Fraunhofer

Whitepaper

Creating values – and acting accordingly

Shaping sovereign value cycles and circular economies

A contribution by the Fraunhofer-Gesellschaft
to the Sustainable Development Goal 12

Content

A common mission

Creating values – acting with values

Tomorrow's value creation must become ***more sustainable***, ***more intelligent*** and ***more circular***.

Companies must be able to actively and confidently shape this development.

Our vision – our principles

The future of value creation needs to be more sustainable, more intelligent and more circular than anything we know today. Businesses and consumers see these complex tasks as an opportunity and are actively shaping the transformation: Sovereign value cycles are replacing linear value chains and leading to "Responsible consumption and production", the core requirement of United Nations Sustainable Development Goal (SDG) 12.

Our principles for sovereign value cycles

The term "value" in value creation cycle refers equally to ecological, social and economic – and therefore sustainable – measures of value. These change in different ways throughout a value cycle. However, at the end of a product's useful life, their net result needs to be positive. To this end, research and development and the design of value cycles are guided by five principles.

1. **Integrating sustainability**
   Sustainable value encompasses ecological, social and economic measures of value equally.
2. **Implementing value cycles**
   In value cycles, materials and products are put through cyclical processes. As they pass through a cycle and when they start a new cycle, their cumulative sustainable value increases.
3. **Achieving sovereignty**
   To measure sustainable value throughout the cycle, producers and consumers need reliable, verified, credible and tailored information about supply chains, production conditions and products, as well as about their effects. This information must be shared by all those involved in a cycle. This necessitates new forms of cooperation and digital support.
4. **Driving forward systemic innovations**
   Systemic innovations are the basis of sovereign value cycles. They arise out of strategies that encompass the entire cycle and are directed equally at ecological, social and economic measures of value.
5. **Developing expertise**
   The development of systemic innovations requires networked knowledge and expertise in social, ecological, technical, economic and regulatory matters.

Securing a supply of primary raw materials and the products produced from these that not only is affordable and environmentally friendly but also meets the highest social standards presents a major challenge despite – or precisely because of – technical progress. The coronavirus crisis, Brexit, trade barriers and customs, a shortage of semiconductors and scarcity of energy resources have all shown that the global supply chains are not as reliable as once thought and that historical models are no longer working. Production and distribution systems that are reliant on these supply chains are suddenly having to deal with insufficient – or a complete lack of – supplies, while there has been a huge spike in the volume of end-of-life waste (e. g., single-use masks). The consequences of this can be seen around the world – particularly in industrial nations. As a result, discussions are now being held as to how traditional economies can be transformed into sustainable ones and how value chains can be converted to intelligent value cycles.

This involves value chains that are based on minerals, metal ores, biomass (as food and animal feed, and as a raw material for industry), fossil-derived raw materials, water, air and soil, as well as complex ecosystem functions. Future resource consumption, economies and consumption must be underpinned by consistency, efficiency and sufficiency strategies. The global community acknowledged this when it committed to implementing the 17 global Sustainable Development Goals (SDGs) in September 2015. In addition to ensuring human dignity and the rule of law as well as ending poverty, hunger and discrimination, the SDGs aim to decouple economic growth and prosperity from the increasing use of natural resources and thus environmental degradation. SDG 12 "Responsible consumption and production" and SDG 7 "Affordable and clean energy" focus on this challenge in particular.

The concept of the circular economy will play a significant role in sustainable resource management on a global scale. The aim of the circular economy is to manage the extent to which – and way in which – raw materials are extracted from the environment so that resources are conserved and increasing consumption and subsistence needs can be met in the long term. This is to be achieved by using managed materials efficiently and keeping these in anthropogenic cycles or using renewable energy sources. The circular economy is therefore more than just "recycling," which primarily concerns waste management – although recycling does represent an important component of it. The circular economy targets measures that cover the entire product life cycle in order to ensure that the resources used in it retain their value and remain in the economic cycle for as long as possible: Sustainable products become the norm, consumers' position is strengthened, resource-intensive industries become circular and waste is reduced because products and material flows circulate in small and large cycles.

