation.

Section 2 of the report presents cross-sectoral insights. These are overarching insights that apply to all four researched sectors. Section 3 shares insights for each sector, starting with a short introduction to the sector, followed by the focus areas for circularity, the opportunities unlocked by a data-sharing tool and the barriers to capitalizing on them. We present them in order of interest and opportunity, according to our research. The document concludes with suggested next steps.

## Approach

Our work adopted a value chain approach (see *Figure 1*) to circular strategies and we strove to include stakeholders from all parts of the value chain to ensure the drafting of a holistic position. The Value Hill in the figure visualizes a product's life cycle and potential reuse along a value chain.

The Value Hill depicts the three life-cycle categories: pre-use where a product gains value as it moves up the supply chain, in use at the top of the hill, and post-use where the product loses value. It illustrates how feeding (components of the) products back into the supply chain retains value. For example, products collected and sold by second-hand sellers flow directly back into the use phase. Refuse in this context means reduced use by the consumer, i.e., buying fewer products.[14]

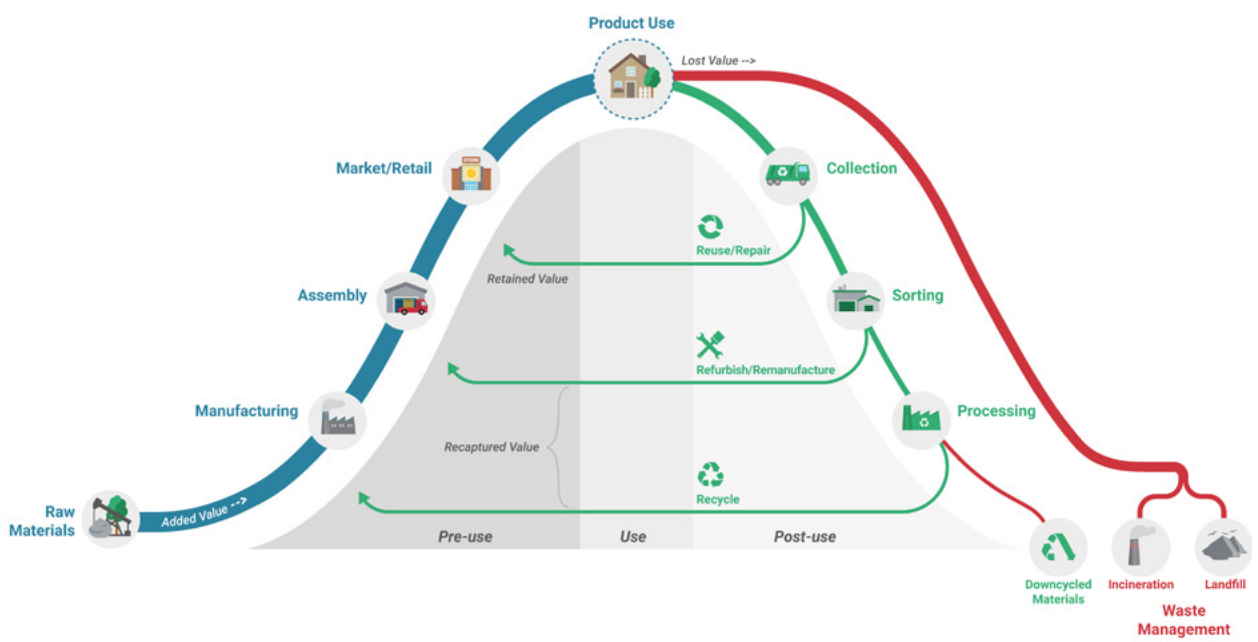
The Value Hill (*Figure 1*) provides a framework to classify circular strategies (R-strategies) and their role along the value chain. In terms of value retention, there is a clear hierarchy for circular strategies throughout a product's lifetime, from design all the way through to end-of-life. The pre-use phase can apply R-strategies referring to the rethinking of practices and redesigning products with circularity in mind. Different data types within a data-sharing tool serve various purposes in driving towards the R-strategies, as well as the overall transparency and traceability of value chain activities.

## Sector mapping

Sector maps are foundational to this report and serve several purposes. They gather insights from stakeholder interviews, desk research and conversations with the European Commission to reveal where the ownership of key data points resides. The maps show actors can leverage this data along the supply chain to drive circularity goals. Finally, the maps depict a view of how the implementation of a data-sharing tool, like that of the DPP, can impact product systems.

We validated the maps in workshops with the stakeholders representing the four sectors in scope: chemicals, electronics, construction and apparel.[15]

**Figure 1:** Metabolic adapted the Value Hill framework developed by TU Delft and Circle Economy



Each sector is a frontrunner in adopting circular practices and therefore receptive to the opportunities of implementing a data-sharing tool like the DPP. Each stands to benefit from enabling circular strategies.

The European Commission has introduced the DPP and its role in supporting sustainable product production, encouraging the implementation of services and repair business models, helping businesses and consumers make well-informed decisions, and aiding compliance verification. However, it has not clarified direct links between these goals and the data needed to enable them. Interviews held as part of this research indicate several areas where value chain actors would ideally need data to achieve circular economy (and other) goals. In classifying the DPP's purposes, we identified six cross-sectoral strategies and embedded these in all four sector maps. Each strategy – detailed below –links to the Value Hill's R-strategies.

**Traceability and reporting**

By tracing materials throughout a product's life cycle, it is possible to hold manufacturers and users accountable for their handling of the product. This can incentivize manufacturers to **rethink** and **redesign** products with **reuse, remanufacturing** and **recycling** in mind. Holistic reporting has the opportunity to reveal the often obscured impacts of (complex) supply chains. Increased awareness of a product's embodied impacts can enable consumers and procurement agents to make conscious buying decisions by **refusing** particular products.

**Responsible product purchasing and use**

Consumers play an important role in a thriving circular economy. The impact of their procurement considerations moves up the value chains of products they decide or **refuse** to buy. Increasing demand for products with low environmental impacts and high circular potential can promote circular economy principles for goods and services. Information on how to treat, maintain and repair a product during its use phase should empower consumers. They, in turn, are accountable for how they handle a product and dispose of it properly, to enable the **reuse**, **refurbishment** or recycling potential of its components and materials.

**Smart design and manufacturing**

A core circular economy principle is greater emphasis on the smart design and manufacturing of products. This links directly to the **redesign** of products and **rethinking** the way in which companies deliver value. Compared to putting greater emphasis on solutions that mitigate the negative impacts of poor design at the end of a product's life, the innovation in product design and manufacturing processes is much greater.

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### Safe and equitable practices

The circular economy can play a critical role in the evolution of societies to prioritize human and planetary health through the equitable distribution of wealth and access to services. Environmental and social justice should be front and center in decision-making and actors should be accountable for their current and future activities along the full length of supply chains. Achieving this goal will require **rethinking** the livelihoods and communities of people involved in the products and services used and **redesigning** supply chain practices to ensure full traceability and transparency.

### Effective material cycling

Being able to recover and return materials effectively and responsibly into technical and biological cycles will be a vital piece of the transition away from using virgin fossil-based resources.[16] The Value Hill captures this with **recycling**. This post-use R-strategy extracts the material of a product or its components for use as a feedstock for new applications. The design of the product and the information available on its material content strongly enable an effective recycling practice. The **redesign** of products and **rethinking** of feedstock to accommodate recycled material use affect the demand for recycled materials.

### Product lifetime extension

Extending the lifetime of products via smart design choices and circular services is a significant leverage point for (negative) impact reduction. It connects to the higher R-strategies on the right side of the Value Hill: **reuse**, **repair** and **refurbish**. These strategies avoid product waste by addressing a product's desirability, fixing impaired features, or upgrading features, respectively.

# 2 Cross-sectoral insights

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This research revealed five overarching, cross-sectoral insights regarding the implementation and opportunities of data-sharing tools like the DPP. They transcend or apply to all four sectors in the scope of this research: chemicals, electronics, construction and apparel. These insights are based on the current state of play and thus focus on the current scope of activities for these sectors. It is important to acknowledge that, in addition to product-specific data points, data-sharing tools that are relevant for products in general and across sectors (such as environmental impact data) may also capture data.

### Product systems often consist of complex supply networks that extend beyond the borders of the EU

Within the current ESPR proposal, the reporting burden for the entire supply chain shifts to the original equipment manufacturer (OEM) that places the product on the European market. We presume a trickle-down effect where the reporting pressure pushes up the supply chain from supplier to supplier. Our data finds that stakeholders are hesitant about the effectiveness of this approach, especially beyond tier 2 suppliers. Our research shows interest for, and a willingness to participate in, additional dialogue on potential solutions.

