EUROPEAN POLICY CENTRE

Vodafone Institute for Society and Communications

DISCUSSION PAPER

SUSTAINABLE PROSPERITY FOR EUROPE PROGRAMME

17 NOVEMBER 2021

Building a circular economy: The role of information transfer

Stefan Šipka
with Annika Hedberg

The image shows reusable containers. Additional information about the product is made available via the QR codes. Credit: DPA

Table of contents

List of abbreviations 3

Executive summary 4

Introduction 6

1. Information transfer for a circular economy 7

1.1. Digital solutions supporting information transfer across value chains 7

1.2. Current and prospective examples of information transfer in circular value chains 8

1.3. Summary of the challenges with digital information sharing 11

2. The EU policy framework for action 12

2.1. The circular economy agenda 12

2.2. The digital agenda 14

2.3. EU funding instruments 17

3. EU policy recommendations 18

Conclusion 21

Endnotes 22

ABOUT THE AUTHORS

Stefan Šipka
is a Policy Analyst in the Sustainable Prosperity for Europe programme

Annika Hedberg
is a Senior Policy Analyst and Head of the Sustainable Prosperity for Europe programme

ACKNOWLEDGEMENT / DISCLAIMER

This Discussion Paper builds on the findings of the EPC project, "Digitalisation as an enabler for Circular Economy", which was carried out in 2021 with the support of the Vodafone Institute for Society and Communications. It explored the current and prospective practices with information transfer across value chains. It also studied how EU policies can help create an enabling environment that encourages the use of data and incentivises the development and deployment of digital solutions for this aim. The project comprised two workshops and additional research activities, which fed into this Discussion Paper.

Visuals created by Jon Wainwright.

List of abbreviations

AI	artificial intelligence
B2B	business-to-business
B2C	business-to-consumers
B2G	business-to-governments
CE	circular economy
CEAP	Circular Economy Action Plan
CF	Cohesion Fund
CSRD	Corporate Sustainability Reporting Directive
DEP	Digital Europe Programme
DGA	Data Governance Act
DPP	digital product passport
EBP	European Blockchain Partnership
EBSI	European Blockchain Services Infrastructure
ECHA	European Chemicals Agency
EDI	electronic data interchange
EDIFACT	Electronic Data Interchange for Administration, Commerce and Transport
EDIFICE	Global Network for B2B Integration in High Tech Industries
EGDC	European Green Digital Coalition
ELV	End-of-Life Vehicle (Directive)
EPR	extended producer responsibility
ERDF	European Regional Development Fund
ESF+	European Social Fun Plus
GDPR	General Data Protection Regulation
GHG	greenhouse gas
H2020	Horizon 2020
ICT	information and communications technology
IMDS	International Material Data System
INATBA	International Association for Trusted Blockchain Applications
IoT	Internet of Things
ISO	International Standardisation Organisation
MFF	Multiannual Financial Fund
ODD	Open Data Directive
PCDS	Product Circularity Data Sheet
REACH	Registration, Evaluation, Authorisation and Restriction of Chemicals
RFID	radio-frequency identification
RRF	Recovery and Resilience Facility
SCIP	Substances of Concern In articles as such or in complex objects (Products)
SME	small and medium-sized enterprise
SPI	Sustainable Products Initiative
SVHC	substance of very high concern
WEEE	Waste Electrical and Electronic Equipment (Directive)

Executive summary

Within the EU, discussions around the European Green Deal, its overarching growth strategy, as well as the COVID-19 recovery are centred on the recognition that Europe needs a twin transition: green and digital transformations could change our economy and society for the better. While these transitions are treated as separate issues too often, aligning them would bring multiple benefits.

This Discussion Paper illustrates what this twin transition could mean in practice by focusing on the role of digitalisation in enabling information transfer, a central piece of the puzzle for creating a circular economy (CE) (see Figure 1). While the journey towards a CE has only just begun, it is in Europe's interest to build on the related business cases and opportunities and create an enabling policy and financial framework to make this twin transition a reality.

The CE is crucial for reducing greenhouse gas emissions, pollution, resource depletion and waste in Europe and beyond. Designing durable products, repairing and recycling can make the EU's economy more competitive and resilient, thanks to reduced dependency on foreign markets to obtain critical materials. The EU is in a promising position to establish and promote such an economic model across the world.

One of the main challenges to a CE is the lack of information transfer across value chains. The ongoing digital transformation carries the potential to address this barrier. Already today, online platforms, databases, apps, sensors, connected machines, QR codes, radio-frequency identification (RFID) and blockchain facilitate the sharing of data and information for the benefit of establishing a CE. Going forward, digital product passports (DPPs) especially provide an attractive solution for enhancing the information transfer in value chains (see Figure 2). Digital information transfer is crucial to ensure our transition to CE and can be a source of added value for businesses.

That said, enabling such information transfer continues to be hindered by concerns over protecting personal and business-sensitive data and a lack of common data standards. In practice, the policy and financial

Fig. 1

ALIGNING THE GREEN AND DIGITAL TRANSITIONS CAN ENHANCE THE CIRCULAR ECONOMY

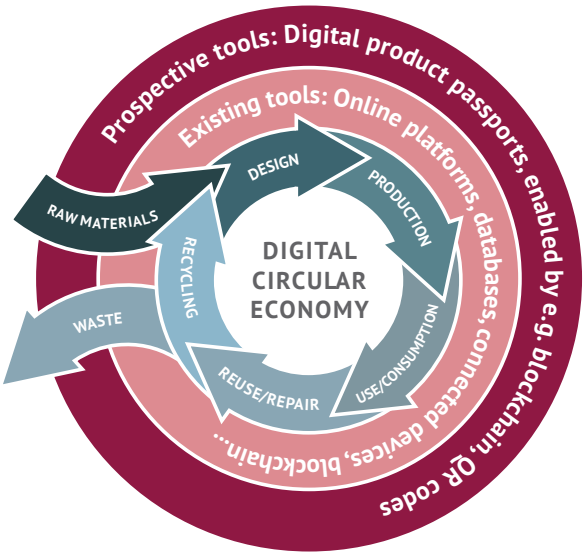
incentives for businesses to adopt digital information transfer for a CE are still limited. Modern supply chains are often transnational and complex, and not all actors have similar interests when it comes to sharing data and information. There are structural challenges, including insufficient investments in digital infrastructure and a lack of digital skills among consumers and businesses. Lastly, if not under control, digitalisation could lead to even more emissions and e-waste.

The enabling policy framework is crucial to ensure that rules on data handling and digital tools for information sharing are developed and used to support the CE. EU policies can create a clear and harmonised set of rules for sharing data and information for the CE across value chains and help the rest of the world follow suit. Moreover, now is the time to act. Digital solutions and the EU's policy framework for enhancing information transfer across value chains are evolving quickly. This makes it timely and important to take stock of ongoing developments and consider how the EU can address the remaining challenges and capture the related benefits.

To get on the right track and build on this potential, the EU should take the following actions:

Fig. 2

DIGITAL INFORMATION TRANSFER FOR THE CIRCULAR ECONOMY



1. **Establish a digital information system for a CE by 2030**, enabling the exchange of information necessary for improving circular practices in value chains, such as the better design, reuse, repair and recycling of products. It should lead the way towards building a global digital information system for a CE by 2040.

2. **The EU's common European data space(s) must enable effective information transfer for CE.** The EU must develop functional common European data space(s) – a governance framework – together with industry, member states, civil society and other relevant stakeholders. The common data space should build on all relevant existing datasets and needs to be customised for different value chains, notably, electronics, automotive sector, textiles, plastic packaging and chemicals.

3. **Establish rules on using DPPs.** Such rules should build on the EU's current efforts to develop common European space(s) and further specify which data should be made available via DPPs, for which product categories and how. The EU should start with developing voluntary standards for DPPs and subsequently assess if and when mandatory rules are necessary.

4. **Use its economic and financial tools to enhance digital information transfer in circular value chains.** The Multiannual Financial Framework and Recovery and Resilience Facility should be used to invest in developing necessary digital tools (e.g. blockchain, IoT), infrastructure and skills. The EU should consider how its sustainable finance agenda can help direct private investments towards digital information transfer for CE.

5. **Lead global efforts to use digital tools to support information transfer for CE.** This entails collaborating with international partners in developing necessary rules and standards while considering minimum CE-related transparency requirements for products entering its single market.

Introduction

There is a strong rationale for Europeans to rethink current production and consumption patterns. Being smarter with the existing resources, increasing resource efficiency and decoupling growth from environmental degradation are the basis for sustainable prosperity. Shifting from the current linear 'take-make-dispose' economic model to a new one – a circular economy (CE) – would come with great benefits to Europe and the entire world. It would help maintain the value of products and materials for as long as possible, and minimise resource use, pollution, environmental degradation and waste by increasing the repair, recovery, reuse and recycling of materials and products.[1]

Shifting to a CE would help reduce the EU's greenhouse gas (GHG) emissions significantly, as those associated with primary resource extraction and production would be avoided or minimised.[2] The CE could contribute to reducing EU's GHG emissions by 55% by 2030, achieving EU's climate neutrality by 2050 and meeting the EU's climate commitments under the Paris Agreement. On a global scale, a CE would reduce carbon dioxide emissions related to key materials (i.e. cement, steel, plastics, aluminium) by 40%; food sector emissions by almost 50%; construction emissions by 40%; and mobility sector emissions by 70%. These sectors would become more circular – for example, by keeping materials in use longer or recycling them – by 2050.[3]

Transitioning to a CE would also enhance European competitiveness. Smarter use of resources within the EU would allow its citizens to control materials better, generate more value from their use and become less dependent on exports of raw materials needed to produce goods and services. The COVID-19 crisis has reminded the resource-dependent EU of the vulnerabilities in global value chains, and the need to ensure access to the necessary materials and products it needs under all circumstances. By ensuring this access, including by reusing and recycling existing products and materials on the EU market, Europe will achieve its green transition in sectors such as energy, mobility and digital sectors.