While a circular economy is regarded today as both a panacea for scarcity of raw materials and a driving force for job creation and prosperity in Europe and Germany, de facto raw material consumption and the associated environmental damage are nevertheless accelerating. Global supply chains often lack transparency into which raw materials, additives, semi-finished products or components are used and which environmental and occupational safety standards are followed. This applies to complex foods as much as additive-enhanced plastic packaging, building materials, aluminum wheel rims or generators in wind turbines: The list is endless. At present, only a small proportion of all processed materials worldwide are managed circularly (7 % globally, around 15 % in Europe). People and markets need a product policy that combines a good standard of living with lower demand for raw materials. Products must be designed from the outset to be compatible with the circular economy and their use phase needs to be optimized. At the same time, high-quality and adaptable recycling must become a reality.

The transition to a circular economy cannot be achieved through recycling alone. This is because, firstly, the demand for non-circular fossil fuels remains very high (and continues to grow) and, secondly, global material stocks tied up in long-lasting products and buildings are increasing rapidly all the time. These materials can only be recovered after a certain amount of time. Accessing material stocks in anthropogenic stores requires information on the mix of building materials, the quantity of materials and the condition of the materials to be available at any time. Achieving SDG 12 requires efficient processes, intelligent products and digital management, as well as experience, knowledge and commitment – in other words, sovereign value cycles in production and consumption.