### Data-sharing tools provide the opportunity to support and streamline existing reporting operations

Businesses from different sectors face increasing inquiries to report on the environmental performance of their operations and their products. Currently, regulatory compliance only partly motivates this but clients and investors are increasingly market leaders in these inquiries. The lack of standardization among different stakeholders results in requests for similar information in many formats and using varying calculation methods.[17] This leads to an unnecessarily high reporting burden, especially for organizations that operate upstream in value chains, like **chemical** companies, which commonly have overlapping supply chains. Our data shows a desire to be able to use a tool like the DPP as a single source of truth with consistent terminology and methodology and, in that form, realize its potential to streamline existing reporting activities, reducing the burden on the value chain.

### Formalizing standards is a prerequisite for data captured in a data-sharing tools, like the DPP

Our data shows a strong desire for those data points required for a data-sharing tool, like the DPP, to follow a formalized definition, calculation method, and predefined data format. This could ensure consistency and, with that, the quality of data points collected.

The European Commission has already started to take steps along these lines with the formalization of life-cycle impact assessments through the introduction of the Product Environmental Footprint (PEF). Our research suggests that to realize the full potential of a data-sharing tool like the DPP, it is necessary to consider a much broader scope of data points than those of the PEF for adoption. To limit burdens on the value chain, it is necessary to seek standardization at the highest possible level, with cross-sector and cross-product validity. Of course, there might be data points, like product performance, that require a product or category-specific approach.

## Ensure data security, accessibility and compatibility

There is a heavy technical component to the implementation of product passports and similar data-sharing tools. In this sub-chapter, we reflect on current suggestions for the DPP, for which the European Commission envisions the primarily decentralized development of the required infrastructure. The Commission will provide the technical requirements for the DPP and leave it to the market to deliver the necessary solutions. The technical rollout of the DPP is instrumental to its success. As such, we have broken this sub-chapter into four components, looking at accessibility, security, compatibility, and the physical component of the DPP.

**A function of the DPP is to make product data accessible to different stakeholders within a product system.** In accordance with this purpose, it is the European Commission's ambition to make much of the data reported through the DPP publicly available in a centralized database (the European data space for smart circular applications).[18] Many organizations in different industries, namely original equipment manufacturers, have raised concerns about the sensitivity of the data they are expected to share, primarily with regard to data that could affect their competitive position, such as disclosing supplier details, where raw materials are sourced, and the pricing of products and supplies. This is also not a requirement, as not all data points are relevant to all actors in the value chain. Access rights to the DPP should be determined on a need-to-know basis, given their function in achieving specific (ESPR) goals. In doing so, they can still safeguard legal consistency in coherence with the Data Act when published in the *Official Journal of the European Union*, with product data relevant to the consumer adhering to the European Accessibility Act.

**The assurance of data security is fundamental to securing organizations' buy-in to sharing their data.** It is necessary to put protocols and security measures in place to safeguard data privacy and confidentiality during the data-sharing process across the value chain. The success of the proposed decentralized and market-led implementation hinges on the clarity of technical requirements.

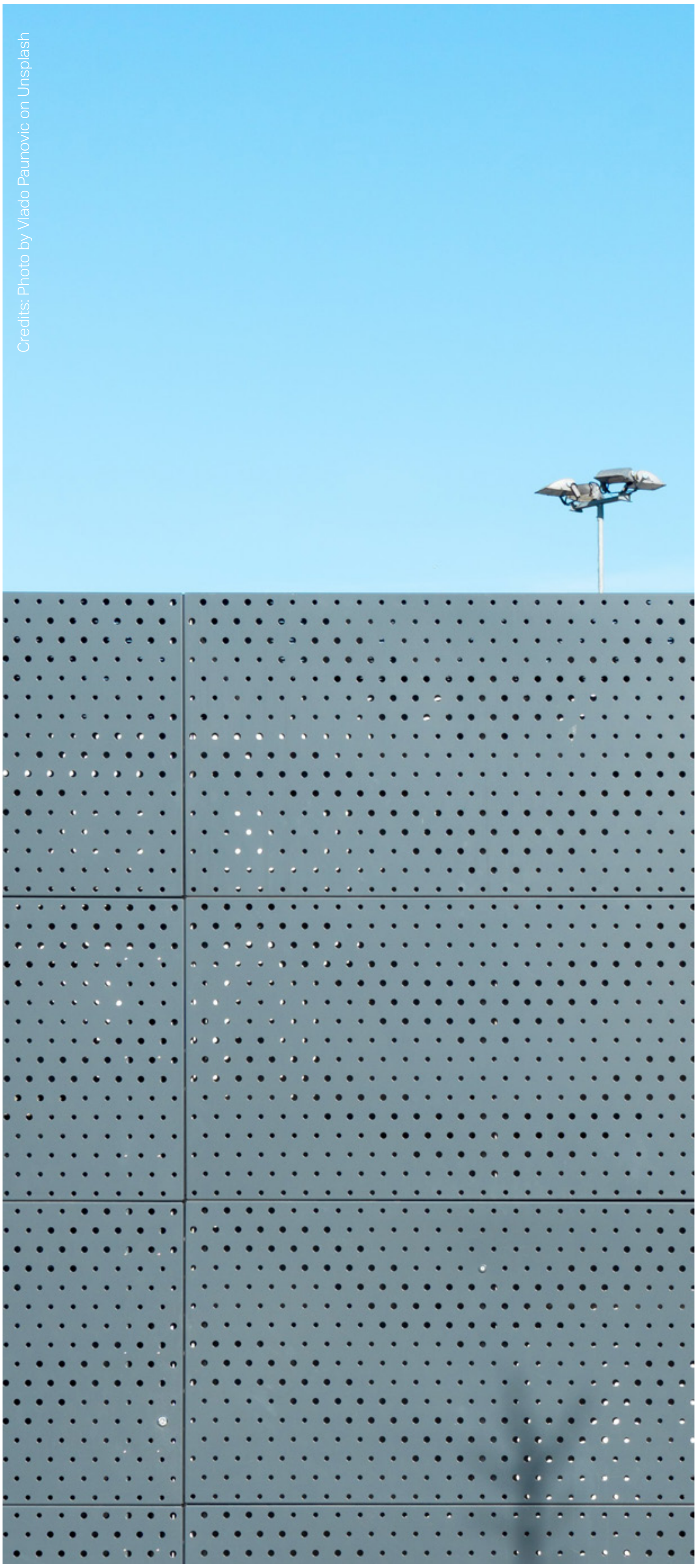
**Technical compatibility of the data in the DPP is an added dimension to the above mentioned standardization.** The technical requirements of the DPP should facilitate the verification of data and compatibility of the format in which stakeholders in the value chain save and share the data. These will require high standards to enable the use of data for their intended purposes within the DPP. Feedback from the LCA community shows the prescribed protocol (using a markup language that provides rules to define data) has a limiting effect on performing LCAs and, effectively, on the data results shared. As a system the DPP may rely on, this highlights how technically induced limitations can potentially be detrimental to the effective deployment of the DPP.

**The physical component of access to the DPP, so-called data carriers, require appropriate selection.** It is necessary to take both the physical characteristics of the product and the manner of accessing the data carrier (such as scanning a QR code) into consideration. The data needs to be easily accessible throughout the product's value chain, including at the post-consumer phase. E-labels, like a QR code, are the preference because they are the least expensive and more-sustainable solution. At the same time, this means taking product-specific considerations into account as well. An engraved QR code on a battery's exterior should not hamper its function and should scan well after dismantling the enclosed product. Yet the same QR code on the inside of a piece of clothing may decrease the efficiency of a textile sorting system, as these items typically do not arrive as uniformly as a battery would in a dismantling facility. Placing a QR code on a removable label, packaging or accompanying papers poses the risk of losing information in the event of the separation of the product from these data carriers.

### The administrative burden of data-sharing tools run the risk of becoming an entry barrier

Our data shows considerations about the possible consequences of a data-sharing tool's implementation/compliance costs as they could pose potential challenges for small and medium-sized enterprises (SMEs). These organizations often have limited capacity and would face a high administrative burden in order to comply with data requirements. The European Commission realizes that DPPs are likely to result in the creation of "preferred suppliers" that have sufficient resources to implement DPPs and is working to avoid this.