A CE could also help create jobs,[4] increase demand for new products and services, raise the EU's GDP by 0.5% and generate a net economic benefit of €1.8 trillion by 2030.[5] Examples of circular business opportunities include the provision of services like product repairs, maintenance and remanufacturing, and recovering components and materials from used products (e.g. via recycling). Businesses can also reduce production costs by changing their business model to product-as-a-service.[6]

The EU is in a promising position to lead the global transition to a CE and help accelerate it beyond its borders. The EU is already leading with its ongoing CE initiatives and can exercise global regulatory power through its internal rules on and standards for products and services. As the EU economy is tightly interwoven with other regions in the world, it can also exert an influence via international trade and the global supply chains within which it operates. The EU and European industry are in a good position for becoming standard-setters for a CE and sustainable production and consumption; to promote market leadership and enhance European competitiveness.

The EU is in a promising position to lead the global transition to a circular economy and help accelerate it beyond its borders.

However, the road to achieving a fully CE remains long. The world economy is only 8.6% circular, and the situation is only getting worse.[7] It is still plagued by the linear take-make-dispose model, which entails short product lifespans, a lack of repairs and ever-increasing waste with limited recycling capabilities. Even though the EU performs better than most countries, its transition to a CE is far from complete. For example, around 5.2 tonnes of waste are generated per EU inhabitant, of which two-thirds are landfilled or incinerated.[8] Businesses and citizens alike find it difficult to contribute to a CE because of either a lack of knowledge, skills, incentives and financial resources, or weak information transfer across value chains.

INFORMATION TRANSFER, A KEY TO THE CIRCULAR ECONOMY

One of the main barriers to achieving a CE is that information does not travel with products and materials, between stakeholders and down the value chains. This means how materials have been sourced, is not always transparent; what is actually in the products we use and dispose of, how their durability could be improved and how they could be efficiently recycled. This complicates the management of products and materials during their lifecycles.

The smooth flow of data and information would enable producers to design more circular products, service providers to repair the equipment they rent, consumers to handle devices in a more circular way and dispose of them properly, and waste operators to repair or recycle products. Greater knowledge of products can support circular practices – maintenance, reuse, repair and recycling – in value chains. Exchanging necessary information between businesses and other stakeholders (e.g. consumers) in the value chain can enhance further collaboration, driving the long-term transition to a CE and unlocking new business opportunities.

Data and digital solutions play a central role in enabling and accelerating this kind of information transfer. Online platforms, digital tags and blockchain-enabled solutions are already being used to improve the flow of information from producers to consumers and waste managers. In the future, digital product passports (DPPs) could help make information transfer faster, more efficient, less costly and more convenient for all stakeholders involved.

Digital solutions and the EU's policy framework for enhancing information transfer across value chains are evolving quickly. This makes it timely and important to take stock of ongoing developments and consider how the EU can address the remaining challenges and capture the related benefits, to accelerate its transition to a CE. This Discussion Paper focuses on current and prospective ways to enhance information transfer across value chains.[9] It considers information transfer from resource extraction to waste management while recognising that the value chains of different products are complex and often interlinked.

THE CAVEATS TO DIGITALISATION

While this Discussion Paper focuses on digitalisation as an enabler for a CE, and thus explores its potential for creating a sustainable, climate-resilient economy, data and digital solutions can only deliver on these goals if they are also sustainable. This is no small task:

- The information and communications technology (ICT) sector currently accounts for significant shares of electricity consumption and GHG emissions.[10] Data centres are one of the most important individual digital sources of GHG emissions. While data centres are already using significant amounts of renewable energy,[11] making them sustainable would greatly impact the greening of digitalisation.

- ICT equipment is often made of critical materials and precious metals, as well as iron and aluminium. Mining, material processing and product manufacturing contribute to GHG emissions, pollution, water stress and biodiversity loss.

- Computers, smartphones and other electronic devices eventually become e-waste. This is currently one of the fastest-growing waste streams because of multiple device ownership, the growth of cloud computing services, and short product lifespans and replacement cycles.[12]

- Digitalisation could actually make our current linear economy go into overdrive, creating more possibilities for overconsumption (e.g. e-commerce). Also, if not controlled, artificial intelligence (AI), algorithms and blockchain can lead to unnecessary energy consumption.

SCOPE AND METHODOLOGY

This Discussion Paper explores the current practices, challenges and prospects with using digitalisation to support information transfer for a CE within and across value chains, and how EU policies can provide an enabling framework for the future. It focuses on how information transfer could be improved so that the relevant stakeholders along the value chain (i.e. producers, consumers, waste managers) can contribute to a CE. The authors recognise that value chains are complex and often interlinked, which must be considered when designing the policy and investment framework.

The Discussion Paper is based on the EPC's research conducted in 2021 as part of the project "Digitalisation as an enabler for Circular Economy", implemented in collaboration with the Vodafone Institute for Society and Communications. The research benefited from:

- a literature review of the relevant legislation, studies, and online information;

- correspondence with relevant stakeholders; and

- findings from two online EPC workshops.[13]

The paper comprises an overview of how digital information transfer can support the transition to a CE, coupled with several case studies; the relevant EU policies for facilitating information transfer across value chains; and policy recommendations.

1. Information transfer for a circular economy

1.1. DIGITAL SOLUTIONS SUPPORTING INFORMATION TRANSFER ACROSS VALUE CHAINS

The digital revolution implies that more digital data is being generated than ever before. Numerous digital solutions – digital sensors, mobile phones, connected devices – generate and collect new data. When this data is mined, systematised, processed and analysed, it can become information. Moreover, shared information can generate great social and economic value, as long as it helps address challenges, enhance collaboration and enable relevant stakeholders to take necessary action. This kind of information transfer is already happening and will increase thanks to different digital solutions – all to the CE's benefit.[14]

It is an especially exciting time to consider the prospects for improving information exchange *across value chains*. Digital solutions can play an important role in improving connections and information sharing between the relevant stakeholders in value chains, including

producers, consumers and recyclers. They can improve transparency as well as the management of materials and products, and thus help promote a CE. Examples of digital solutions and their benefits are outlined below.

Stakeholders within and across value chains often use **online platforms** to share information about materials and products. Restricted access to platforms can help protect confidential data, which is important for many businesses.

Several **databases** gather and share relevant information. **Cloud** solutions, a network of remote servers hosted on the internet, can store, manage and process huge quantities of data from different providers and thus facilitate database management.

The **Internet of Things** (IoT) and **connected devices** are everyday physical objects or devices connected to the internet and identifiable to other objects. IoT is enabled by sensors and digital tags like radio-frequency identification (RFID).[15] IoT-enabled solutions can help improve information transfer across value chains and predict when machines need maintenance and repair.[16]

Blockchain is a distributed ledger that can record and share information. As information can be managed in a decentralised way, this minimises security breaches. Information provided via blockchain cannot be altered without leaving a trace in the system, thus enhancing trust between the stakeholders. Blockchain-enabled solutions can ensure that CE-related information travels down value chains with products and materials while also respecting intellectual property rights.

DPPs comprise (i) a unique product identifier (i.e. a code akin to a personal identification number); (ii) a digital tag (i.e. a machine-readable representation of the identifier, e.g. a QR code that a smartphone can scan); and (iii) background information about the product in the digital tag. By scanning the tag, producers, consumers, waste operators and public authorities (e.g. law enforcement agencies) could access and upload the information. DPPs could thus facilitate the flow of information to improve the circular management of a product throughout its lifecycle, especially if it is supported by more sophisticated tools (e.g. blockchain, IoT).

1.2. CURRENT AND PROSPECTIVE EXAMPLES OF INFORMATION TRANSFER IN CIRCULAR VALUE CHAINS

The case studies below demonstrate solutions that are already in use **today**, as well as prospective solutions for **tomorrow** that are currently being tested and piloted. Many of the case studies are from sectors that use significant resources and have considerable environmental footprints. Addressing the information barriers in these sectoral value chains would benefit the climate and environment majorly. However, many of these solutions could also be applied beyond these sectors.

1.2.1. The automobile industry

The EU's current plans to incentivise a shift to electric vehicles are expected to increase the export of diesel and petrol cars outside the EU, but also their disposal. Information transfer is important to identify hazardous substances in end-of-life vehicles and facilitate circular waste treatments. The EU has a good basis for building upon: already in 2018, when around 6 million vehicles became waste in the EU, an estimated 87% of parts and materials were reused and recycled.[17]

Today: In 2000, several large automotive companies established the International Material Data System (IMDS), a **global data repository** that contains information on materials used in the industry. The data is collected and standardised to facilitate compliance with corporate reporting requirements across the globe. These requirements include reporting under REACH 1907/2006 (Registration, Evaluation, Authorisation and Restriction of Chemicals) and the End-of-Life Vehicle (ELV) Directive 2000/53/EC. Companies also use IMDS information to report to the SCIP database (Substances of Concern In articles as such or in complex objects). The success of the IMDS can be explained by the relative power of several automotive companies over other suppliers in the value chain, which prompts suppliers to provide relevant information. Furthermore, automotive companies maintain the information system free of charge for their supply chains, with a clear set of standards to facilitate the reporting process and access to information.

1.2.2. Dangerous chemicals in products

Public authorities and citizens are often interested in improved transparency around chemicals in materials and products because of their possible impacts on human health and the environment. Better information transfer on chemicals in value chains can also support the transition to a CE. In turn, hazardous chemicals can complicate the transition, especially if they pollute waste streams and waste operators are unaware of their presence or how to treat them. This can make recycling more expensive and complex and secondary materials less competitive than virgin materials.

Better information transfer on chemicals in value chains can support the transition to a circular economy.

Today / Tomorrow: The SCIP database, developed by the European Chemicals Agency (ECHA), aims to increase access to data and information on substances of very high concern (SVHCs) in products and articles (smaller items that are not always final products) throughout

their lifecycles. Under REACH, companies are required to report the presence of SVHCs in their products and articles to the ECHA if it exceeds 0.1% concentration. The SCIP database was created in 2020 to help member states meet the legal obligation under Waste Framework Directive 2008/98/EC on ensuring that companies report the presence of SVHCs to the ECHA.

The database's ultimate goal is to help reduce the amounts of SVHCs in products, enhance waste management and improve environmental governance. While the data available via SCIP is not yet disseminated to the beneficiaries and the ECHA is yet to develop online search tools, the database is moving in the right direction. Based on the SVHC data, waste operators should be able to recycle waste more efficiently; consumers could choose more circular products; and public authorities could make better decisions on new policies and law enforcement.

