European Commission

Products
and Circular Economy

Policy recommendations derived from Research & Innovation projects

Independent Expert Report

EN

Research and Innovation

Products and Circular Economy

European Commission
Directorate-General for Research and Innovation
Directorate C — Healthy Planet
Unit C.1 — Circular Economy & Biobased Systems

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Directorate-General for Research and Innovation
Healthy Planet

2020

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INTRODUCTION

Circular Economy

"[…] a more circular economy, where the value of products, materials and resources is maintained in the economy for as long as possible, and the generation of waste minimised […]"

European Commission, Circular Economy Action Plan, 2015[1]

"Looking beyond the current take-make-waste extractive industrial model, a circular economy aims to redefine growth, focusing on positive society-wide benefits. It entails gradually decoupling economic activity from the consumption of finite resources, and designing waste out of the system. Underpinned by a transition to renewable energy sources, the circular model builds economic, natural, and social capital. It is based on three principles:

- *Design out waste and pollution*
- *Keep products and materials in use*
- *Regenerate natural systems"*

Ellen MacArthur Foundation, 2017[2]

This report presents the findings from a review of more than one hundred Research & Innovation (R&I) projects under EU Framework programmes FP6 and FP7[3], dealing with a range of circularity considerations related to product design, manufacturing, use and after-use. Nine independent experts analysed these projects, brought in their own expertise, and identified key messages and lessons for policy makers with regard to possible future research and policy action. These findings may prove useful in the implementation of the brand-new second Circular Economy Action Plan, which develops a vision for an innovative circular material policy embedded in the broader context of the ambitious objectives for climate change mitigation that the new Commission expressed in its European Green Deal.[4]

As half of total greenhouse gas emissions and more than 90% of biodiversity loss and water stress come from resource extraction and processing, the European Green Deal launched a concerted strategy for a climate-neutral and circular economy where economic growth is decoupled from resource use and its environmental impacts. We need to break away from our linear production and consumption pattern of "take-make-use-dispose". Many products break down too quickly, cannot be reused, repaired or recycled, and many are for single use only. At the same time, the EU Single Market gives Europe a critical mass to set standards in areas related to product sustainability and influence product design and value chain management worldwide. Not surprisingly, the new Action Plan has a landmark concept for a sustainable product policy framework at its heart.

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[1] COM(2015) 614 final: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A52015DC0614.
[2] https://www.ellenmacarthurfoundation.org/circular-economy/concept.
[3] http://ec.europa.eu/research/fp7/index_en.cfm.
[4] COM(2019) 640 final: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=COM%3A2019%3A640%3AFIN.

Within the EU, Circular Economy (CE) is a relatively new policy concept, brought into the spotlight by the European Commission's CE Action Plan in 2015. There are diverging views as to what the EU, Member States (MSs) and other stakeholders mean by CE, with no universally agreed definition. CE has only recently been incorporated in R&I policy and was not a guiding term within FP6 or FP7. Some MSs appear to have seen CE as a new term for current recycling practices and this view was prevalent in many of the FP6 and FP7 projects reviewed. For example, few FP6 or FP7 projects in this report had a focus on preventative maintenance, repair, remanufacturing, material selection or critical raw materials (CRMs) within the CE context. The social dimension of CE has been largely neglected in past projects.

Project proposals for EU funding are often made by companies with the intention to develop knowledge, networks and other benefits for themselves. In a CE context the flow and control of information, products and materials is "closed source, closed loop". In many reviewed projects, a lack of consideration was evident over how civil society and NGOs are seeking to intercept products in an "open source, open loop" manner through repair cafes, open source software, etc. These two perspectives may be in tension as CE develops and this requires better understanding.

The projects reviewed highlighted some useful and diverse work on product and materials related initiatives that may provide valuable information for further development of CE actions by authorities and economic operators alike; however, these connections have been rarely expanded upon, which makes the linkages often vague and unclear.

On the following pages, lessons and recommendations from the various R&I projects will be discussed in detail. There is little need for a description of the state of play regarding products, product policy and circular economy, as the European Commission did exactly that when it published its CE implementation update on 4 March 2019.[5] This update included a Report on the implementation of the CE Action Plan[6] and a Staff Working Document (SWD) on sustainable products in a circular economy.[7] The latter highlights key product categories for further work such as textiles, electronics, chemicals, furniture and housing, and intervention areas. The focus of the analysed R&I projects in this report matches the breakdown and problem description in the SWD very well.