One means of lowering this barrier is to count on cloud-as-a-service solutions, whereby data intermediaries will be critical in allowing easy plug-in at a minimal cost. As such, a data-sharing tool like the DPP will provide a common framework to increase transparency and fair competition between larger brands and smaller businesses.



# 3 Insights by sector

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Much of the details of the data part of the European Commission's DPP remain unclear. However, this is a key enabler for transitioning to a circular economy and also the aim of the DPP. Therefore, shedding light on the data needs and wants of stakeholders throughout a value chain is essential in creating an effective policy instrument. As our research found, there are many concerns regarding balancing the needs for data transparency with the need for data privacy within and between value chains. Moreover, the question of which data is necessary to really enable a circular economy for each sector or product group is also pertinent to creating an effective and feasible instrument.

This section shares the insights and sector maps created from our research that are specific to each of the sectors in scope: chemicals, electronics, construction and apparel. The sector maps illustrate the relevant data points that exist within each of the value chains investigated. Moreover, they point out which actors own the data and which stakeholders the reception of the data– through a DPP or similar data-sharing tool – will enable in order to incorporate more circular practices in their operations. Each sector uses the following structure:

- A brief introduction to the sector, touching upon relevant sector-specific circularity themes;
- Sector maps, providing a visual representation of data wants and haves linked to specific circular economy purposes;
- The focus areas, highlighting the circular economy goals aided by the implementation of a data-sharing tool, like the DPP;
- A list of specific opportunities a tool like the DPP unlocks, by sector;
- Finally, the barriers to capitalizing on these opportunities.

It is important to note here that the insights generated on unlocking circular economy opportunities do not link to the exact and current format of the European Commission's DPP (of the ESPR) at the time of writing. The insights stem from a lengthy consultation with stakeholders and their wishes and desires for a data-sharing tool that could help enable a circular economy, among others (see Chapter 1).

**INFO BOX – Reading the sector maps. Each map contains the same four-column structure representing data owner stakeholders; data points for a data-sharing tool; data user stakeholders; and potential purposes for the data as applicable to each sector.**

Column 1: Stakeholder (owner) – the stakeholder groups that currently have access to specific data points relevant to a data-sharing tool, like the DPP.

Column 2: Data type – the piece of data that the Data Owner is expected to share with the Data User through a tool, like the DPP, in order to achieve set circular goals. We have identified four categories of Data Types: embodied materials or processes, social and environmental impact data, instructions for care or end of life, and product performance data.

Column 3: Stakeholder (user) – the stakeholder groups that the use of specific data points shared through a data-sharing tool, like the DPP, enables to achieve specific circularity goals.

Column 4: Purpose – the potential goals that the Data Users can realize with the facilitation of a data-sharing tool like the DPP. Symbols distinguish each purpose according to the six purpose categories discussed earlier in this report:

- Traceability and reporting
- Responsible product purchasing and use
- Smart design and manufacturing
- Effective material cycling
- Safe and equitable practices
- Product lifetime extension.

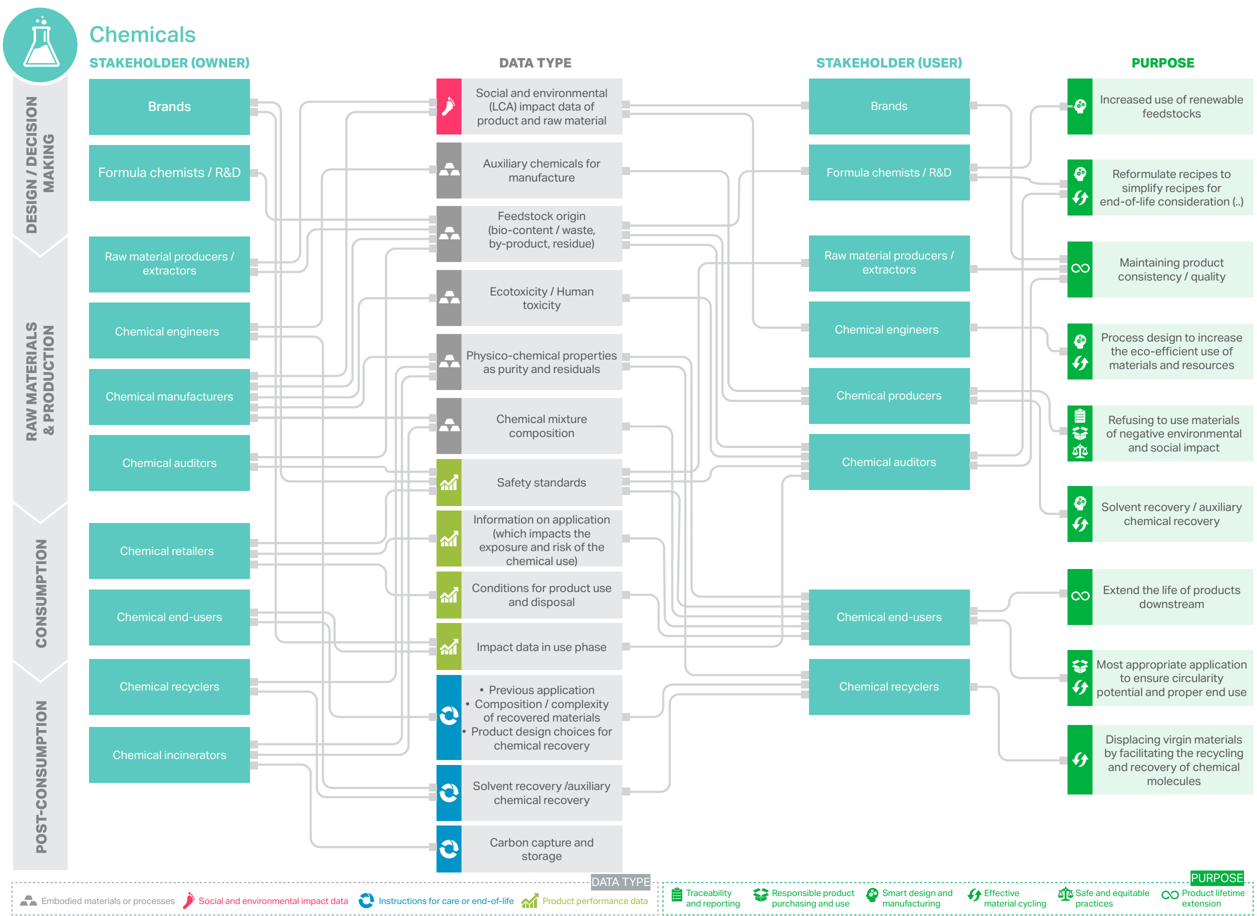
## 3.1 Chemicals

Chemicals are ubiquitous across many sectors in finished goods and the production processes used to make them. Nearly 140,000 industrial chemicals are available worldwide, driven by the increasing growth of chemical-intensive industries such as agriculture, construction, plastics, textiles, mining and electronics.[19] Some of these consist of hazardous chemicals, products that contain them or their hazardous wastes. With chemicals used in the past still present in old products and materials, we highlight the pre-implementation of the REACH regulation and the relevance of recording the composition and movement of these materials, particularly in the post-use phase, and of prohibiting their accumulation in the environment, independent of their application sector.

The chemicals industry plays a critical role in the acceleration of circularity and planetary health along the full life cycle of many product groups as it consumes and transforms many chemicals into other materials (for example, plastics, adhesives). This includes the recovery of valuable compounds from post-consumption materials. The European Commission's European Green Deal also recognizes this, stating that energy-intensive industries, including the chemicals industry, are indispensable to Europe's strong and sustainable economy of the future.

The chemicals industry can play an active role in supporting the recycling processes of many sectors, such as the recycling of wind turbines and producing of battery components to reduce $CO_2$ emissions in the manufacturing of electric vehicles.[20] Building on the EU Strategy to achieve "a toxic-free environment",[21] the chemicals sector can influence and enable many downstream actors to integrate low-carbon, non-hazardous, and energy- and resource-efficient technologies, materials and products. Stakeholders should also consider proactively reformulating products and materials to eliminate compounds that inhibit downstream recycling as effective levers.

**Figure 2:** Sector map for the chemicals sector



## Focus areas for circularity in the chemical sector

Some 96% of manufactured goods today use resources derived from chemical processes. Altering climate change, restoring nature, and addressing inequality require the chemical industry to transform to a "Planet Positive"[22] system and thus play a key role in enabling a functioning circular economy. This includes, for example, shifting from volume to value, engaging with adjacent sectors up and downstream in the value chain, and integrating new capabilities and partnerships.