Today / **Tomorrow:** The AskREACH project is coordinated by the German Environment Agency alongside 20 partners from 13 countries and is funded by the EU's LIFE programme, among other partners' and national environmental funds. The project facilitates consumer access to information about SVHCs in products, helping consumers choose more sustainable and circular products. It responds to the legislative requirement under REACH Article 33 that companies must provide information about SVHCs in their products to consumers on request. However, using AskREACH is voluntary for businesses since they have other means to fulfil this requirement.

The **Scan4Chem App**, developed under AskREACH, enables consumers to access information about the presence of SVHCs in products by scanning a barcode or searching names. Companies can either submit data to the AskREACH **database** or inform consumers directly if the latter requests it. Companies can also go beyond legislative requirements and submit data on SVHCs that make up less than 0.1% of products (e.g. it would be beneficial for marketing purposes).

Due to technical incompatibilities, the German AskREACH and the ECHA's SCIP are separate projects with their own databases, despite their common goal of making information about SVHCs in products more accessible to wider audiences.[18] These solutions illustrate the scope of possibilities, as well as the teething problems that will need to be addressed.

1.2.3. Towards circular electronics

Mining the necessary resources for electronics and processing and manufacturing materials contribute to GHG emissions, pollution, water stress and biodiversity loss. Short product lifespans and replacement cycles, for example, are accelerating the e-waste stream, which is already one of the fastest-growing in the world. Moreover, Europe is not adept at reusing existing resources in its market: only around one-half of e-waste is collected and recycled in the EU.[19] Better information transfer could result in the production of electronics with a lower climate and environmental footprint, enhances their durability, repair and reuse; and improves e-waste collection and treatment.[20]

Today: The I4R Platform is an **online platform** operated by the WEEE Forum. It allows waste operators to access information on the presence and location of substances, materials, mixtures and components of concern in electronics, to improve the treatment of e-waste. The platform was jointly launched by the WEEE Forum, APPLiA and Digital Europe. It was a response to the Waste Electrical and Electronic Equipment Directive 2012/19/EU (WEEE Directive), which requires producers to inform waste operators on how to treat used electronics. Information is provided on waste operator's request through an electronic form available on I4R. Information is provided on a product category level (i.e. industry averages) rather than individual products.

Today: BOMcheck is an industry-led shared **database** that Siemens, Philips and GE Healthcare founded. Numerous companies use it to manage their supply chains and comply with regulatory requirements (e.g. REACH, the Restriction of Hazardous Substances Directive 2002/95/EC). BOMcheck enables suppliers to provide data to manufacturers. It tracks and reports substances, chemicals and materials (i.e. critical materials) in products in a standardised and automated manner. BOMcheck currently has 9,000 users (i.e. suppliers and manufacturers).

1.2.4. Material passports for buildings

The global construction industry uses almost half of the raw materials extracted globally and accounts for a quarter of global GHG emissions. In Europe, 450 to 500 million tonnes of construction and demolition waste are generated annually,[21] of which around one- to two-thirds is recycled.[22] Information transfer about building materials can help with their recovery and support the reuse of construction and demolition waste in the end-of-life phase, thus making the construction sector more circular and sustainable.

Information transfer about building materials can help with their recovery and support the reuse of construction and demolition waste in the end-of-life phase.

Tomorrow: The BAMB project brought together 15 partners from 8 EU countries to support the European construction industry's transition towards a CE. Available via an **online platform**, Material Passports provide information about construction materials and how to retain their value in the economy. The Reversible Building Design tool is a design protocol that aims to inform building designers about the circular aspects of construction products, including ways to make them

reusable. Both tools support the Circular Building Assessment Prototype, an information management tool for integrated decision-making in the building sector. The BAMB tested the Prototype in six case studies across different pilot countries.

1.2.5. Digital product passports for textiles

73% of all clothes that have reached their end-of-life stage worldwide is landfilled or incinerated, while less than 1% is used to produce new apparel.[23] Improving information exchange on textiles can help consumers choose, use and dispose of garments more sustainably, and recyclers to recycle textiles, for example.

Improving information exchange on textiles can help consumers choose, use and dispose of garments more sustainably, and recyclers to recycle textiles.

Today / **Tomorrow:** Circular.fashion has developed an **information system** to increase transparency and access to knowledge and resources, supporting services for extended product life and enabling digital product identification for recycling. It also aims to standardise data management to achieve higher connectivity throughout the textile industry's value chain. To that end, it launched the Circularity.ID® system to enable connections between textile producers, consumers and waste operators.

The Circularity.ID® system enables product identification and traceability throughout lifecycles. It entails **digital tags** (e.g. QR codes), which enable users to access more information about a garment. The aim is to help consumers know how to repair an item and where to dispose of it for recycling. It can be used to guide waste operators to sort and recycle particular textiles.

1.2.6. The plastic packaging challenge

The EU recycles only 40% of its plastic packaging waste today.[24] When not recovered in the end-of-life phase, plastic packaging becomes a problematic source of pollution. Information sharing can enhance the tracing of plastics and improving their sorting and recycling.

Today: The French food retail group Auchan uses **RFID** technology to track plastic crates for reverse logistics purposes. According to their evaluations, reusing plastic RFID containers reduces crate loss, saves tons of waste, and decreases carbon emissions by 30%.

Tomorrow: Pioneer Project HolyGrail, led by Procter & Gamble and facilitated by the Ellen MacArthur Foundation, has developed a **digital watermark** for the automatic sorting of plastic packaging. This IoT solution uses a barcode that enables machines to detect and automatically sort waste plastic packaging.[25] To make this solution fully scalable, the plastics value chain – from producers to recyclers – still needs to agree on several technical standards and clarify questions surrounding data ownership.

Tomorrow: R-Cycle has developed a **DPP** which tracks and traces plastic packaging. The initiative resulted from the concern that plastics are often not recycled due to a lack of information about their recyclability. The DPP allows different stakeholders to provide information about plastic items, which is stored on a common data platform and accessible via digital tags (e.g. QR codes). As a result, waste operators could identify recyclable plastics and advise how to manage them in their end-of-life phase. R-Cycle is currently conducting over 10 pilot projects with various actors in the value chain (e.g. designers, manufacturers, packagers, waste operators).

1.2.7. Going beyond the given sectors

In reality, value chains are complex and often cross-sectoral. The solutions for information transfer must, ultimately, manage these complexities.

Today: TagItSmart allows stakeholders across the value chain – producers, customers, recyclers – to track items and provide additional information. This solution uses **IoT** enabled by **functional QR** codes to trace, track and monitor fast-moving consumer products throughout the supply chain and their lifecycles. TagItSmart is already in use in nine companies in eight EU member states.

Today: Organix is a digital platform launched by SUEZ. It is a marketplace for organic waste, whereby waste producers are connected with methane producers to convert their waste into energy.

Today / **Tomorrow:** Circularise, a Dutch start-up, improves transparency and communication across value chains via **blockchain** technology. Its smart questioning technology securely exchanges information between the information holder (e.g. producer) and requestor (e.g. repairer). More specifically, a waste operator can scan digital tags (e.g. QR codes) and ask if products contain hazardous chemicals. The producer provides the information, which can facilitate the end-of-life management of products. The information is secure because the blockchain provides a pathway for information exchange between the stakeholders. The information provider maintains control of the data, while the requestor receives only a limited piece (e.g. if a device contains a particular substance) and not background knowledge of the product (i.e. zero-knowledge proof).

Tomorrow: DigiPrime (2020-23) is a Horizon 2020 (H2020) project that the Polytechnic University of Milan manages in a consortium of 36 organisations. It aims to establish an **online platform** to support the cross-industry exchange of data and information, which would guide the reuse, remanufacturing and recycling of products and components. The platform will be decentralised and connect several information systems thanks to a common set of technical standards and data

policy framework to ensure data protection (e.g. providing only limited information to remanufacturers to help solve a particular problem). It will also assist in matching supply with demand, enabling stakeholders to exchange assets and facilitate the auctioning and signing of contracts. Based on the available information, the platform will also provide forecasting to help minimise the unpredictability of supply and demand on particular devices and materials.

1.3. SUMMARY OF THE CHALLENGES WITH DIGITAL INFORMATION SHARING

Despite the current good practices, digital information sharing is still in its infancy. Several barriers to enhancing digital information transfer can be identified.

1.3.1. Access to good-quality data

Unreliable and/or incorrect data can lead to poor outputs. Verifying the initial input shared via blockchain, for example, would require additional resources to validate the information (e.g. independent auditors).

Access to user-friendly data is often not a given. Even when digitised, data is not always systematised; meaning standardised, comparable or available in an interoperable format. Even if there are standards for data or information transfer in particular value chains, the lack of *global* open standards limits the sharing of relevant information across value chains.

Diverging interests and practices can hamper access to data and information. The value of data varies between the value chains. For example, the electronics sector is lively with many rapid innovations. Therefore, the value of data in its value chain is often regarded as high, and data owners are hesitant to share information with other stakeholders. Moreover, the lack of clarity on data usage rights and the diverging degrees of freedom on data flow can hamper access to data.

1.3.2. Concerns over data protection and security

Finding a balance between information sharing and protecting citizens' and businesses' sensitive data is not easy. The private sector and citizens are concerned with how and for what purposes data is used. Concerns about the confidentiality of business-sensitive data can hamper the sharing of data between businesses (e.g. manufacturers and repairers; B2B), as well between businesses and consumers (B2C) and the government (B2G).

Concerns about the confidentiality of business-sensitive data can hamper the sharing of data between businesses.

Security considerations can hinder the use of online platforms and databases. Concerns around security and confidentiality can undermine trust in both platforms and databases.

1.3.3. Managing complexities

Current information and data sharing is limited to particular sectoral value chains (e.g. automobiles, textiles). It is easier to enable information transfer practices in closed, regional loops and with trusted partners than in more complex, international value chains.

The complexity of supply chains, a lack of bargaining power and the global nature of supply chains can make it difficult for product manufacturers to obtain information from upstream suppliers (e.g. providers of materials and certain components). This makes it more difficult for manufacturers to share CE-related information with public authorities, other companies, consumers and waste operators.