"Sovereign value cycles in production and consumption

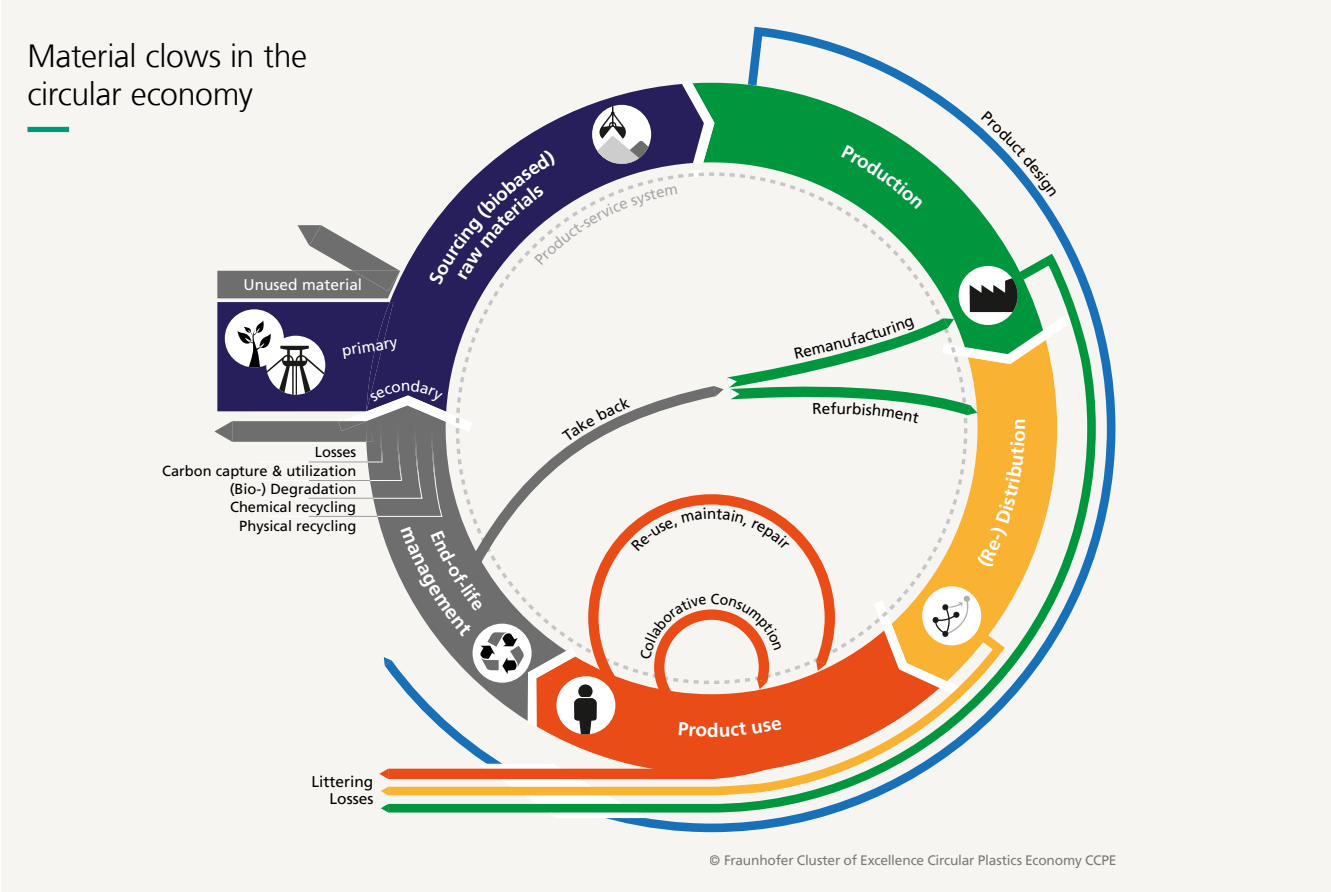

Fig. 1: A value cycle comprises all stages of raw material extraction, material production, energy supply, product manufacture, product use, refurbishment, repair and the conversion of products or their components into new added value – across established value chains.

Creating values – and acting accordingly

The flexibility, resilience and sustainability of supply chains has a significant impact on the economic and social value of products. The global community is dependent on international trade and thus on long trade routes that are difficult to control. Businesses have often delegated sovereignty over processes and products to global supply systems; however, these have structures that are far from transparent. The challenge now lies in transforming such structures to make them circular.

Strategies for sustainable production and consumption patterns

Current production methods and consumption patterns are reaching our planet's limits. In the medium term, their ecological and social effects will push nature and society beyond their capacity. To achieve SDG 12 and the ambitious targets related to this, a variety of political and economic initiatives targeting sustainable production and consumption have been implemented, such as the German National Program for Sustainable Consumption, which forms part of the German Sustainable Development Strategy, the German Resource Efficiency Program (ProgRess); and, on the political front, the EU Strategy on Corporate Social Responsibility. Examples of industry initiatives include the Roadmap of the World Business Council for Sustainable Development (WBCSD); "Chemie³", a sustainability initiative of the German Chemical Industry Association (VCI); and the IRENA (International Renewable Energy Agency) Coalition for Action.

From the point of view of businesses and the general public, it is not uncommon for day-to-day experiences to lead to a sense of powerlessness in the face of these ambitious goals. They simply do not have the sovereignty to identify more sustainable alternatives along an entire life cycle and to be able to choose these alternatives, where appropriate. At the same time, there is a lack of knowledge and transparency about the raw materials and substances used and the environmental and social standards that apply.

Against this backdrop, Fraunhofer has identified three key strategies for future sustainable production methods and consumption patterns:

1. **Consistent implementation of cycles:** Everything that is manufactured and used must be suitable for use as a resource for further production or consumption. Ideally, there should be no emissions into the environment. As well as reducing the pressure on natural sources of raw materials, the circular economy also calls for responsibility within society, politics and industry beyond the economic systems and lifestyles we are familiar with today.
2. **Creation of sustainable value:** To ensure that a cycle is permanently given precedence over linear value creation, it needs to create sustainable value as it progresses. This new value creation must be measurable using economic, social and ecological measures.
3. **Need for design sovereignty:** Sustainable cycles only happen if they are resilient enough to disruptions from inside and outside. In a globalized world, this sovereignty is based on transparency, cooperation and shared values.

The concept of sovereign value cycles puts these objectives into practice.

Principles for the implementation of sovereign value cycles

A total of 16 Fraunhofer institutes have analyzed what action is required to achieve sovereign value cycles for the four lead markets – the chemical industry, the agriculture and food industry, the energy sector and the construction industry – and have consolidated the concept into five principles:

- Integrating sustainability
- Implementing value cycles
- Achieving sovereignty
- Driving forward systemic innovations
- Developing expertise

The concept of sovereign value cycles must address the current and future needs of global value creation networks beyond products, processes and businesses. This requires methodological, technological and systemic innovations, as well as new forms of collaboration.