The chemical sector map (*Figure 2*) identifies stakeholders that own key data points and how actors along the supply chain can leverage this data to drive specific purposes that enable circularity in the sector. Our research identified the most important circularity trends within the chemicals sector. These trends link to the purposes shown on the system map through the six circularity strategy categories that form the backbone of this analysis.

**Green chemistry** to ensure that the chemicals manufactured and embodied in downstream products are not of risk to human and ecosystem health. This includes phasing out chemicals of concern from products altogether and using safe-by-design principles to establish management systems for chemicals and waste that mitigate damage to natural resources, including water, air and soil.[23]

- Relevant stakeholders: brands, formulation chemists, chemical manufacturers, chemical end-users

**Reuse and recovery** of auxiliary chemicals and heat used during their industrial processes. This requires proper waste management infrastructure to allow for the collection of processing waste and heat and ensuring sufficient quality of recovered solvents and auxiliary materials. This can also support the application of alternative business models, such as chemicals as a service.

- Relevant stakeholders: chemical engineers, chemical manufacturers

**Using more waste-, bio- and $CO_2$-based feedstocks**, and the technologies to efficiently transform them, in the transition to reducing the use of virgin and non-renewable raw materials. Depending on the cases, companies can use these raw materials as feedstocks or directly feed them into the same reactor alongside petrochemical and virgin materials. Mass-balance accounting can facilitate and effectively communicate the use of recycled and bio-based feedstocks by calculating percentage output and supporting the transition.

- Relevant stakeholders: manufacturers, formulation chemists, raw material producers

**Decarbonization of processes** through the use of renewable energy and innovation for increased efficiency. There is an ambition for the European chemical industry to become climate neutral by 2050. As a keystone sector for low-carbon process innovation, it serves as an accelerator of reduced greenhouse gas emissions across multiple downstream sectors.[24] As chemical production is a key upstream activity of many supply chains, chemical companies will play a vital role in the reporting of scope 3 GHG emissions.[25] Improving resource and energy efficiency can be done by using digital tools such as predictive analytics and energy management through artificial intelligence in the future, which can complement a tool like the DPP as well.

- Relevant stakeholders: manufacturers, chemical end-users

**Extending the lifetime and recoverability of products** by helping downstream users choose chemical products that increase the physical durability of their manufactured goods and at the same time allow for the recoverability of all materials at the end of their useful lifetime.[26]

- Relevant stakeholders: formula chemists, chemical producers and chemical end-users

## Opportunities for data-sharing tools in the chemical sector

We identified the following opportunities for data-sharing tools like, or partially covered by, the DPP to contribute to the important role the chemicals industry will play in a transition to a circular economy across many other industries.

**Promoting systemic design choices in downstream products and processes:** By providing data on material properties and environmental impact metrics, chemical manufacturers can support downstream users in their design choices and the application of certain materials in their final products. This will accelerate the scaling up of responsible innovation in both product and process design along the value chain. It will allow chemical manufacturers to integrate services for improved resource efficiency and circular material management.[27] With increasing downstream cross-sectoral demand for recycled materials, there is an opportunity for tools like the DPP to support the real-time monitoring of recycled materials and their final applications. Chemical recyclers will have an important role in defining the feedstock specification data that other partners will need to provide for materials to responsibly cascade through recycling systems to retain the highest material value.

**Ensuring fair competition between different actors in the value chain:** DPPs and similar data-sharing tools can support cross-border adjustment mechanisms to compare products from different origins to ensure and promote higher quality and ensure fair competition between chemical manufacturers.[28]

**Developing guidance on responsible sourcing:** Stakeholders can leverage tools like the DPP to create guidance on responsible sourcing practices across the sector, using raw material impact data to inform manufacturers on new or alternative potential feedstocks. This will become increasingly important for monitoring the carbon emissions reduction potential of waste-, bio- and $CO_2$-based feedstocks.

**Supporting compliance, regulatory action and standard-setting:** The collection of material sourcing and performance data can support regulatory bodies to ensure the phasing out of all substances of concern accordingly and the taking of appropriate steps to ensure the safe application of chemical products. Policymakers and regulatory bodies should be able to capture the impact of circularity and technology developments over time[29] and the European Commission's DPP infrastructure could readily support this temporal analysis

## Barriers to implementing data-sharing tools in the chemical sector

**Data collection for multiple actors along complex supply chains:** There is a need to create strategies to collect reliable data that is often missing from upstream activities, such as the production of auxiliary chemicals, solvents and lubricants manufactured by other suppliers. With complex chemical supply chains often crossing borders in the EU, it is important that the data collection process align with the protocols of supply chain partners and regulatory bodies outside of the EU to collect the data for inclusion in data-sharing tools, like the DPP.[30]

**Standardizing data types:** Co-creating the scope of data collection practices and data types across the industry will be a critical yet challenging success factor in building a streamlined approach for regulators and certifiers to validate the quality of the data. This process will include alignment with existing reporting requirements and their metrics, across and within industries.
Being industry-agnostic and industry-specific and their level of granularity will be important in standardization to ensure the use

of definitions across and within the industries that align with impact metrics. Failing to achieve such standardization will lead to the data occurring in as many forms as there are organizations collecting it. This creates a barrier to bringing the data together in an effective manner and ensuring consistency.

**Sharing of confidential information and securing data storage:** As noted, the chemicals sector is an important sector because industries consume and transform many chemicals into other materials (for example, plastics, adhesives). Chemical producers are worried about losing competitive advantage by sharing sensitive data points in tools like the DPP. This will become increasingly important as engagement grows along the supply chain from upstream to downstream actors.

**Economic burden of reporting:** Assembling data for data-sharing tools like the DPP has an operational cost. Expectations are for these costs to be high for complex supply chains such as those involving chemicals.