Accessing and sharing information can be difficult and inconvenient for consumers if apps, for example, are complicated or consumers must wait to receive information.[26] As a result, if consumers do not actively use existing tools to request information on products, this may reduce corporate interest in making data and information available by digital means.

International collaboration on developing an information transfer system for a CE is still at an early stage. Global agreements and standards for promoting information transfer across value chains for the benefit of a CE are lacking. As long as this is the case, developing DPPs for international value chains will be difficult.

1.3.4. Incentives for businesses

The lack of convincing and applicable business cases for sharing data and information can hamper businesses' willingness and interest in this regard. If businesses do not see added (e.g. economic) value in exchanging information or are not requested to by policymakers, they may not see an incentive to engage in information transfer.

Data collection without a clear purpose – collecting data without a vision and plans for its use – **can undermine stakeholders' interest to share data or information.**

Administrative burdens and time loss can make it less appealing and effective for businesses to share data and information for a CE. This is particularly the case when businesses are requested to upload similar data on different governmental registries.

Recovering components and secondary materials from used products entails significant efforts to coordinate and communicate between different stakeholders (i.e. producers, consumers, repairers, waste operators, municipalities), compared to extracting virgin materials from a single location.

1.3.5. Fundamental barriers to digital transformation

Europe's economy and society as a whole are progressing slowly on digital transformation. The EU struggles to improve not only its connectivity but also business digitisation, e-commerce and digital public services, especially when it comes to small and medium-sized enterprises (SMEs).[27] The EU risks falling behind in the digital race (in e.g. 5G, IoT, AI), especially vis-à-vis China and the US. The lack of cybersecurity is often mentioned as a key barrier to fully transitioning towards a digital economy, thereby undermining the collective trust in digital developments.

A lack of funds may prevent SMEs, start-ups and lower-income consumers from taking up and managing digital information sharing systems. Similarly, impoverished regions may lack the digital infrastructure to enable connectivity and thus fast and efficient information transfer.

A lack of digital skills to access and share information about materials, products and services can be a barrier. For example, waste operators and repairers may lack the skills to use a scanner device or smartphone and access product-related information in a DPP. Consumers could upload information about products they use via an online platform or DPP, but lack of knowledge may prevent such practices.

Digital solutions can only support the green transition if they themselves become sustainable. Digitalisation comes with a significant environmental and climate footprint which will need to be addressed (see Introduction). Efforts are being made to address the energy consumption of data centres and improve resource use and waste management of digital devices (e.g. smartphones). Nevertheless, much more must be done to make data centres run on renewable electricity; reduce the use of virgin materials for electronics; improve the reuse, repair, durability and recycling of devices that are central to the digital transition; and enhance the sustainable use of solutions like AI.

These challenges reveal the scale of what still needs to be done by European industry, consumers and policymakers to reap the environmental and economic benefits of digital information sharing. This transformation will be hampered if there is no enabling policy framework at the EU level that provides clear rules, standards and incentives for digital information transfer across value chains to bring about a CE.

2. The EU policy framework for action

The EU is currently engaged in two transformations – the green and digital transitions – that could change our economy and society for the better. They are at the heart of the European Green Deal, the EU's new growth strategy, as well as the COVID-19 recovery. But much more needs to be done to align these twin transitions to create a more sustainable, climate-resilient and competitive economy.

As the previous sections show, data and digital solutions can address the ultimate challenge in establishing a CE: information transfer across value chains. This section assesses the EU policy and financial framework and ongoing developments, such as on DPPs and a data space for circular applications. It considers the existing basis for turning data and digital solutions into enablers for information transfer in circular value chains.

2.1. THE CIRCULAR ECONOMY AGENDA

The Circular Economy Action Plan (CEAP) – put forward by the European Commission in 2020 – outlines a policy framework for the future, building on the previous 2015 agenda and sectoral policies. It lays out a "regenerative growth model that gives back to the planet more than it takes" while recognising the opportunities a CE provides for industry.[28] The CEAP envisages many initiatives, including a sustainable product policy framework and an enhanced waste policy framework. It also aims to enhance a smarter use of resources in several sectors, such as electronics, plastics, packaging, chemicals and construction.

The CEAP recognises the role of digitalisation as an enabler for the CE, especially in enhancing information transfer along value chains. It proposes creating a common European data space to support the CE. This framework would help develop and apply digital solutions, such as DPPs. It is linked to a wider initiative on the common European data space under the EU's Data Strategy; this initiative is hoped to overcome barriers to data sharing.

The Circular Economy Action Plan recognises the role of digitalisation as an enabler for the circular economy, especially in enhancing information transfer along value chains.

The CEAP also considers adopting regulatory measures to mobilise the potential of DPPs and digital tags. The Commission envisages developing systems that track and manage information on substances that hamper waste recovery operations. The CEAP also makes brief references to IoT and blockchain in supporting innovative (circular) businesses.

These plans offer a valuable basis, but the work is only just starting. The details of what these initiatives will mean in practice and how they will actually be implemented remain to be defined. It is thus timely to take stock of the ongoing discussions and developments, and provide recommendations for the needed measures (see section 3), as specific strategies and legislation for improving information transfer are still to be developed.

2.1.1. The Sustainable Products Initiative and digital product passports

The design phase of a product can facilitate information transfer because, at this stage, products could be equipped with digital solutions to carry product information across value chains (e.g. digital tags, DPPs). The CEAP's Sustainable Products Initiative (SPI) – expected to be proposed by the Commission in early 2022 – envisages a set of policy interventions to make products more circular, including introducing DPPs. The backbone of the Initiative will be the revision of the existing ecodesign policy framework.

The SPI is expected to extend product circularity requirements to consumer electronics like smartphones, tablets and laptops. The SPI will also cover textiles, furniture and high-impact intermediate products (e.g. steel, cement, chemicals). The aim will be to improve the durability, reparability, upgradability, maintenance, reuse and recycling of these products. The SPI is expected to be accompanied by rules and standards for introducing DPPs into products, supporting information transfer for a more circular economy.

The Commission will likely develop a common set of standards accompanied by specific legislation to improve information transfer in particular value chains. Given the complexity of this exercise, starting with selected value chains is wise. These rules should include information for improving circularity, on who can access this data and under what conditions, and technical standards.

While there is new momentum for DPPs at the moment, the work is not starting from scratch. In 2020, the Commission proposed the Batteries Regulation, which would require introducing DPPs into large batteries for electric vehicles and industrial purposes. If adopted, this legislation could make information on the battery contents accessible and facilitate their end-of-life treatment. The exercise under this Regulation would provide valuable lessons on DPPs in other products, such as electronics and textiles. The future of DPPs will also likely build on other existing practices, like the digital tagging of energy labels in electronics.[29]

Going forward, the complexities of introducing DPPs into products cannot be underestimated. There are differences in B2B, B2C and B2G information transfer. The information must be relevant for and thus specifically targeted to the different stakeholders. Furthermore, there are significant differences between value chains (e.g. textiles versus batteries) and even within value chains (e.g. due to various electrical and electronic products).

Moreover, while introducing DPPs into valuable assets (e.g. large batteries) could provide added value to businesses, the economic case may not always be straightforward for all products. Tracking and tracing smaller electronics, for example, can be time-consuming, and the costs may outweigh the benefits for businesses.

2.1.2. Green public procurement and consumer law

Green public procurement (GPP) and the aim to improve consumers' access to CE and environment-related information on products is expected to increase demand for better information transfer in value chains.

The EU's Public Procurement Directive 2014/24/EU envisages voluntary GPP and has developed criteria for certain electrical and electronic office equipment. Moreover, the CEAP suggests developing and introducing *mandatory* GPP criteria. One could expect that these would increase interest in improving information transfer on product contents. However, the current GPP rules and announcements about introducing mandatory GPP are not related directly with information transfer for a CE.

The Circular Economy Action Plan suggests developing and introducing mandatory GPP criteria. One could expect that these would increase interest in improving information transfer on product contents.

As a new development for consumers, the CEAP envisages revising consumer law to "ensure that consumers receive trustworthy and relevant information on products at the point of sale, including on their lifespan and on the availability of repair services, spare parts and repair manuals."[30] The Commission is also working on another policy initiative to strengthen the 'right to repair'. Moreover, it is preparing a proposal for legislation that would require companies to substantiate their claims about the environmental footprint of their products, to combat greenwashing.

This said, while the EU's consumer policies are well-developed and include some environment-related rules (e.g. voluntary ecolabels, mandatory energy efficiency labels), the link with the CE has been rather weak. While the role of digital solutions in informing consumers seems for the time being to be downplayed, there is certainly scope to build on this potential. For example, introducing new rules that enhance the right to repair could drive up the use of data and digital tools for information transfer that enables product repairs.

2.1.3. Chemicals legislation

Building on the CEAP, the Chemical Strategy for Sustainability calls for enabling access to information about the presence of hazardous chemicals in products and tracking it throughout the value chain to facilitate waste management. This builds on the EU's overarching regulatory framework on chemicals, including REACH and the Classification, Labelling and Packaging Regulation 1272/2008 (CLP).

Article 33 of REACH requires companies to communicate the presence of SVHCs in their products to relevant businesses (e.g. waste operators) and consumers on request if it has a concentration above 0.1%. For this purpose, the EU is developing a SCIP database (see section 1.2).

Although a notable effort by the EU, complications and duplications with reporting requests must be addressed. In addition to using the SCIP database, under Article 7 of REACH, companies are obliged to notify the ECHA about SVHCs in their products if they total over one tonne per year via another platform: IUCLID. As a result, many companies need to make two separate reports on SVHCs.

2.1.4. Waste management

Improving information transfer across value chains can help not only producers design more circular products but also waste operators recover valuable materials and components from end-of-life products. The CEAP recognises this by suggesting that further action is needed to "encourage sharing of information and good practices in waste recycling."[31]

The EU's Waste Framework Directive sets out rules for waste management and introduced the principle of extended producer responsibility (EPR), which holds producers responsible for the care of products they place on the EU Single Market once they reach their end-of-life phase. EPR offers a valuable basis for further action, as it can incite producers to provide information digitally to consumers and waste operators on how to handle end-of-life products properly.