Principle 1: Integrating sustainability

Sustainable value encompasses ecological, social and economic measures of value equally. Global developments have shown that awareness and implementation of sustainability factors in supply chains are becoming increasingly important.

Example: German Supply Chain Act

With effect from 2023, large companies will be obliged to assume responsibility for their supply chains – this is governed by the German Supply Chain Due Diligence Act (LkSG). Businesses must be able to trace their supply chains, including production processes and working conditions, and conduct due diligence to avoid or rectify any irregularities. The aim is, inter alia, to ensure that human rights are better protected, for example by setting minimum statutory social standards and protecting workers from harmful environmental influences.

The concept of sovereign value cycles – a paradigm shift

From the value chain to the value cycle

The basic idea is to close value chains to form circles in order to save resources and reduce emissions but also to strengthen responsibility for sustainable value and to divide that responsibility effectively among those involved. Every product that a value cycle participant manufactures or uses is input for the next participant in the loop. Through the cycle, each participant ultimately gets part of their own output back to use as input. This increases participants' willingness to assume responsibility for cycles even over long periods of time.

The term "value creation" is usually defined as output minus intermediate consumption. In a value cycle, the sustainable value of a secondary raw material is higher than the pure monetary value of a primary raw material, meaning that using the former is the more attractive option.

If social and ecological costs are internalized in their real values, using secondary raw materials is often the more attractive option on a market-oriented basis. Developments over the past few years have shown that buyers now have a greater awareness of "soft", non-monetary values and, as a result, these have a significant influence on purchase decisions.

Principle 2: Implementing value cycles

In value cycles, materials and products are put through cyclical processes. As they pass through a cycle and when they start a new cycle, their cumulative sustainable value increases.

Example: Concrete recycling

Concrete is an extremely durable building material that requires large quantities of raw materials. When buildings are demolished, however, concrete is rarely recovered as a building material, but instead mainly ends up in landfill or used for road construction, which equates to downcycling. The recycling rate for concrete in Germany is only 0.5 %. One of the reasons for this is that recycled concrete is only approved for use in building construction in Germany to a very limited extent. Concrete is thus a critical material flow: The production process emits large quantities of greenhouse gases and requires significant amounts of water, sand, gravel and cement. To achieve value cycles for concrete, policies and corresponding legal frameworks are required to help increase the recycling rate.

Example: Lithium-ion batteries

There is a lack of technological alternatives to lithium-ion batteries and battery electrodes. There are no efficient process combinations in recycling for cycle management of the required materials. This is partly due to a lack of economic viability, particularly with regard to non-metallic components such as plastics, electrolytes and graphite. There is a systemic need for strategic approaches to ensure circularity – also with a view to alternative applications for materials. In addition, the social added value must be considered, evaluated and priced in along the entire value cycle in a transparent manner. To do this, an effective regulatory framework must be established – one that takes into account the externalized ecological and social costs of raw material extraction and processing.