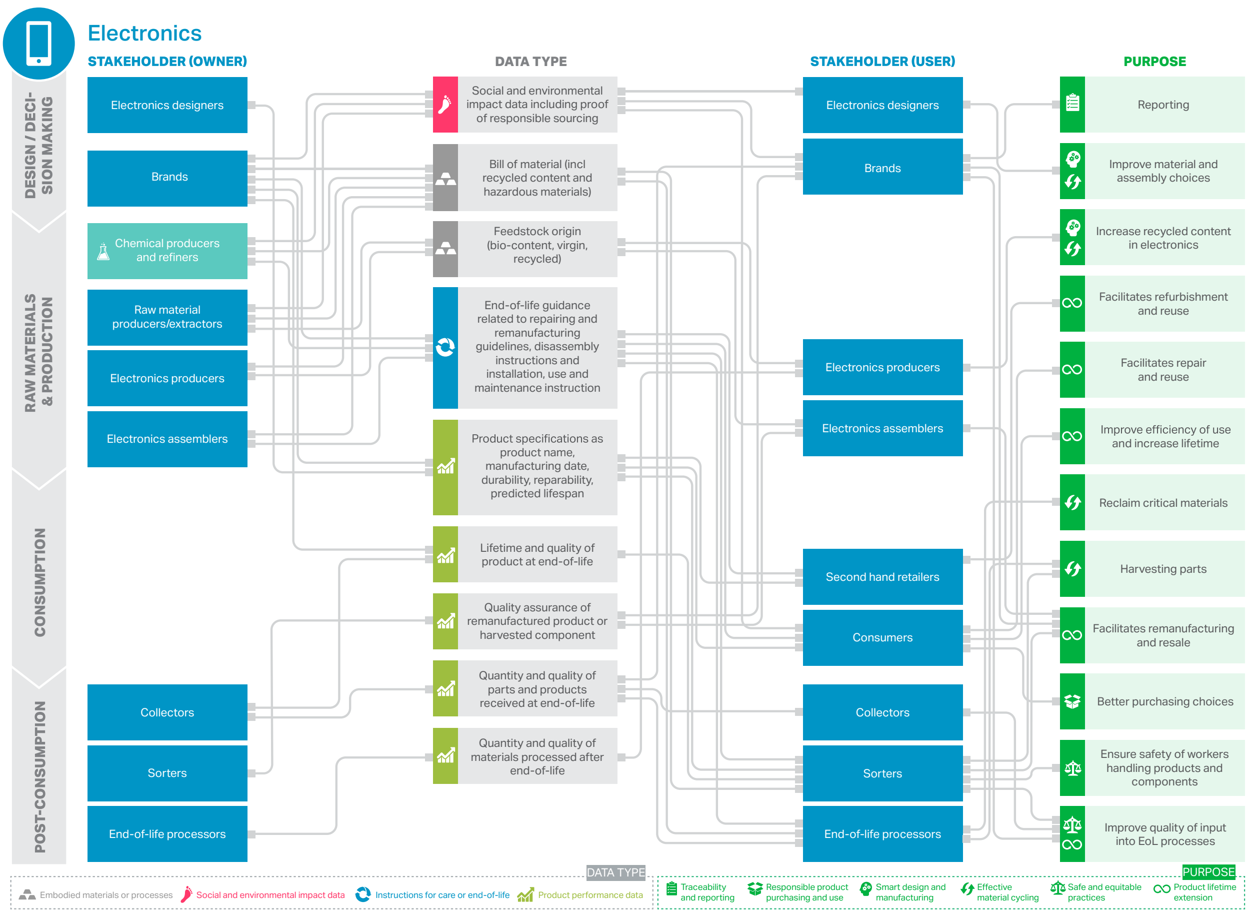
## 3.2 Electronics

There is a rapid increase in demand for complex electronic equipment, which also happens to be the product of a highly fragmented global supply chain. Growth in e-waste has also accompanied this growth in demand,[31] along with increased demand for critical materials currently used at an exponential and unsustainable rate. With such complex value chains, which also tend to include an informal network, formalizing and streamlining data collection and sharing can improve the sector's circularity.[32] To ensure that the growth in the electronics sector is socially equitable, environmentally responsible and circular, tools such as the DPP will enable collaboration spanning the value chain and transparency at every stage, as well as the reintegration of materials back into production systems at their highest value.

Related to the electronics sector, the battery sector has ambitiously addressed some of these issues head-on with several progressive initiatives. One of these is the Global Battery Alliance, a partnership of public and private sector organizations directly or indirectly linked to the product system responsible for rechargeable batteries.

Rather than targeting a single point in the supply chain, their work transcends sectors to employ a holistic approach when addressing the challenges. The results have provided the European Commission with a comprehensive, cross-sectoral blueprint draft of the requirements of the battery product passport.

**Figure 3:** Sectoral map for the electronics sector



## Focus areas for circularity in the electronics sector

The electronics sector map (*Figure 3*) identifies stakeholders that own key data points and how actors along the supply chain can leverage this data to drive specific purposes that enable circularity in the sector. The focus areas below are the most important circularity trends identified within the electronics sector.[33] These trends link to the purposes in the map through the six circularity strategy categories that form the backbone of this analysis.

**Product lifetime extension:** Product design includes durability and the ability to last longer through the use of higher quality materials and timeless designs, reducing obsolescence. Circular business models for product repair, refurbish/remanufacture, reuse, resale and rental support this. While the initial design and manufacturing phase is important, buy-in from consumers and end-of-life actors, and the availability of relevant infrastructure are also necessary to enable the extension of product lifetime.

- Relevant stakeholders: Designers, manufacturers, brands, consumers, secondhand retailers, collectors, sorters

**Design for disassembly:** Product design should ensure it is possible to disassemble them at the end of their life to implement circular "R" strategies such as repair, refurbishing, remanufacturing or recycling. This is particularly relevant for critical materials in the increasing consumption of electronics. Producers and recyclers need to align incentives to design and recover valuable e-waste materials at the end of the product's life to enable lifetime extension or their circular application. Producers can also design products with higher recycled content.

- Relevant stakeholders: Designers, manufacturers, brands, collectors, sorters, recyclers

**Product or component recycling:** Harvesting of components and materials from products for recovery and recycling. The recovery of valuable materials ensures processing that can obtain the same (high-grade) or lower (low-grade) quality for application in other products or product parts.

- Relevant stakeholders: Collectors, sorters, recyclers

**Safe-by-design:** Ensuring that the chemicals and materials used in products are not a risk to human and ecosystem health.

- Relevant stakeholders: Chemical and raw material manufacturers, designers, manufacturers, brands

## Opportunities for data-sharing tools in the electronics sector

**Implementing feedback loops and sharing of data:** Data sharing across the value chain can improve the efficiency of circular practices such as recycling and facilitate safe, sustainable and ethical work practices. Our data found that feedback from end-of-life stakeholders, such as sorters and recyclers, to stakeholders higher on the value chain, such as collectors and brands, regarding the quality and composition of products/material received could improve the quality of input into the end-of-life processes and thereby the effectiveness and efficiency of these processes.[34]

**Designing for circularity:** Design decisions coupled with increasing end-of-life value retention can facilitate a market for reused and recycled products, components and materials. The design and production phases can greatly influence a product's circular objectives as estimates show that this phase determines up to 80% of a product's environmental impact.[35] Practices such as design-for-longevity, design-for-disassembly, and the use of safe and recycled materials can support the implementation of circular practices at the end-of-life of a product. Data-sharing tools like the DPP can enable this circular potential at the products' use phase and end-of-life through the provision of correct instruction for maintenance and disassembly.

Integrating circular thinking in the design of a product alone is not enough; the specific handling of the product by its user and end-of-life processors is fundamental to value retention and reducing its resource intensity.[36]

**Optimizing maintenance and repair guidance:** Empowering consumers and the informal sector with data and guidelines could facilitate better product use and extend the lifetime of products. Having this information directly accessible via a tool such as the DPP will increase the ability of these groups to maintain the quality of products. From purchasing all the way to reuse, data can also encourage better-informed choices, including insight into product sustainability. On the producer end, repairability and durability indexes, while in their infancy, could hold companies accountable for increasing the repairability of products and encouraging circular and durable design, and the implementation of these business models.[37]

**Accountability for data collection:** Brands may influence five out of nine data points highlighted in the electronics sectoral map, meaning they hold significant accountability when it comes to data collection in globalized value chains. This may prove convenient for lawmakers in providing the unique opportunity to centralize the accountability of data collection with brands, expanding the reach of European legislation beyond the borders of its jurisdiction where large proportions of these globalized supply chains reside. Ideally, brands could hold a central role in holding each member of a value chain accountable for their respective contributions.

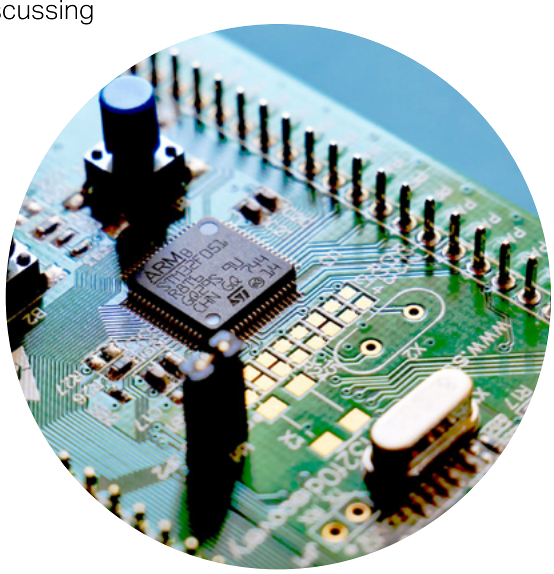
## Barriers to implementing data-sharing tools in the electronics sector

Barriers for the electronics sector accompany the opportunity for a data-sharing tool like the DPP. To reduce the administrative burden on businesses, the European Commission should look at building an integrated data-sharing tool that can incorporate reporting requirements, including existing initiatives, under one umbrella.

**Sharing of confidential information and securing data storage:** The data maps demonstrate that brands have access to many of the data points identified as being important to achieving the goals of data-sharing tools. This can give brands significant influence over the dissemination of data across the value chain. From our interviews with brands, discussing the disclosure of information across the value chain raised several insights. What stands out are concerns about privacy, loss of competitive advantage, and potential regulatory/reputational repercussions when discussing the disclosure of information across the value chain.[38]

**Data collection for multiple actors along complex supply chains:** Collaboration and communication among stakeholders across the entire value chain is key to the successful implementation of a data-sharing tool like the DPP and in enabling circularity.[39] The efficiency and efficacy of end-of-life circular processes can improve, for instance, with the provision of the bill of materials and quality of material/products to sorters by designers/brands and collectors, respectively. Meanwhile, the value chains in the electronic sector are complex and stretch across multiple continents. Electronics brands have indicated that the many steps of the value chain form barriers in themselves, especially considering the fact that seven or eight tiers of suppliers can exist between the manufacturing operations and the raw material extraction. Obtaining the correct data from tier 1 and 2 suppliers may thus prove challenging.

With the fragmentation of the data itself, following materials and products through multiple value chains adds another layer to a lack of transparency. Sourcing alternatively from recycled feedstocks, however, may aid the simplification of these supply chains and increase transparency.