The EPR is currently applied to e-waste, batteries, vehicles and packaging, in one form or another. Producers' responsibility to make information on the treatment of end-of-life products available to waste operators is already specified in the WEEE and ELV Directives. These Directives refer to "electronic media" as a possible tool for providing this information, albeit in a somewhat vague or outdated manner (i.e. "online services", "CD-ROM"). The I4R Platform and IMDS – developed in response to the WEEE and ELV Directives – are positive, industry-led examples of how information transfer can help meet the legal requirements (see section 1.2.).

Although it encourages information transfer between producers and waste operators, EPR does not refer to modern digital tools for information transfer, such as DPPs. Rules on batteries and packaging do not require producers to provide relevant information to waste operators. For textiles and construction products, the EU-level requirements on waste management are still on the drawing board.[32] It should also be noted that the rules on providing CE-related information to consumers concerning the end-of-life phase of products remain limited under EU law. [33]

Although it encourages information transfer between producers and waste operators, extended producer responsibility does not refer to modern digital tools for information transfer, such as digital product passports.

2.2. THE DIGITAL AGENDA

2.2.1. Data flow

The EU has already made significant advances in creating rules for the development of safe and efficient information transfer. Importantly, the work on improving access to data and ensuring data flow between stakeholders is progressing.

Regulation 2018/1807 aims to remove obstacles to the free movement of non-personal data between different EU countries and IT systems. It facilitates data processing across the Union and introduces measures to encourage data porting and switching between cloud service providers, which is important to facilitating information transfer across value chains.

The Open Data Directive 2003/98/EC (ODD) makes public sector data reusable for commercial and non-commercial purposes. There are limitations, however, as private actors can, for example, make such data available on the condition that it cannot be accessed by a wider audience to safeguard data confidentiality. The ODD establishes categories of 'high-value datasets', which should be available free of charge to requestors and in a machine-readable format. The ODD identifies a broad range of such categories which remain to be specified by implementing acts. One of the categories is 'earth and environment', but the CE is not listed. This risks side-lining CE-related topics when determining what dataset should be 'high level' and thus made available free of charge.

Furthermore, the EU's Intellectual Property Rights strategy recognises Europe's need for "a solid framework to allow businesses to create, access, share and use data" to "facilitate repairs".[34] To that end, the Commission is evaluating intellectual property rules to ensure a balance between information transfer and data protection.

Other instruments that could facilitate access to relevant data for a CE include the Freedom of Access to Environmental Information Directive 2003/4/EC. It requires public authorities to make environmental

data available and is currently under review. Moreover, the INSPIRE Directive 2007/2/EC sets rules for "the establishment of the Infrastructure for Spatial Information […], for […] Community environmental policies and policies or activities which may have an impact on the environment."[35] The Directive covers monitoring, production, industrial and agriculture facilities, and energy and mining and has several implementing acts on how to standardise the generated CE- and waste-related data.

Although concerns over the protection of personal, private and commercial data remain, the EU has made significant progress on this matter. For example, the Database Directive 96/9/EC, Trade Secrets Directive 2016/943/EU, ePrivacy Regulation 2002/58/EC and General Data Protection Regulation 2016/679/EU (GDPR) aim to address these concerns. Notwithstanding the importance of EU legislation on data protection, they can also restrict or slow down the flow of information that is necessary for a CE across value chains.

2.2.2. The common data space(s)

In 2020, the Commission adopted a new Digital Agenda to drive the EU's digital transformation. This included the Data Strategy, which aims to establish a single market for data. The backbone of this proposal is establishing one or more common European data space to enable the sharing of industrial data, unlocking new business opportunities and achieving common objectives, such as the transition to a CE.

It is expected that the common data space(s) will provide an economic and social governance framework for using data and enabling information sharing between different sectors. It will comprise technical standards, such as a common vocabulary and concepts (i.e. the 'ontology'). The data space will also include rules and conditions on accessing and using data, to safeguard confidential information. The EU will invest in the development of necessary infrastructures, such as secure cloud-based systems that different businesses can use.

It is expected that the common data space(s) will provide a governance framework for using data and enabling information sharing between different sectors.

In addition to a 'horizontal' common data space that establishes general rules and standards, there will be a specific governance framework and interconnected data spaces for different sections of the economy and society. One of these will be a data space for Smart Circular Applications; either as a separate data space or a subset of larger common data spaces on the European Green Deal and Smart Manufacturing. This lack of clarity as to the exact structure of the common data space raises concerns about fragmentation, which could hamper information transfer across value chains.

A starting point for establishing common European data space(s) is the Commission's proposal for a Data Governance Act (DGA). This would facilitate different stakeholders' (i.e. businesses, citizens, researchers) access to information held by public authorities, notably when such data is provided by private entities and data confidentiality is not an issue. Moreover, the DGA would help intermediary organisations manage data on behalf of data providers and users. It would facilitate data sharing for 'altruistic purposes', including the common good (e.g. research purposes), and therefore be relevant to the green agenda and CE.

The DGA is important because governments store huge amounts of data, including on products and their content (e.g. REACH, the European Product Registry for Energy Labelling). Intermediary companies can provide data management services to ensure that DPPs or IoT systems, for example, perform well. Defining the more systematic, altruistic sharing of data could facilitate researchers' access to information, which again could support the design of more circular products. It should also be noted that, apart from a short reference to the importance of the Green Deal, the DGA does not make further links with sustainability or CE-related topics. Without a clear link, applying the DGA to facilitate information transfer for a CE will be more difficult.

As a second legislative pillar for the development of common data space(s), the Commission is expected to propose a Data Act by the end of 2022. This legislation would facilitate access to and the use of data in B2B, B2C and B2G situations. The Inception Impact Assessment on the Data Act envisages that the Act will review or clarify the existing data protection legislation, namely The Database Directive and the Trade Secrets Directive. Furthermore, the Data Act is expected to reinforce the GDPR's provision to give data users the right to transfer their data from one data provider to another.[36] Data providers are not currently obliged to set up schemes for automatic information transfer. The Data Act is expected to address this matter.

The Inception Impact Assessment makes a concrete reference to the importance of sharing information to enable predictive maintenance. The Data Act proposal should build on this recognition and make a link to the importance of information transfer across value chains for the benefit of a CE. It would also be worth recognising the role of tools such as DPPs in these efforts.

While an ambitious and welcome initiative, in theory, there are still many uncertainties concerning the architecture, functioning and performance of the data space. The common European data space is yet to be defined, or a clear picture of how it would actually look. This rather the Commission's approach on developing the database gradually, in collaboration with all the relevant stakeholders and without predefining the outcomes too

early. Moreover, it is still unclear how the Commission intends to make the data space actionable so that different stakeholders (e.g. companies, consumers, waste operators) can easily access and use the relevant information.

Given the scale of efforts needed to create data standards, set rules on data governance, and deploy digital tools for information transfer, establishing a functional common data space(s) that can support a CE will take years.

2.2.3. Other European initiatives on information transfer

Besides the aforementioned EU-led initiatives, additional European initiatives are worth considering because of their (potential) role in facilitating information transfer for a CE.

The **GAIA-X project** aims to develop common requirements for open data infrastructure in Europe. The main focus of these interoperability standards is to enhance the use of cloud-based databases and, therefore, the information transfer between different users of such databases (e.g. companies, researchers), with potential applications for the CE. GAIA-X is a collaborative effort between seven European countries, led by Germany and France, and involves policymakers, industry and the scientific community. As it is not directly linked to the EU's initiative on common data spaces or the CE agenda, this could lead to new rules on data infrastructure and duplication of efforts. Thus, while an interesting initiative, it also underlines the need to ensure synergies between EU- and member state-driven initiatives on developing common data infrastructure for information transfer that can benefit CE.

The Luxembourg Ministry of the Economy has developed the **Product Circularity Data Sheet** (PCDS) as part of its Circular Dataset initiative. PCDS serves as a standard for communicating data on the CE properties of products and is an example of how member states can take the initiative and develop rules on data standards. Such initiatives would be especially valuable if they help guide, feed and support EU-wide initiatives, such as the common European data space(s). The Ministry is collaborating with the International Standardisation Organisation (ISO), which, in turn, is developing international standards on the PCDS.

The **European Blockchain Partnership** (EBP) is a joint effort between the EU27, Norway, Liechtenstein and the European Commission. It aims to create a European Blockchain Services Infrastructure (EBSI) to support the delivery of cross-border digital services by public and, eventually, private actors. Such a blockchain infrastructure could also facilitate information transfer for a CE (see section 1.1.). However, a clear link between a future EBSI and the CE – or sustainability for that matter – has not been established.

The Commission recognises the need for a human-centred IoT approach that would also enable the CE.[37] Initiatives like the multi-stakeholder **Alliance for Internet of Things Innovation** have been launched to promote the development of IoT solutions in Europe, including to support the green transition and CE.

In 2021, 26 ICT companies created the **European Green Digital Coalition** (EGDC) to foster interlinkages between the green and digital transitions, including for the benefit of a CE. While its current focus appears to be on greening ICT, the EGDC could also provide a valuable sounding board for the methods of using digitalisation to facilitate information transfer for a CE.

2.2.4. Global initiatives on information transfer

While it can be easier to develop policies, initiatives and solutions for improving information transfer within closed loops and in European regions, ultimately, creating a functioning information exchange ecosystem across sectors and borders will require international cooperation. Collaboration will be needed on standardising data, enabling data transfer, and developing technological solutions for information transfer across value chains.

Ultimately, creating a functioning information exchange ecosystem across sectors and borders will require international cooperation.

Several international initiatives are considering data standardisation and exchange. For example, **EDIFACT** (Electronic Data Interchange for Administration, Commerce and Transport) and **EDIFICE** (Global Network for B2B Integration in High Tech Industries) have established standards for electronic data interchange (EDI). The European Parliament has recently highlighted the relevance of EDI standards for monitoring waste (shipment) flows, and the Commission is looking into possibilities for introducing EDI in this area. The next step should be linking EDI standards with the EU's ongoing work on developing common data space(s) for a CE.

GS1 is an international organisation that develops standards to identify, capture and share data. It is known for developing a barcode standard that is used around the world. It aims to have a global set of open standards that could be used by different industries and across different value chains, and facilitate the introduction of DPPs. GS1 is in contact with the European Commission regarding the development of these standards, supporting the latter's work on common data standards while not forgetting the need to ensure their global applicability. As modern value chains are global, enhancing information sharing across value chains would benefit from international collaboration, including on standards.