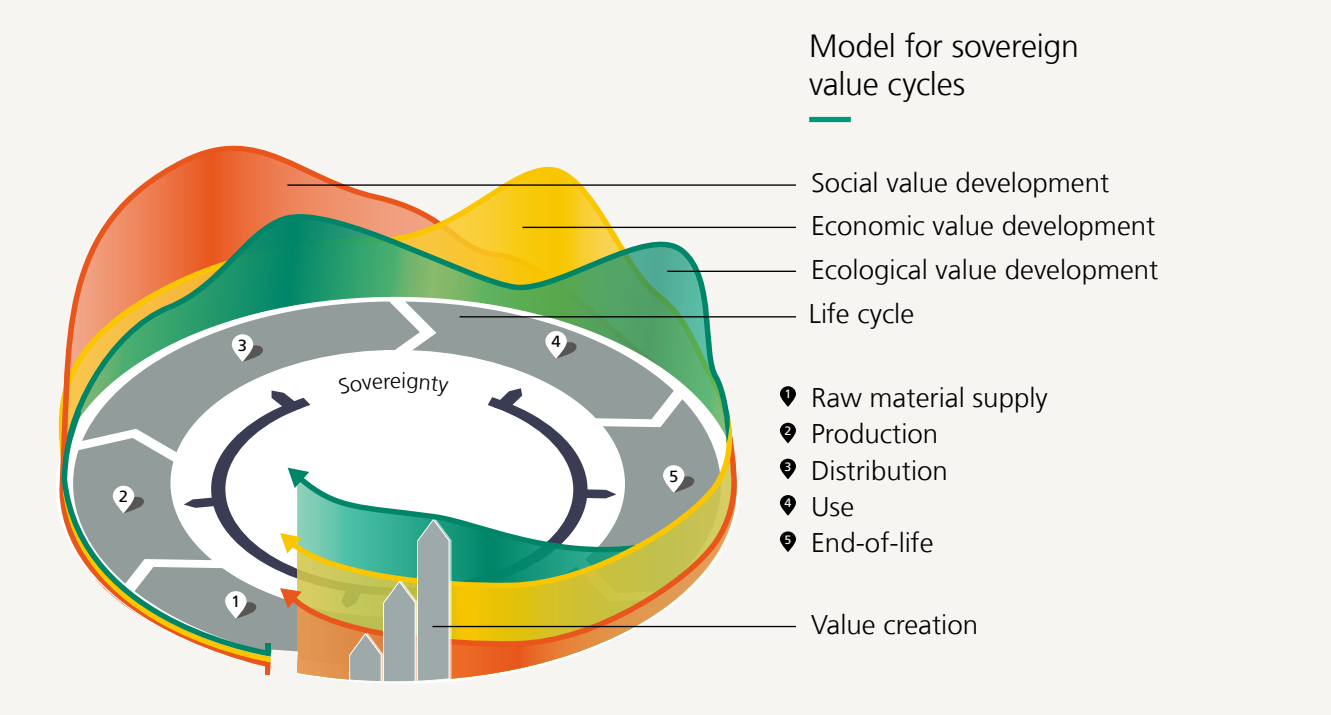

Fig. 2: Integrating sustainability: The change in economic, social and ecological measures of value runs parallel to the traditional life cycle. Increasing a target can, but does not have to, lead to an increase in other targets. When passing through a value cycle, however, the change must be positive at the end. © Fraunhofer UMSICHT

From a monetary value cycle to a sustainable one

When we talk about measures of value in value cycles and consider the various parameters for sustainable development, the term "value" must be redefined. In addition to purely monetary aspects, non-monetary criteria such as greenhouse gas emissions avoided, child labor avoided, etc., must equally be taken into account in the determination of value.

We therefore use the term "value" to mean all measures of value, whether environmental, societal or economic, that contribute to the concept of sustainable development. A value cycle is designed to increase these measures of value as they pass through the cycle (Fig. 2).

A social value (e. g., with regard to working conditions during the resource extraction stage) might be especially high and an ecological value (e. g., with regard to greenhouse gas emissions) relatively high, while an economic value (e. g., with regard to a dealer's profit margins) is rather low. The change over the course of a value cycle must, however, result in an overall positive at the end – increasing a target can, but does not have to, lead to an increase in other targets. The underlying value system thus consciously adds to the economic value with social and ecological dimensions. This is based on the assumption that, in the future, successful economies will be dependent on these dimensions. Value cycles can become attractive in practice and endure in the long term only if all three dimensions are strategically incorporated in the future.

Principle 3: Achieving sovereignty

To measure sustainable value throughout the cycle, producers and consumers need reliable, verified, credible and tailored information about supply chains, production conditions and products, as well as about their effects. This information must be shared by all those involved in a cycle. This necessitates new forms of cooperation and digital support.

Example: Muesli bars

Sustainably producing a muesli bar is a complex process and requires producers to make a variety of sovereign decisions. Consumers also need transparent information that they can evaluate – what is important when making a purchase decision? Is it price, ethical standards (Fairtrade) or the ingredients (no palm oil)? It is not just trends such as superfoods that result in global supply chains in the food industry. Transparency into upstream supply chains as well as the use of ingredients sourced from abroad play an important role in this regard. Pricing and delivery conditions have long been key criteria for establishing relationships with suppliers. With regard to sustainable production, there has been a shift in attitude: Human rights and environmental protection are coming to the fore. Consumers are also willing to pay more for certain ingredients and fair value creation. However, action is required in terms of implementing integrated data structures and establishing evaluation criteria for supply chains and transparent labeling based on these criteria (with the help of quality marks and certification labels).