Credits: Photo by Vishnu Mohanan on Unsplash

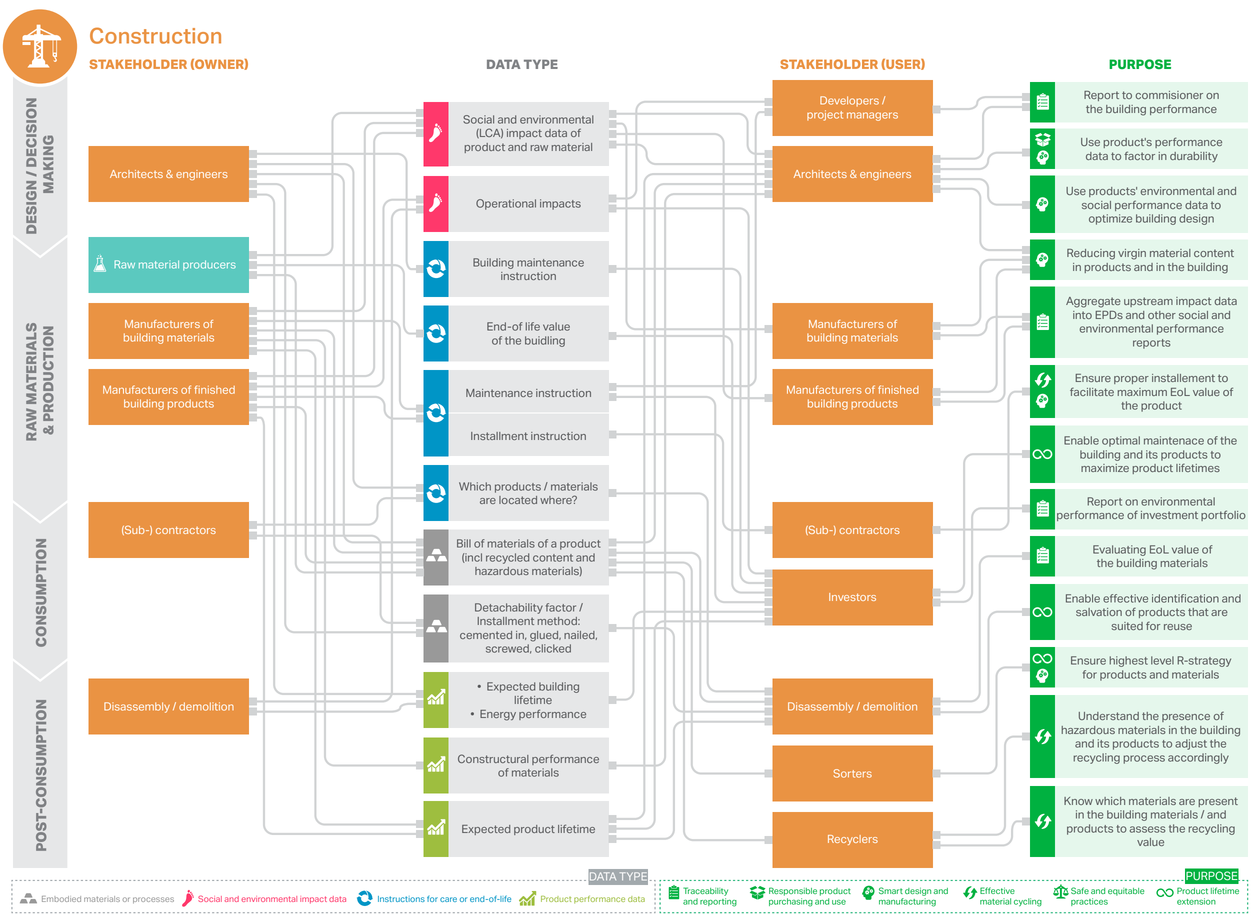
## 3.3 Construction

The construction industry is one of the most resource-intensive. Globally, the sector is responsible for an estimated 60% of raw materials as input and produces approximately 40% of all solid waste and 23% of GHG emissions produced globally.[40] Companies build the products flowing into the construction sector with longevity in mind but did not build the current stock of buildings with circular intentions and practices in mind. That these products outlive the buildings themselves is clear – construction and demolition waste account for more than one-third of all waste generated in the European Union.[41,42]

The introduction of data-sharing tools like the DPP in the construction sector has a huge potential to reduce the negative impacts of the sector and drive circularity in the industry. Documenting and sharing details on materials (and their application) can enable increased material circulation in the industry, providing environmental and economic benefits.[43] As the population grows, so will construction activity.

Data sharing can offer great potential in stimulating the use of safer and easy-to-repurpose/recycle materials. Solutions and sophisticated platforms already exist within the sector that make product and building data available for stakeholders across the value chain. A tool like the DPP presents an opportunity to supplement and streamline these existing solutions.

**Figure 4:** Sectoral map for the construction sector



## Focus areas for circularity in the construction sector

The construction sector map (*Figure 4*) identifies stakeholders that own key data points and how actors along the supply chain can leverage this data to drive towards specific purposes that enable circularity in the sector. The focus areas below are the most important circularity trends identified within the construction sector. These trends link to the purposes in the map through the six circularity strategy categories that form the backbone of this analysis.

**Design for circularity:** Designing buildings with the intention of reusing materials and parts of the building at the building's end of life, thereby reducing environmental impact and maximizing economic value.

- Relevant stakeholders: Architects and engineers, manufacturers, developers, (sub-)contractors

**Minimize virgin material use and waste production:** The reuse and recycling of materials in the construction sector can reduce the amount of waste produced and reduce the impact of extracting new materials otherwise required.

- Relevant stakeholders: Architects and engineers, manufacturers

**Design for reduced impacts:**
More conscious decisions for the use of low-impact products and materials decrease the overall embodied impact of a building. Circularity begins at the design phase. Companies can apply extension of lifetime strategies to parts designed for dismantling and reuse, further supporting R-strategy opportunities.

- Relevant stakeholders: Architects and engineers, manufacturers, developers

**Product or material recovery:**
Harvesting products or materials from buildings for recovery, reuse or recycling. This is especially relevant for a huge building stock not designed for disassembly.

- Relevant stakeholders: Collectors, sorters, recyclers

**Regenerate natural systems:**
Regenerative architecture and raw material sourcing strive to restore ecological health, increase resilience and have a net-positive impact on the environment.

- Relevant stakeholders: Architects and engineers, manufacturers

**Design for adaptability:**
Designing the structural part of the building, its skeleton, in such a way that it can facilitate different purposes. This can include designing with adaptability, flexibility and detachability in mind. It is then possible to change a building's function by modifying the inner layers of the building.

- Relevant stakeholders: Developers, architects and engineers, investors

## Opportunities for data-sharing tools in the construction sector

**Streamlining the compilation of aggregated sub-products:** Buildings and other constructions are in fact an aggregation of existing products and materials. The products processed in a building vary widely, from finished products like tiles, electric wires or a roll of insulation material to raw materials, like sand. For a data-sharing tool like the DPP, the passports for each product that goes into a building will bring a wealth of information to support existing tools, like Madaster's building passport systems.[44] In doing so, and with all products used in construction regulated under the ESPR, the building passport could in theory be derived from the aggregated data of its product passports.

**Enabling impact-driven design decisions:** Architects and engineers decide in the design phase the products they will use for both the construction and the interior of the building and its systems. Building design programs allow for the complex modeling of a building's many dimensions. The environmental performance of products is in some cases already taken into account, for example through the use of building information modeling data that increasingly includes information about the environmental impact of products. Data-sharing tools like the DPP would allow for more refined modeling of the environmental impact of the building.

**Facilitating the assessment of the end-of-life value:** The majority of the existing building stock is not designed for disassembly. This means that demolition contractors need to do a physical assessment of the building to determine the recoverable value (demolition planning). This can prove intensive, inefficient and prone to human error, as it includes walking through the building, knocking on walls, counting windows, etc. Data-sharing tools at the product level, however, have the potential to provide a layer of detail to existing buildings and their passports, significantly streamlining this process.

**Optimizing maintenance and repair guidance and services:** Buildings already come with extensive maintenance plans for the construction, facade and service systems. Data-sharing tools can provide maintenance instruction and planning and include information on part replacements and the provision of consistent supplier contacts. This can make maintenance more effective and thereby prolong the lifetime of the building and its components.