GS1 continues to develop new standards on product identifiers, including digital tags. It is currently assessing possibilities to develop unique identifiers (i.e. ID codes) for different products or product categories, which would be supported by digital tags and data sharing protocols. GS1 and the World Wide Web Consortium have already

joined forces to create a common ontology that connects digital tags to the World Wide Web and thus supports the CE. Thanks to this GS1 Digital Link, providing more product-related information from different sources would be possible.

On blockchain, the EU supports European and global standardisation efforts (e.g. ISO, European Telecommunications Standards Institute, European Committee for Standardization, European Committee for Technological Standardization, Institute of Electrical and Electronics Engineers, International Telecommunication Union). It is also involved in the **International Association for Trusted Blockchain Applications** (INATBA), which facilitates interactions between blockchain developers and regulators. The EU Blockchain Observatory and Forum maps key initiatives, monitors developments and inspires common actions on blockchain. The EU is also involved in international standardisation initiatives on IoT, such as **oneM2M**. While these initiatives may not actively make a direct link to the CE and sustainability in general, such global collaboration efforts are important as they can facilitate the use of these solutions for information exchange across borders, in global value chains.

2.3. EU FUNDING INSTRUMENTS

2.3.1. The Multiannual Financial Fund and the Next Generation EU

The EU's funding instruments can support the necessary collection and analysis of data, and facilitate the development and deployment of digital tools and infrastructure to enable information transfer for a CE. In December 2020, the EU adopted the 2021-27 Multiannual Financial Fund (MFF; €1.074 trillion) alongside the EU recovery plan, Next Generation EU (NGEU; €750 billion). These funds will support the green and digital transitions, including for a CE. Furthermore, 30% of all EU funds are earmarked for climate action. The package also includes InvestEU, a public-private instrument expected to trigger hundreds of billions of euros in additional investments.[38] Following the adoption of the MFF and NGEU, individual instruments have been or will be adopted.

The EU's funding instruments can support the necessary collection and analysis of data, and facilitate the development and deployment of digital tools and infrastructure to enable information transfer for a circular economy.

With an overall budget of €7.5 billion, the Digital Europe Programme (DEP) will play a key role in deploying and taking up digital technologies. It will focus on five areas: supercomputers, AI, cybersecurity, digital skills, and the deployment and best use of digital capacity and interoperability. The DEP will crucially fund the common European data space(s), which is essential for more efficient information transfer across value chains. The call for applications to develop a data space to support smart manufacturing (i.e. related to the CE) has already been announced.

Horizon Europe succeeds H2020 (2014-20), with an overall budget of €95.5 billion. Although it does not establish a link with the two agendas, Horizon Europe will support digitalisation and the CE transition. The Horizon Europe Strategic Plan states that one of the priorities of Horizon Europe is "making Europe the first digitally enabled, circular, climate-neutral and sustainable economy through the transformation of its mobility, energy, construction and production systems".[39] It recognises the importance of data sharing for greater resource efficiency. It also makes several references to using Horizon Europe to support the digitally enabled development of interoperable digital infrastructure, blockchain and IoT – tools that are important for information transfer for a CE. H2020 already supported projects that aim to develop collaborative online platforms on the CE (see section 1.2.). Horizon Europe could therefore provide an additional boost to developing innovative ways to share information across value chains.

InvestEU and the Recovery and Resilience Facility (RRF) will contribute 16% and 20% of their funds to the Digital Agenda, respectively. While they make broad reference to the green and digital transitions, more specific references – including the role of digitalisation in supporting the CE, are lacking. Moreover, there is a great risk that despite member states having prepared Recovery and Resilience Plans to access the funds, they do not actively propose ways to use digital solutions to enable the CE.

The Commission's proposal for the Cohesion Fund (CF) and European Regional Development Fund (ERDF), totalling almost €234 billion, refers to the CE and digitalisation – albeit without linking the two. The Smart Specialisation Platform, supported by the EU's cohesion policy, is a particularly useful tool for supporting regional development. The proposed European Social Fund Plus (ESF+) (€88 billion) contains references to both digital and green skills. The European Skills Agenda, to be mainly funded by the ESF+, contains stronger cross-references to the CE and digitalisation. The Pact for Skills, a multi-stakeholder engagement model for skills development in Europe, is the first initiative launched under the Agenda. The ESF+, CF and ERDF are relevant for the digital information transfer in a CE because they can enhance pertinent digital skills and infrastructure. Given these funds' heavier focus on lower-income areas, they can support the just transition in the EU's more vulnerable regions.

2.3.2. The sustainable finance agenda

The EU's sustainable finance agenda aims to help direct private investment towards the green transition and can also be relevant for the CE and enhancing information

transfer. The agenda comprises several initiatives on defining sustainable activities, improving corporate and financial reporting, disclosing data, and developing a European Green Bond Standard. The Commission recognises the importance of linking digital and sustainable finance agendas, although specifics are yet to be determined.[40]

The European Commission is developing a general framework to determine what economic activities are to be regarded as 'sustainable' and can thus support investors in their investment decisions (i.e. 'taxonomy rules'). The Commission has already made progress in this with regard to climate mitigation and adaptation. It is also expected to propose by the end of 2021 an environment-related taxonomy that includes definitions of sustainable activities regarding the CE. The ongoing work of the Platform on Sustainable Finance – an expert group advising the Commission on the taxonomy rules – recognises that data-driven ICT solutions can support a CE and should therefore be considered when developing environment-related taxonomy.[41] The work on the EU taxonomy is also relevant for developing the common European data space since the latter will need to outline what information must be shared to enable the CE.

Recognising the importance of information sharing for achieving a CE, including information transfer as a criterion for labelling an economic activity as 'circular' makes sense. This would also incentivise companies to disclose more sensitive data so that their activities are deemed circular. Despite the aforementioned possibilities, the actual link between a CE taxonomy and information transfer is yet to be established in the EU taxonomy rules.

Another important initiative is the Commission's proposal for a Corporate Sustainability Reporting Directive (CSRD). It would build on the Non-financial Reporting Directive 2014/95/EU, which required large-scale companies to disclose information on how they operate and manage environmental challenges, including resource use and the CE. The CSRD would introduce more detailed reporting requirements and extend the scope of companies covered. Companies will need to provide 'digitally tagged' (i.e. machine-readable) information via a single electronic reporting format. Digitalised corporate reporting would not only improve EU policymaking on the CE. It could also facilitate the sharing of information provided by companies with remanufacturers, circular product designers, and developers of digital information transfer tools for a CE, in accordance with the data governance legislation (e.g. the upcoming DGA).

3. EU policy recommendations

These recommendations are intended for the EU – namely, the European Commission, Parliament and member states – unless specified otherwise.

STRATEGIC DIRECTION

To achieve the objectives of the European Green Deal and make the European economy climate-neutral, sustainable and competitive, the EU must accelerate its transition to a more circular economy. Since the EU is already focused on the twin green and digital transition, it should build on the power of data and digital solutions to enable the CE. The EU must become a global leader in using digitalisation *sustainably* to address the remaining barriers to a CE, including information transfer in value chains.

- By 2030, the EU must establish a digital information system for a CE that would incentivise and enable the exchange of information necessary to improve circular practices in value chains, (e.g. better design, reuse, repair and recycling of products). The EU should lead the development of a global digital information system for the CE by 2040.

- The EU must use its Digital Agenda to speed up the deployment of digital solutions for a CE, including for essential information transfer in value chains (i.e. blockchain, cloud, IoT, DPPs).

- Public authorities must take measures to prevent or reduce the negative side effects of digitalisation on the climate, environment and society at large. They must develop rules and standards for and invest in digital solutions that are energy- and resource-efficient. Greening data centres will be essential. Digital solutions should be steered to address Europe's environmental and climate challenges.

- Public authorities must engage with the relevant stakeholders for information transfer across value chains, including producers, consumers, repairers, remanufacturers, waste operators and NGOs. Conversely, private and non-profit organisations must proactively collaborate with the decision-makers.

OBJECTIVE 1: CREATE AN ENABLING FRAMEWORK FOR INFORMATION TRANSFER

- **As the EU starts its work on the European data space, it should contribute to the creation of a data governance framework that incentivises and enables access to and the sharing of data and information for a CE across value chains.** This requires identifying, across different sectors and value chains, the data and information needed to achieve the transition to a CE – in collaboration with the industry and civil society. The latter's concerns must be heard, and the framework must incentivise innovative sharing and use of data.

- Regardless of the final architecture, **the EU must ensure that all data and information circulating within data space(s) are integrated**. There should be one metadata space, which can be divided into several data spaces in terms of function (e.g. supporting CE, agriculture, mobility) while avoiding technical barriers for the free flow of information across different sections of the data space. The EU's work on common data space(s) should also be connected with member states' initiatives, like the GAIA-X project, to maximise the synergies and avoid duplicating work and creating inconsistencies. The EU should explore how AI, for example, can manage this metadata more efficiently across the EU, members states and businesses.

- **Ensure that the envisaged legislative framework for common data space(s) supports circular applications and innovation.**

    - The EU must use the DGA and Data Act to support information transfer between the public and private sectors and between private actors (e.g. businesses, researchers). The EU could make specific references to the CE in the legislation or adopt guidelines to facilitate the sharing of data and information.

    - The high-value dataset envisaged under the ODD should make specific reference to CE-related information and thus make relevant public information available to businesses, researchers and NGOs free of charge.

    - The EU should build on the INSPIRE Directive and the Freedom of Access to Environmental Information Directive to be able to access relevant data.

- **Improve interoperability between different public databases in the EU**, including national and subnational information systems. The aim should be to create a system whereby businesses provide information to public authorities only once, which can then be reused by different authorities and made easily accessible to other businesses, civil society and researchers. National regulations may also need to be revised to provide access to data needed for third-party services.

- **Additional guidance and a review might become necessary to ensure that the GDPR is applied and enforced across Europe equally.** Public administrations should provide businesses with examples of how data can be made available and shared while respecting the GDPR. Clearer definitions of *personal* and *non-personal* data may also be required.

- **Consider how the information within the common data space(s) can be made actionable.** Information needs to be formulated and communicated so that the relevant stakeholders can use it and thus contribute to a CE.