Sovereignty in value cycles

Implementing value cycles requires businesses to adapt their normative orientation, resulting in a new level of sovereignty in decisions and actions. Inadequate progress in sustainable development is often attributed to a lack of such sovereignty: whether due to competitive pressure, regulatory constraints or technological barriers.

Corporate and consumer sovereignty is achieved through self-determination and assertiveness towards other parties in the chain or cycle. It is determined by the following criteria:

1. **Knowledge of the parties involved:** A prerequisite for sovereignty is the availability of sufficient knowledge of all parties involved and the subsystems for which they are responsible, as well as the conditions to which they are subject.
2. **Substitutability of a party:** This depends on the number of available alternatives and the effort required to switch to these. If a certain activity can be dispensed with altogether, the maximum level of substitutability is achieved.
3. **Influenceability of a party:** They may be motivated by contracts, technological opportunities, market relationships, etc.
4. **Resilience:** Parties that are heavily influenced by external interferences compromise sovereignty.

All parties in a cycle must have sufficient degree of sovereignty. Sovereignty requires symmetrical distribution of information, shared responsibility and cooperative working methods. Traditional relationships between customers and suppliers must be reimagined to permanently establish a mindset and approach that embodies a community of values. Sovereignty is thus the core value underpinning sustainable development.

Principle 4: Driving forward systemic innovations

Sovereign value cycles require systemic innovations. They arise out of strategies that encompass the entire cycle at every stage and are directed equally at ecological, social and economic measures of value.

Example: Photovoltaic module

Renewable energy sources play a critical role in reducing greenhouse gas emissions. However, a large portion of the PV module value chain has moved to production locations outside the European Union, which leave an environmental and social footprint due to the way in which raw materials are extracted and processed there. A prime example of this is the issue of forced labor in Chinese polysilicon plants, which account for 45 % of the world's polysilicon production. In addition, polysilicon production is the most energy-intensive step in the PV value chain and is thus responsible for the majority of CO_2 emissions. Despite a mandatory recycling rate of 80 %, specialized recycling of PV module waste that allows for material cycle management is currently not economically viable due to low return flow volumes. Demonstrating the added ecological, social and sovereign value of value cycles is the first step in overcoming monetary obstacles.

The three-dimensional model: the challenge for modern entrepreneurship

Sustainability, circularity and sovereignty: These are the three building blocks that characterize sovereign value chains. They address the "society and environment", "technology" and "management" dimensions. The concept of sovereign value cycles will only be a success if these dimensions are successfully combined. This presents a key challenge for modern entrepreneurship: assuming responsibility, being innovative, and empowering people and organizations to act in a responsible manner.

Tab. 01 The three-dimension model

Dimension	Concept	Entrepreneurship
Society and environment	Sustainability	Responsibility
Technology	Circularity	Innovation
Management	Sovereignty	Acquisition of competencies

Principle 5: Developing expertise

The development of systemic innovations requires networked knowledge and expertise in social, ecological, technical, economic and regulatory matters.

Technology meets responsibility: transforming training

There are currently few strategic initiatives to establish new, holistic interdisciplinary and transdisciplinary teaching and research approaches that pass on the expertise required for large-scale transformation tasks in industrialized regions. Research and teaching that use social context to inform their research questions and that – based on the answers to these questions – provide solutions for highly complex decisions regarding the future course of action to be taken, thereby combining academic work with social engagement, are extremely attractive to young scientists and, by extension, their future employers. This type of research and teaching integrates values and value change into its educational design without losing sight of economic applications and social benefits. Sustainable leadership skills are obtained by transferring scientific knowledge to real application environments, in addition to further developing personal soft skills and acquiring suitable management tools.

Strategic areas of action

The following areas of action are paving the way for sovereign value cycles.

They were developed as part of a participatory process involving several Fraunhofer institutes and were based on an upstream gap analysis. This gap analysis reconciled the target situations with the corresponding current situations in terms of the targets for SDG 12 (e. g., legal frameworks, standards, commitments, results of studies, criticism and requirements of non-governmental organizations (NGOs) and social groups) and mapped out the gaps in the achievement of the SDG targets. The gap analysis was carried out for the following lead markets: the chemical industry, the agriculture and food industry, the energy sector and the construction industry.