**Matching supply and demand for re-used products and materials:** The reuse of products and materials in construction can only be economically and environmentally viable if it is possible to reapply these goods in the same geographic region. This ensures that the impacts associated with long-distance transport do not offset the gained impact reduction from reuse. In doing so, it is possible to minimize the financial and practical barriers of refurbishment, storage and material property testing. A brokerage between building materials released from demolition sites to construction sites for application to the new building could meet such matching of material supply and demand. Data within a data-sharing tool like the DPP could provide fundamental input to construction and demolition planning, independently and by feeding into building passports. This would require synching to enable the optimal reuse of building materials between regional sites.

## Barriers to implementing data-sharing tools in the construction sector

**A building is an aggregate of a broad spectrum of products and materials:** This implies that a building's value chain is the aggregation of the value chains of its embodied materials and products. Any barriers experienced by its supplying sectors – including chemicals, electronics and the higher level of the apparel value chains – may hinder the optimal use of a data-sharing tool, either directly or indirectly within the construction sector. Companies may experience this barrier on top of other data availability challenges that material and product manufacturers, specific to the construction sector, already face.

**Time between design and start of construction:** It is often necessary to complete a building's design before applying for the construction permit. The application period can last many months, depending on the country of application and its legislation. This can cause a delay between design completion and the start of the construction. This delay can create supply challenges as the design of the building already includes the choice of materials and products. At the time of placing orders, for example, the market might have changed: prices may have risen, and products may no longer be available. This often leads to the application of alternative materials to the building rather than those initially agreed on in the design. This is particularly challenging when the agreed materials are from the reuse market, for which the stock and thus price may be volatile. This dynamic can minimize a data-sharing tool's potential in enabling secondhand markets and create resistance to their input in building passports, specifically when the building design prescribes different products and materials than those ordered by the contractor.

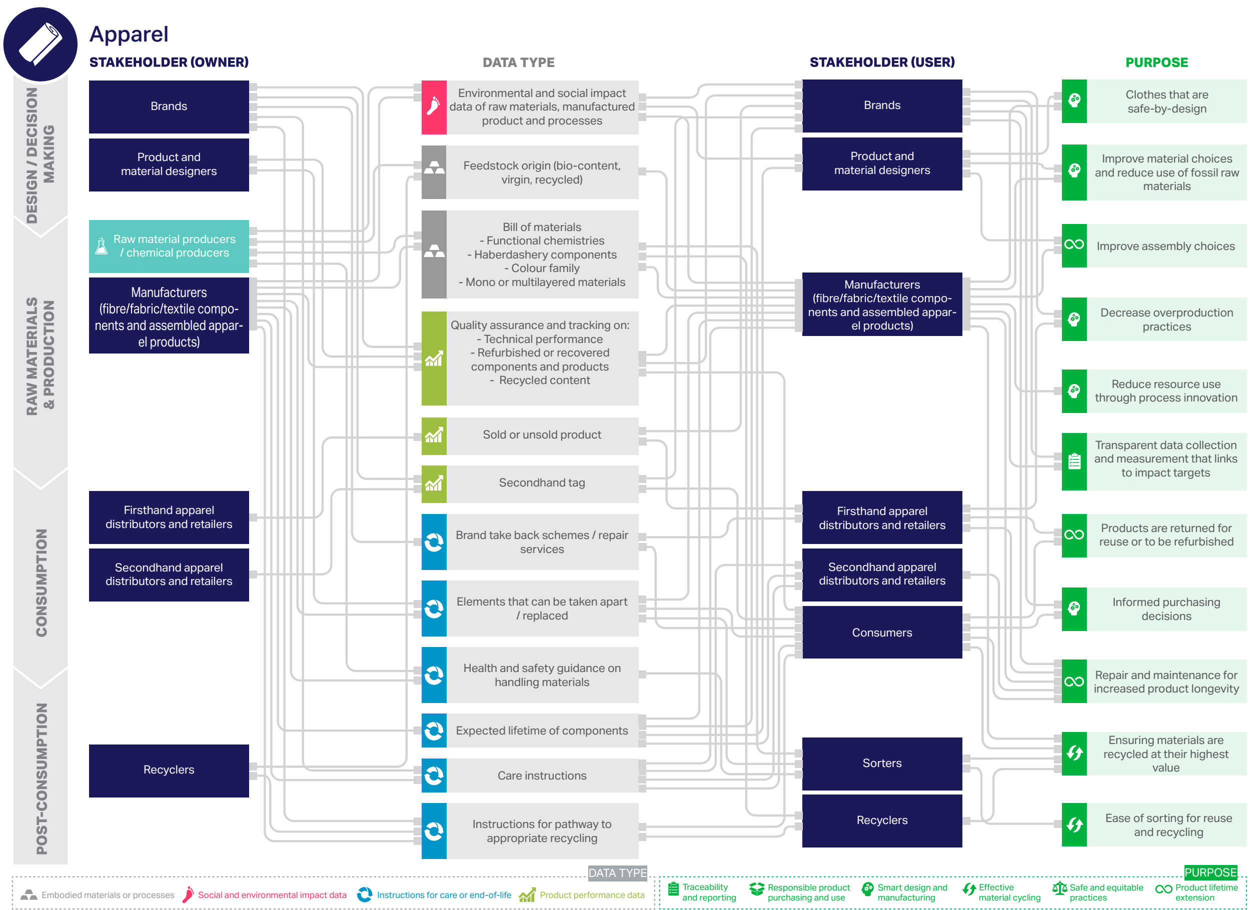
**Disconnect between design and execution:** The construction of a building involves many contractors and subcontractors, each with clearly defined jobs. The construction project manager, together with the architects, engineers and their architectural plan, understand assignment allocation and how these come together in the planned building. In reality, there are many micro-decisions made on the job during the execution phase that deviate from the design. Such deviations do not often occur in integral decisions, such as in the foundation or supporting construction, but they do occur on the minor detailed level, such as the choice between using ordinary tile glue instead of detachable glue. While such decisions have little to no impact on the visible end-result, they do have an effect on the circular potential of the tiles, for example. Many micro-decisions go undocumented. Their accumulation can affect the quality of the data within a data-sharing tool like the DPP and thus their potential in enabling the effective implementation of circular strategies.

Credits: Photo by Julia Pfeifer on Dreamstime.com

## 3.4 Apparel

In 2021, global fiber production increased to a record 113 million tons, approximately 64% and 28% of which were synthetic and plant fibers, respectively.[45] While efforts are in place to recycle textiles, up to 7.5 million tons of garments go to waste annually in Europe,[46] including post-industrial, pre-consumer and post-consumer materials. The production of these wasted materials consumes significant amounts of energy, water and chemicals, which could be averted. The EU Strategy for Sustainable and Circular Textiles acknowledges the potential of "clear, structured and accessible information on the environmental sustainability characteristics of products" in empowering the informed decision-making of businesses and consumers, and improving the communication between actors in the value chain.[47] With the European Commission's DPP to be made mandatory for textiles sold on the EU market by 2030, this data sharing will help align the sector with important data points for curbing the overproduction and destruction of unsold garments; strengthening business-to-business (B2B) supply chain relationships in the delivery of circular services; providing evidence for the impact reduction potential of new design thinking and circular business models; and improving the visibility and credibility of sustainable companies and products.

**Figure 5:** Sectoral map for the apparel sector



## Focus areas for circularity in the apparel sector

The apparel sector map (*Figure 5*) identifies stakeholders that own key data points and how actors along the supply chain can leverage this data to drive specific purposes that enable circularity in the sector. The focus areas below are the most important circularity trends identified within the apparel sector. These trends link to the purposes in the map through the six circularity strategy categories that form the backbone of this analysis.

**Safe-by-design/material selection strategies:** Apparel products embed many complex chemistries in both materials and processes. Hazardous chemicals risk entering local ecosystems and, in incidences of river and surface water pollution, have drawn attention to the sector's material and resource consumption, along with the accountability of textile production impacts. Using safer and alternative chemistries for fibers, dyes and other coatings can offer possibilities for tackling microplastic and chemical pollution along the apparel supply chain.[48] Setting standards for material quality and the composition of products entering the market will further advance other circular goals for product longevity and the potential for material recovery. Aligning fiber and material design with available and emerging end-of-life infrastructure can ensure all materials safely and responsibly cycle back into their respective technical and biological systems.

- Relevant stakeholders: Product and materials designers, recyclers

**Product lifetime extension:** Product design ensures they last longer, supported by circular business models for repair, resale and rental. Extending the active lifetime of textile products and their components is a critical measure that will significantly decrease the impacts of the apparel industry, including slowing waste generation.[49] Information flows that clearly highlight the benefits of product longevity and supporting services to consumers support these alternative choices for "slow fashion".