    - Consider structuring databases according to the needs of each particular stakeholder (e.g. companies, consumers, enforcement authorities, NGOs, academia).

    - Establish multi-stakeholder expert groups for different sectors (e.g. electronics, textiles) to reflect and establish how and what information can be shared with the stakeholders in the most user-friendly manner.

- **Develop common terminology and technical data standards** for data and information sharing across value chains. The EU should work closely with member states, producers, waste operators, municipal associations and consumers in these efforts.

    - Based on stakeholders' inputs, the EU should determine case by case if guidelines are sufficient or if mandatory rules for technical data standards are necessary.

    - The discussions on the terminology and definitions for information transfer for a CE should be connected to the current work on developing a CE-related taxonomy under the sustainable finance agenda. It is important to define terms like *circular*, *open/closed loop*, *repairable*, *recovered* and *recycled*.

- To support the work on the data space, the EU, in collaboration with the private sector, should already in the short term **develop common and open protocols on and encourage voluntary information transfer between public and private stakeholders across value chains**. The goal should be to encourage data transfer and facilitate the use of digital tools like blockchain, IoT and, ultimately, DPPs so that they benefit the stakeholders involved and support the transition to a CE.

    - Encourage voluntary schemes or launch pilot projects between the relevant stakeholders (i.e. producers, waste operators, consumers) – or 'coalitions of the willing' – to enable information sharing within and across sectors. They should build on existing initiatives (e.g. I4R).

    - Building on the lessons learned from the voluntary schemes, assess the need and ways to establish mandatory requirements on data accessibility and information transfer for a CE.

    - Request minimum data disclosure in the EU rules on public procurement to provide a strong incentive to exchange CE-related information concerning procured products and services.

- While it can be easier to start with improving information transfer within European value chains, the ultimate target is the *global* value chains. The EU and its member states must **enhance global collaboration** on information transfer to ensure that the information on products and materials from outside

is reliable, compatible and of use in the EU. They should encourage the global development of open, interoperable data and application solutions, thus enabling large-scale information sharing for circular processes.

- Encourage the development of global guidelines on the sharing of data and information across value chains (e.g. World Trade Organization, Organisation for Economic Co-operation and Development, Group of Seven). The EU should promote international collaboration between governments and industries to develop a common set of standards on information transfer sharing, which could also support DPPs.

- Promote international collaboration on developing a common set of standards on data transfer across value chains. This should build on existing standards, such as the EDIFACT, EDIFICE, Global Material Flows Database, and Global Resources Outlook.

- **The EU and its member states should actively consider the drivers for information sharing and incentivise businesses to share data and ensure information flows across value chains.**

  - Businesses should understand the rationale behind data collection, what information is actually needed, how it is used and how data exchange can benefit them.

  - Under the sustainable finance agenda, the EU should include information sharing as a criterion of the CE taxonomy. Private investments would thereby be directed to companies oriented towards sharing data and information for the CE.

OBJECTIVE 2: ENABLE THE UPTAKE OF DIGITAL SOLUTIONS FOR INFORMATION TRANSFER

- **Ensure adequate infrastructure for connectivity.** Invest in reliable, high-speed connectivity (i.e. 5G) and sustainable data centres, which are fundamental when using digital solutions for information transfer.

- **Develop and deploy the solutions necessary to manage data efficiently.** This means investing in data-processing capabilities (i.e. AI, edge computing), cloud-based databases for storing data, and stable online platforms for submitting and accessing data.

- **Use the financial instruments MFF and NGEU** to boost the development and deployment of digital solutions for circular information transfer.

  - DEP should be the main funding instrument for the roll-out of the infrastructure for common data space(s) and support pilot tests of IoTs, blockchain, online platforms and DPPs for CE.

  - Horizon Europe should support further research on and the development of digital tools for information transfer (i.e. IoT, blockchain, online platforms, DPPs) that can support CE.

  - InvestEU and NGEU should support the scale-up of businesses that develop or use digital information transfer for a CE. These can include the developers of the relevant solutions, producers, service providers, repairers and waste operators that use such tools.

  - Member states should use the RRF to uptake sustainable digital solutions that can support a CE. The EU should assist member states in this and develop relevant guidelines for the future.

  - Structural funds (i.e. ESF+, CF, ERDF) and the related Smart Specialisation Platform and Skills Agenda should support the scale-up of digital tools for information sharing and the upskilling of the workforce to use digital tools. This support should target those actors and regions lagging the most and enable an EU-wide just transition.

- **Consider introducing a requirement to the GPP, whereby procurers of products and services can access the relevant CE-related information** thanks to digital solutions. The EU could start with voluntary GPP criteria and consider mandatory criteria after assessing the effectiveness of the former.

- **Explore adjusting EPR rules** so that producers are asked to provide information digitally to consumers and waste operators on how to handle end-of-life products. Besides the current obligations for electronics and vehicles, similar rules could be introduced for batteries, packaging, textiles and construction. The ongoing revision of the EU's sustainable consumption law and upcoming rules on the 'right to repair' should be interlinked with such new EPR requirements on providing CE-related information to consumers.

- Looking to the medium to long term, as part of the current work under the SPI, the EU must **develop the regulatory framework for introducing DPPs into products**.

  - This requires specifying further the information that will be needed for the DPPs. Identifying and classifying this relevant information and necessary data should be coupled with the EU's efforts to develop a CE taxonomy. The EU should closely collaborate with international standardisation bodies like GS1 when creating global and open standards for DPPs for a CE, to promote their use in transnational value chains.

  - As part of the SPI, the EU should support the introduction of DPPs into products to reduce their environmental footprint throughout their lifecycle. Impact assessments for each product type should

precede this introduction. These assessments would estimate the economic and environmental benefits and costs, including the difference between voluntary and mandatory rules on DPPs.

- The rules on DPPs must be developed in close collaboration with all relevant stakeholders. The goal would be to provide the needed information to producers, waste operators, repairers and consumers. Information transfer should be user-friendly while avoiding unnecessary costs and administrative burdens for producers and safeguarding confidential business information and personal data.

- Consider introducing DPPs for valuable products (e.g. electronics) while building on the lessons of the DPPs in large batteries. Depending on the outcomes of these efforts, continue to explore ways to introduce DPPs for also other types of products.[42] Start with voluntary rules for DPPs and, depending on the performance of such rules, consider introducing mandatory rules for DPPs.

- **Take a leading role in international and pan-European initiatives on standardising digital solutions** such as blockchain (EBP, INATBA) and IoT (IAOTI, oneM2M). Ensure that these standards support the roll-out of digital tools to enable information transfer for CE. The EU should coordinate its efforts with initiatives like the EGDC to enhance the deployment of digital solutions for CE-related information transfer. The Global Alliance on Circular Economy and Resource Efficiency should become one of the fora to discuss and promote digital information transfer for CE.

- Looking ahead, **consider introducing minimum circularity requirements on products** that enter the Single Market from third countries. Also, consider **enabling the transparency** on the materials and use, repair or recycling of the products with the help of digital tools like DPPs. Lack of compliance with such requirements could prompt the EU to refuse to import foreign products or to introduce a levy akin to the instrument being developed under the Carbon Border Adjustment Mechanism.

Conclusion

Achieving digitalisation with a purpose – managing data and developing and deploying digital solutions to solve some of our greatest sustainability challenges – would greatly benefit the planet, people, businesses, society and economy. Together with the greening of ICT, using digitalisation to enable and accelerate a transition to a more sustainable society and economy should form the core of the twin green and digital transition.

This Discussion Paper considers how digitalisation can help us shift from the current, linear, take-make-dispose economic model to a CE by addressing one of the biggest challenges in this transition: information transfer across value chains. The paper provides concrete examples of the green and digital transitions being aligned; of data and information being shared across value chains for the benefit of a CE. To that end, it pays particular attention to the value chains of major relevance for the CE: electronics, chemicals, automotive, plastic packaging and construction.

Information on materials and products transferred across value chains, from producers to consumers and recyclers, can support circular practices like maintenance, reuse, repair and recycling. Producers can receive feedback and use it to design more circular products.

There are already numerous examples of data and information being shared across value chains for the benefit of a CE. While some digital tools for information transfer are already developed (e.g. online platforms, IoT), others also show interesting prospects to be scaled up (e.g. blockchain, DPPs).

The most fundamental challenges to information transfer for a CE are related to concerns over data protection, fragmented data ecosystems, underdeveloped digital solutions and the lack of incentives for businesses and consumers to share data and information. This is why the EU must step in and provide an enabling framework for information transfer. It must harness the full potential of data and digital solutions to enable the CE. The benefits would be substantial: greater sustainability, competitiveness and resilience of the European economy.

But the EU cannot act alone. In a globalised economy, it is important to create global rules and standards on information transfer for the CE. The EU must lead the way, promote its twin transition in international fora and reap the benefits of the *global* transition to a circular economy.

[1] See e.g. Kirchherr, Julian; Denise Reike; and Marko Hekkert (2017), "Conceptualizing the circular economy: An analysis of 114 definitions", *Resources, Conservation and Recycling*, Volume 127, pp.229.

[2] Haigh, Laxmi; Marc de Wit; Caspar von Daniels; Alex Colloricchio; and Jelmer Hoogzaad (2021), "The Circularity Gap Report 2021", Amsterdam: Circle Economy. Material Economics (2018), "The Circular Economy – A powerful force for climate mitigation", Stockholm.

[3] Ellen MacArthur Foundation (2019), "Completing the picture: How the circular economy tackles climate change".

[4] It is still difficult to ascertain the circular economy's (CE) full potential for creating new jobs. These jobs would relate to specific sectors and are not easily captured by conventional statistics. Nonetheless, some attempts have been made to provide proxy-based estimations. For example, the International Labour Organization asserts that in working towards a CE, a net total of between 7 and 8 million new jobs could be created worldwide by 2030. Cambridge Econometrics *et al.* estimate that it could result in a net increase of 700,000 new jobs in the EU. According to RREUSE, for every 10,000 tonnes of resources that are recycled instead of incinerated, 36 additional jobs are created. International Labour Organization (2019), "Skills for a greener future. Key findings", Geneva, p.9; Cambridge Econometrics, Trinomics and ICF (2018), Impacts of circular economy policies on the labour market: Final report, Brussels: European Commission, p.6; RREUSE (2015), "Briefing on job creation potential in the re-use sector", Brussels. See also Dufourmont, Joke and Esther Goodwin Brown (2020), "Jobs & Skills in the circular economy: State of play and future pathways", Amsterdam: Circle Economy.