The experts' recommendations are as diverse as the analysed projects. They should be seen as a laboratory of ideas and an open invitation to policy makers, rather than a ready-made policy framework. To facilitate any possible follow-up actions, it was important to phrase and group the recommendations in a way that shows the intervention logic and makes them easily understandable for all involved parties. The breakdown into crosscutting, demand side and supply side recommendations is one possible way of approaching the topic. Although there are overlaps, and one might claim that all promising recommendations must be crosscutting to some extent, there is a strong logic to this structure. Crosscutting issues concern shared visions, targets and interests. Many of these interventions are quite fundamental. Demand side CE policy creates and supports the demand for circular products and services. Supply side policy helps create and produce these new products and services. All three types of interventions are useful and necessary.

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5 See http://ec.europa.eu/environment/circular-economy/ and http://europa.eu/rapid/press-release_IP-19-1480_en.htm.

6 COM(2019) 190 final: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52019DC0190&from=EN.

7 SWD(2019) 91 final: http://ec.europa.eu/environment/circular-economy/pdf/sustainable_products_circular_economy.pdf.

It will be crucial that the blind spots identified in this report, such as the social dimension of sourcing and (re)manufacturing, will be targeted in Horizon Europe (FP9). Moreover, R&I in CE should move from relatively isolated interventions to a more systemic approach. The perhaps strongest message that the analysed R&I projects deliver is that regulatory policy and R&I belong together and should inform each other if we want a successful transition from a linear to a circular economy.

CROSSCUTTING RECOMMENDATIONS

1 Define, quantify and measure circularity

The Commission should collaborate with European stakeholders, international partners and standardisation bodies on a shared terminology and definitions for a circular economy.

There is need for a common definition of CE and the terminology associated with it. There are many definitions of CE but no universally agreed version throughout Europe and worldwide.[8] In addition, numerous terms are associated with CE[9] but the usage may differ. This means that terminology used directly or indirectly in relation to CE, products and product policy is not universally agreed and that measuring and comparing efforts towards circularity, e.g. amongst sectors, is impossible. ISO/TC 323 is working on standardisation in the field of CE.

The Commission should establish key environmental performance indicators for products and processes.

There is a lack of shared definitions and indicator sets that allow the comparison of the environmental performance of products and services within and across sectors (SUSTAINHUB, DESIRE, MYECOCOST). CE policy should be based on a common conceptual framework with key definitions, targets and environmental performance indicators relevant for the EU strategic frameworks. The high-level definitions can become a common basis for more specific definitions and indicator sets, e.g. for specific materials, product groups or sectors, which in turn can underpin technical standards, methods and tools.

A more harmonised approach will help improve and standardise key environmental performance data including circularity across economic sectors e.g. by producing standardised reporting templates at company level. This will improve comparability and exchangeability of data within (e.g. TOP-REF) and between economic sectors (SUSTAINHUB). In order to measure the decoupling of environmental impacts from economic growth and the use of resources, the project TOP-REF developed so called Key Resources Indicators (KRI) for process industry, which are based on non-invasive, real time and on-line monitoring and control tools. Definitions should take into account existing mandatory and voluntary reporting standards and be drafted in collaboration with stakeholders. This should build on existing processes coordinated by the Commission, notably the long-standing efforts to develop a harmonised methodology for the calculation of the environmental footprint of products and organisations. Sufficient research data is available.

In this context, traditional life cycle thinking needs to be reassessed as product circularity focuses on extending the value of products, materials and components, which implies a new understanding of product lifetime. Products, materials and components may go through various feedback loops as they are returned for repair, refurbishment or remanufacturing, and subsequent re-use in economic and social systems.

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[8] Cf. Martin Charter (2018) Designing for the Circular Economy.

[9] For a synthesis, see BS 8001:2017, published May 2017: https://www.bsigroup.com/en-GB/standards/benefits-of-using-standards/becoming-more-sustainable-with-standards/BS8001-Circular-Economy/.

The Commission should substantiate the relationship between CE and GHG emissions and benchmark its CE policy against GHG reduction targets.