The results were consolidated into nine strategic areas of action, as shown below:

1 Methodological principles for identifying and analyzing sovereignty, circularity and sustainability

- Tools for identifying supply chains, production conditions, products and their impacts
- Indicators and standards, including evaluation approaches (sovereignty, circularity, sustainability)

2 Development of strategies to improve sustainability, sovereignty or circularity

- Analyzing barriers and developing strategies to establish sovereign value cycles

3 Methodological principles for establishing value cycles

- Methods for designing cycle-based processes, incorporating in particular the use of secondary materials

4 Technological principles for establishing value cycles

- Increasing the reuse/repair proportion in process chains
- Developing technological principles for closing material cycles
- Reducing material waste in cycles

5 Promotion of sovereign and sustainable decisions made by producers and consumers

- Ensuring transparency of supply chains, product conditions and the impact of products
- Managing data as well as communications and labeling

6 Development of business models for value cycles

- Adapting businesses' products and business models in line with the concept of sovereign value cycles
- Identifying external and externalized costs and their internalization

7 Support for the development of regulations and political decision-making processes

- Influencing the development of comprehensive amendments to legislation and other regulatory guidelines establishing quotas and target values

8 Development of framework conditions for promoting innovation in value cycles

- Developing customized offers to promote innovation and designing corresponding framework conditions
- Formulating research topics

9 Transfer of methods and expertise to value cycles

- Developing training formats and offers for different target groups

Implementing areas of action at Fraunhofer

Fraunhofer is already contributing to the implementation of the areas of action through its topic-specific groups and the applied research and development undertaken at individual Fraunhofer institutes. Cross-institute groups that coordinate research at Fraunhofer and support collaborative work have been established for the lead markets considered here – the chemical industry, the agriculture and food industry, the energy sector and the construction industry.

In addition, there are development clusters such as the Fraunhofer Cluster of Excellence Circular Plastics Economy CCPE. This pools the expertise and infrastructures of six Fraunhofer institutes in order to research the fundamentals for the transformation to a circular plastics economy, open up possible courses of action for the economy and society, and provide system services.[1]

1 www.ccpe.fraunhofer.de/en.html

The next step: CIRCONOMY® Hubs

Sustainable production, sustainable consumption and a circular economy require systemic and technological solutions, which are created in innovation networks. Existing networking initiatives predominantly focus on either a common region or a common technological strength. Fraunhofer therefore wants to build a network of CIRCONOMY® Hubs across Germany. These hubs are a new, agile instrument for cooperation on the basis of a shared mission and a shared, reliable data space in order to create added regional, national and international value. In each hub, Fraunhofer institutes will work with their partners in industry, science, politics and society on a mission not just to contribute to the circular economy but to develop innovations for sustainable, resilient value cycles, climate neutrality, circularity and bioeconomy. The hubs will be used to better understand and manage economic systems and value cycles on a digital basis. To do so, each hub will be able to exchange expertise with all other hubs via a common data space, thereby learning from successes and accelerating transformation. CIRCONOMY® Hubs will establish agile project consortia with partners from industry, science and society, which will tackle project developments for innovation processes in a mission-oriented way. CIRCONOMY® Hubs will address both individual industries (such as automotive, chemical, food) and cross-sector groups that encompass the entire value chain (interface innovations).

They will make use of the opportunities of virtual, distributed and digital cooperative structures: fast agreement processes, agile teamwork, creative problem-solving and digital access to findings without spatial or temporal limitations. Modular systems that can be used to map different characteristics (e. g., purely virtual or including infrastructure) are available for the organization of the hubs. The hubs will be coordinated by a management team comprising representatives from the worlds of business, science and civil society. This management team will assume the function of a "mission team" for a CIRCONOMY® topic, with an international perspective: It will bring together project ideas or develop them itself, put forward proposals for project consortia, and organize and moderate project developments and innovation processes. CIRCONOMY® Hubs will serve as a compass for forward-looking action for industry, science, politics and society – creating value and acting accordingly.

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