[5] Ellen MacArthur Foundation (2015), "Growth within: A circular economy vision for a competitive Europe", Cowes, p.12.

[6] European Commission (2016a), Servitisation. Pay per use. Business Innovation Observatory. Case study 67, Brussels.

[7] Haigh *et al.* (2021), *op.cit.*

[8] See *Eurostat*, "Waste statistics > Total waste generation" (accessed 19 August 2021).

[9] While beyond the scope of this paper, it should also be noted that data and information transfer that is enabled via digital solutions plays a role in supporting the circular economy (CE) in other ways, too. Several platforms are used to exchange information and knowledge about a CE, such as the European Circular Economy Stakeholder Platform and the European Resource Efficiency Knowledge Centre. Online platforms can also support product repairs and waste management, for example. Several online trading platforms serve as marketplaces for used products (e.g. eBay, Amazon, 2emeMain), specialised replacement parts or excess materials (e.g. Excess Materials Exchange). Via its internal asset marketplace, Vodafone resells and repurposes excess stocks of large decommissioned electronic items (e.g. masts, antennae). iFixit is an open-source online platform that provides guidance on repairing electronics and machinery. Technologies like artificial intelligence, robotics and digital twins, which can support different phases of the CE, and innovative business models, such as product-as-a-service, require data and, at times, information. Moreover, information sharing can improve policy monitoring and the measurement of EU and business performance in achieving the CE. See Hedberg, Annika and Stefan Šipka (2020), *The circular economy: Going digital*, Brussels: European Policy Centre.

[10] The ICT sector accounts for 5% to 9% of the total electricity demand worldwide and is only expected to increase. It accounts for 2% of global greenhouse gas emissions, making it comparable to the aviation sector. See Avgerinou, Maria; Paolo Bertoldi and Luca Castellazzi (2017), "Trends in Data Centre Energy Consumption under the European Code of Conduct for Data Centre Energy Efficiency", *Energies*, Volume 10, Issue 10, p. 1470. Enerdata (2018), "Between 10 and 20% of electricity consumption from the ICT sector in 2030?". Baldé, Cornelis Peter; Vanessa Forti; Vanessa Gray; Ruediger Kuehr and Paul Stegmann, (2017), "The Global E-waste Monitor 2017: Quantities, flows and resources", Bonn/Geneva/Vienna: United Nations University/International Telecommunication Union/International Solid Waste Association, p.19.

[11] Walton Robert, "Big tech companies are becoming the top buyers of green energy to meet data needs: BNEF", *Utility Dive*, 15 November 2018.

[12] While beyond the scope of this paper, certain efforts are being made to minimise the environmental impact of electronics via EU policies and initiatives and within the industry. For example, Deutsche Telekom, Orange, Telefónica, Telia Company and Vodafone have launched the Eco Rating label scheme to help consumers identify circular smartphones. Fairphone has developed a modular and reparable smartphone that favours durability and contains recycled and fairly sourced materials (e.g. plastics, gold).

[13] The organisations that contributed to the EPC's research efforts include Apple, APPLiA, Brussels Environment, Cambre associates, Cefic, CEN, circular.fashion, Circularise, Delft University of Technology, Dell Technologies, DIGITALEUROPE, DunavNET, European Innovation Council and SME Executive Agency, eReuse.org, European Chemicals Agency, European Commission, Finnish Innovation Fund Sitra, German Environment Agency, GS1, iPoint, kita, Koning Boudewijnstichting, Korea International Trade Association, Ministry of the Economy Luxembourg, Orgalim, Politecnico di Milano, Schneider Electric, Sustainable Digital Infrastructure Alliance e.V., The Restart Project / Open Repair Alliance, University of Graz, UPC, Vodafone Institute for Society and Communications, World Business Council For Sustainable Development, WEEE Forum, West Finland European Office, SUEZ and DXC Technology.

[14] See Hedberg and Šipka (2020), *op.cit.*

[15] See *SK-Electronics*, "IOT and Tag" (accessed 12 October 2021).

[16] E.g. Thyssenkrupp's elevators, Bundles' home appliances.

[17] *Eurostat*, "End-of-life vehicles statistics" (accessed 01 November 2021).

[18] The AskREACH project precedes SCIP and will end in 2022. Furthermore, AskREACH only provides information about final consumer products, while SCIP provides more 'granular' information on smaller items that are not necessarily final products. The AskREACH database may also contain information about SVHC concentrations of less than 0.1% per item, while the latter only entails SVHCs of more than 0.1% concentration per item, as requested under Article 33 of REACH. See Dosis, Ioannis (2020), "SCIP (ECHA) – AskREACH databases: Separate ways, similar goals", LIFE AskREACH.

[19] Haarman, Arthur; Federico Magalini; and Joséphine Courtois (2020), "Study on the Impacts of Brominated Flame Retardants on the Recycling of WEEE plastics in Europe", Sofies, p.18. Baldé, Cornelis Peter; Michelle Wagner; Giulia Iattoni; and Ruediger Kuehr (2020), "In-depth review of the WEEE Collection Rates and Targets in the EU-28, Norway, Switzerland, and Iceland", United Nations University/ United Nations Institute for Training and Research, p.27.

[20] Šipka, Stefan (2021), "Towards circular e-waste management: How can digitalisation help?", Brussels: European Policy Centre.

[21] The European Cement Association (2016), "Cement, concrete & the circular economy", Brussels, p.13.

[22] *European Cement Association*, "Construction & Demolition Waste" (accessed 02 September 2021).

[23] Ellen MacArthur Foundation (2017), "A New Textile's Economy: Redesigning Fashion's Future", Cowes, pp. 18-22.

[24] PlasticsEurope (2020), "Plastics – the Facts 2020", Brussels.

[25] Digital watermarks can contain information relevant to the sorting process (e.g. manufacturer, type of plastic, food versus non-food usage).

[26] Information may not be user-friendly, as it requires more knowledge than the average consumer has in order to comprehend, or more time. Furthermore, while consumers can be important data providers (e.g. by uploading data about the product's location or status via an app or online platform), if the means to do so are difficult or inconvenient, this can hamper the flow of information about the use of products.

[27] European Commission (2020a), Digital Economy and Society Index (DESI) 2020: Thematic Chapters, Brussels.

[28] European Commission (2020b), A new Circular Economy Action Plan For a cleaner and more competitive Europe, COM(2020) 98 final, Brussels, p.2.

[29] These digital tags, enabled by QR codes, are linked to the European Product Registry for Energy Labelling, which contains additional information about products' energy efficiency. The profile of the information/data requestor determines the level of information they can access via the database (e.g. consumers do not have the same access as law enforcement authorities). This limited access can safeguard confidential business-related information while ensuring that recipients receive the relevant information.

[30] European Commission (2020b), *op.cit.*, p.8.

[31] *Ibid.*, p.13.

[32] The amended Waste Framework Directive (2018) mentions that the European Commission should consider setting waste management targets for construction and textiles, while member states should set up separate waste collection for textiles by 2025. The Circular Economy Action Plan envisages introducing the principle of extended producer responsibility into the textile sector, and additional specifications will probably be laid out in the upcoming EU strategy for textiles. As the work on future legislative requirements for textiles and construction continues, possibilities to introduce requirements on information transfer between different actors in the value chain are also opening up.

[33] E.g. the End-of-Life Vehicles Directive requires producers to provide circular economy-related information to consumers without specifying the digital means to enact such information transfer.

[34] European Commission (2020c), Making the most of the EU's innovative potential: An intellectual property action plan to support the EU's recovery and resilience, COM(2020) 760 final, Brussels, p.13.

[35] Directive 2007/2/EC of the European Parliament and of the Council of 14 March 2007 establishing an Infrastructure for Spatial Information in the European Community (INSPIRE) (2007), Brussels, Art.1, p.4.

[36] E.g. these rules on personal data sharing can enable quick IoT-based information transfer between service providers, supporting the predictive maintenance of the device in use.

[37] European Commission (2016b), Advancing the Internet of Things in Europe, SWD(2016) 110 final, Brussels.

[38] This will be achieved by providing an EU guarantee that allows the European Investment Bank and other financial partners to invest in more and higher-risk environment-related projects.

[39] European Commission (2021a), Horizon Europe Strategic Plan (2021-2024), Brussels, p.67.

[40] European Commission (2021b), Strategy for Financing the Transition to a Sustainable Economy, COM(2021) 390 final, Strasbourg, pp.8, 11.

[41] Platform on Sustainable Finance (2021a), Taxonomy Pack for Feedback, European Commission; Platform on Sustainable Finance (2021b), PART B – Annex: Full list of Technical Screening Criteria, European Commission.

[42] Starting with more valuable products could help bring industry on board and gather valuable experience to extend the legal requirements on digital product passports to other products at a later stage (e.g. construction, textiles, less valuable electronics, plastic packaging).

The **European Policy Centre** is an independent, not-for-profit think tank dedicated to fostering European integration through analysis and debate, supporting and challenging European decision-makers at all levels to make informed decisions based on sound evidence and analysis, and providing a platform for engaging partners, stakeholders and citizens in EU policymaking and in the debate about the future of Europe.

The **Sustainable Prosperity for Europe** (SPfE) programme explores the foundations and drivers for achieving an environmentally sustainable and competitive European economy. While the climate crisis is a complex challenge to be addressed, non-action is not an option. Prospering within the planetary boundaries requires rethinking the existing take-make-dispose economic model, reducing pollution and being smarter with the resources we have.

The Paris Agreement and the Sustainable Development Agenda provide a direction for travel, and SPfE engages in a debate on the needed measures to achieve a fair transition to an environmentally sustainable economy and society. It focuses on areas where working together across the European Union can bring significant benefits to the member states, citizens and businesses, and ensure sustainable prosperity within the limits of this planet.

With the strategic support of King Baudouin Foundation
Working together for a better society

With the support of Europe for Citizens Programme of the European Union