- Relevant stakeholders: Raw material producers, fiber manufacturers, fabric producers, producers of textiles components

**Traceability and transparency of social justice within supply chains:** Supporting robust traceability and transparent communication practices throughout the sector will be essential to address global social impacts, such as human rights violations and unsafe working conditions.[50] Organizations can leverage a data-sharing tool for environmental and social justice, empowering them to deeply understand their own supply chain and improve their insights into tiers 1, 2 and 3.

- Relevant stakeholders: Raw material producers, fiber manufacturers, fabric producers, producers of textiles components, brands

## Opportunities for data-sharing tools in the apparel sector

**Implementing information feedback loops and sharing of data:** Data-sharing technologies like the DPP show potential for increasing the number of material feedback loops and the rate at which companies can share information and act on it. These support businesses in making informed decisions on how to improve their business models and practices, contributing to national and international circularity targets. The data accessibility facilitated by these platforms provides the means by which brands and manufacturers can be held accountable for their circular investments and activities. For example, by collecting and sharing data on the quality and performance of recycled and biobased materials with fabric and garment producers, it is possible to build trust on new and "preferred" fibers with lower environmental impacts and thus their supply on the market. Brands with access to the data trends in their value chain can also better predict the consumption of textiles, for example, to prevent overproduction.

**Centralizing and standardizing communication on impact metrics:** Data-sharing tools could be a high-potential medium for centralizing communication on impact and circularity in the complex network of producers, recyclers and consumers. Ensuring the scoping and standardizing of these metrics and their building on a common language will be critical to both business-to-business and business-to-consumer (B2C) communication lines.[51] It is necessary to develop this with actors higher in the value chain, such as cotton farmers, to ensure data quality and granularity and, with that, consistency.

**Ensuring safe and smart choices in the composition of complex products:** Data-sharing tools like the DPP can support policymakers and regulatory bodies by collating clear and robust data on fiber composition and functional chemistries (such as dyes, coatings, fertilizers applied to cotton crops), including potential impact factors like ecotoxicity, human toxicity, biodegradability and persistence. Regulators can leverage data sharing to check the quality of information presented to consumers and assure that sustainability claims are authentic, credible and easy to understand.

**Supporting small businesses in sharing impact value propositions:** The EU Textile Strategy highlights the need for tighter controls on greenwashing are necessary within the apparel industry.[52] Data sharing presents opportunities to support SMEs and microbusinesses in applying circular business models, via data collection and validation to help substantiate circularity claims. Tools like the DPP provide a common framework to increase transparency and fair competition between larger brands, as well as for smaller businesses and those with more disruptive circular models.

## Barriers to implementing data-sharing tools in the apparel sector

**High turnover and variation in products:** The current linear nature of fashion trends includes very short life cycles, which promote the overconsumption of many product types. To handle this high turnover and variability and ease the reporting burden, it is possible to apply data to batches of products from the same company.[53] However, support from eco-design principles to standardize materials and their inputs at the design stage will be necessary to ensure that data-sharing tools like the DPP for product groups can accurately represent material composition, which is useful for downstream recycling, reuse and repurpose partners.

**Complexity of supply chains:** The textile sector is one of the most globalized sectors, with 38% of EU turnover coming from the global market.[54] It will be important to ensure the inclusion of upstream and downstream actors in the rollout of the data collection and physical infrastructure required to make a data-sharing tools like the DPP a success. The European textile sector is based on SMEs and microbusinesses, in which companies with less than 50 employees account for more than 90% of the workforce.[55] For such a complex and rapidly changing sector, empowering the network of SMEs will be vital to ensure the achieving of circularity goals along the supply chain. It is necessary to further research and test the practical application of data-sharing tools to ensure they support smaller businesses in collecting, processing and delivering their data to the appropriate users.

**Tier 1 data ownership:** Our research highlights that data collection is cost-intensive and proves operationally challenging for retailers, as much of the data on material composition sits at the factory level. There are currently logistical and confidentiality issues with obtaining sensitive factory-level process data, with many brands seeing the data-sharing as a risk to their competitive advantage.[56] Further work is necessary to understand how to build trust to avert the uncertainties associated with collecting data at the factory level, including who is responsible for the data and how to best collect, process and store it.

**Aligning data carriers with emerging circular infrastructure:** It is necessary to align the physical component of a data-sharing tool like the DPP with the capabilities of sorting facilities. Today's automated sorting technologies harness near-infrared (NIR) spectroscopy to identify the material composition of post-consumer textiles.[57] Should textiles use QR codes as their data carrier, additional labor costs will accompany added manual labor for scanning and sorting in the absence of an automated alternative.[58] Furthermore, the physical compatibility of various textiles and their data carriers, as well as the durability of this carrier, will be highly relevant in ensuring a readable carrier is still associated with the product at the end of a garment's useful lifetime.

# 4 Conclusion and next steps

# 4 Conclusion and next steps

The European Commission has voiced its ambition to approve the ESPR regulation, including the Digital Product Passport data-sharing tool, in 2024, implementing the first product groups by 2026/2027. This leaves a narrow timeframe to address some of the concerns and barriers our research has identified, as explored in this document for data-sharing tools like the DPP. To expedite the next steps within this timeframe, we have extracted the following points from our findings on the barriers and opportunities for further research, development and rollout of a data-sharing tool like the DPP. Answering these can help unpack the full potential of data-sharing tools and what their implementation can represent for Europe's overall transition to a circular economy.

- The multi-tiered supply network of many manufacturing companies spans several, if not all, continents and visibility on them dilutes very quickly beyond an organization's direct suppliers. The European Commission should consider working with original equipment manufacturers to overcome these challenges, especially for suppliers operating outside of the EU.

- Understanding the dominant structures of the current reporting burden is relevant to the leveraging of existing infrastructure and organizations in the implementation of data-sharing tools. Doing so has the potential to streamline reporting instead of adding to it, made accessible through a tool like the DPP.

- Identifying the sector-transcending metrics (such as environmental impact metrics) and prioritizing their standardization would primarily ensure consistency for upstream businesses in the supply chain that serve multiple sectors. This can also support the comparability of information in, and ease the uptake of, data-sharing tools.

- Product-specific metrics require a deeper understanding of the sector-specific leverage points for a circular product system, as well as how particular data points can enable the transition. The sector maps in this document lay the groundwork for a more detailed mapping of data requirements for implementing data-sharing tools.

- Considering an iterative approach in the formalization of the specific data points shared in tools such as the DPP and accommodating for new insights as our knowledge on sustainable product systems progresses with time will be imperative for the relevance and function of data-sharing tools.

- Consulting the information technology (IT) industry is necessary in developing the technical requirements of a data-sharing tool like the DPP. The success of decentralized implementation will be highly dependent on the quality of the centrally imposed requirements. The professional experience of setting up similar complex IT infrastructure will be invaluable in defining the requirements that are both feasible and effective in facilitating accessibility, security, operability and compatibility.

- Considering the practicality of QR codes and similar data carrier applications for product groups and working with the industries and value chain actors on this development will be relevant for the products carrying the unique identifiers and, for example, the infrastructure needed for relevant actors to read the identifier throughout the product's lifetime.

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Metabolic is a systems change agency striving to transition the global economy to a fundamentally sustainable state where people and nature thrive. We guide decision-makers and implement real-world projects that bring ambitious ideas to life. With five core areas of operation, we conduct leading research, develop future-facing strategies, build software tools, scale impactful ventures, and empower communities on the ground.

## ABOUT WBCSD

WBCSD is the premier global, CEO-led community of over 200 of the world's leading sustainable businesses working collectively to accelerate the system transformations needed for a net zero, nature positive, and more equitable future.

We do this by engaging executives and sustainability leaders from business and elsewhere to share practical insights on the obstacles and opportunities we currently face in tackling the integrated climate, nature and inequality sustainability challenge; by co-developing "how-to" CEO-guides from these insights; by providing science-based target guidance including standards and protocols; and by developing tools and platforms to help leading businesses in sustainability drive integrated actions to tackle climate, nature and inequality challenges across sectors and geographical regions.

Our member companies come from all business sectors and all major economies, and our global network of almost 70 national business councils gives our members unparalleled reach across the globe. Since 1995, WBCSD has been uniquely positioned to work with member companies along and across value chains to deliver impactful business solutions to the most challenging sustainability issues.

Together, we are the leading voice of business for sustainability, united by our vision of creating a world in which 9+ billion people are living well, within planetary boundaries, by mid-century.

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