According to the Intergovernmental Panel on Climate Change, the need to meet the 2030 GHG reduction targets requires a cut of at least 45% in GHG emissions[10], and a corresponding cut in primary materials use. This reduction is unlikely to be met by increased recycling alone and requires closed loop practice including product life extension strategies such as re-use, repair, refurbishing and remanufacturing.

R&I The Commission should intensify research into measuring the aggregate consumption aspects of the CE.

There needs to be further research into performance indicators related to product circularity at activity level e.g. remanufacturing, repair, etc. Currently, Eurostat is using a number of indicators to measure the CE[11] and these include:

- Production and consumption (self-sufficiency of raw materials for production in the EU; Green Public Procurement (GPP); waste generation; food waste);
- Waste management (recycling rates, specific waste streams);
- Secondary raw materials (contribution of recycled materials to raw materials demand; trade of recyclable raw materials between the EU Member States and with the rest of the world);
- Competitiveness and innovation (private investments; patents related to recycling).

In addition to already common indicators (i.e. on recycling), the EU and MSs need to agree on and adopt a set of indicators on the CE with regard to the consumption side; these might include:

- Replacement rates of products;
- Average lifetime of products (based on real use);
- Re-use, leasing and repair data;
- Trends on EU eco-labelled products and services;
- Product take-back and repair statistics;
- Number of sharing schemes;
- Collaborative consumption statistics.

R&I The Commission should fund research on how to include an evaluation of the state of implementation of CE and CE related activities e.g. repair, remanufacturing, in policy monitoring schemes.

At a theoretical level, the monitoring of the state of CE policy implementation and of impacts has to be improved. Therefore, a reporting system on policy implementation ("output"), on observation of market reactions ("outcome") and on monitoring of impacts ("impacts") should be established, and the generated knowledge should be fed into policy again ("feedback loops") (ASCEE, FESCOLA, POPP, SCOPE2). Research in relation to CE related outcomes, impacts and feedback loops needs to be intensified.

[10] Cf. https://report.ipcc.ch/sr15/pdf/sr15_spm_final.pdf, p. 14.
[11] https://ec.europa.eu/eurostat/web/circular-economy/indicators.

2 Strengthen policy coherence and comprehensiveness, avoid conflicts and create synergies

The Commission should review existing "green" product policy instruments to determine their relationship to CE.

There needs to be more clarity over the relationship between CE, products and product policy in the EU. This includes the need for better understanding of the links between Sustainable Consumption and Production (SCP) and CE, and individual Action Plans. For example, CE was not addressed in the Sustainable Consumption and Production (SCP) Action Plan[12] back in 2008, whereas Integrated Product Policy (IPP) and Green Public Procurement (GPP) were included. At present, the overarching SCP policy and sub-policies appears to be dormant and exploring the linkages to CE may breathe life back into the policy area.

There also needs to be a better understanding of the links between CE, products and product policy and sustainable development (SD). CE should be seen as part of SD. It is important to ensure that policy avoids the risk of dismissing the results of useful sustainability research as product circularity policy and actions develop, as there may be useful lessons to be learnt. Consideration of the three dimensions of sustainability, i.e. environmental, economic and social, and the understanding of potential trade-offs with CE are crucial. Another CE relevant policy field that needs to be coordinated is raw materials.

The Commission should produce a roadmap showing the potential of CE to contribute to the UN Sustainable Development Goals (SDGs). From this exercise, opportunities related to product policy should be identified.

There are uncertainties about the impacts of policy instruments and sustainable production and consumption strategies, generally and specifically in relation to circularity (POPP). This issue is of growing importance in view of the priority given to CE in Europe and the attention given to responsible consumption and production in UN SDG 12.[13] As the UN SDGs of 2015 gain increased visibility within Europe and globally, there needs to be clarity on the relationship between CE, products and product policy, and the SDGs. While understanding the relationship to Goal 12 will be particularly important, this is not the only SDG with possible links to CE.

New research questions might evolve from this process, e.g., what indicators are needed to align with SDG 12 to track progress on CE and product circularity (GLAMURS).

The Commission should develop an Integrated Circular Product Policy (ICPP) building on past lessons from Integrated Product Policy (IPP) that also takes account of the relationships with other policy fields.

Product policy is a comprehensive policy field related to sectors like waste, but also chemicals, and also to cross-cutting topics like mobility or energy. These approaches need to interact, based on a clear leadership from EC (ASCEE). An ICPP building on the lessons learnt from IPP should be developed to take account of product circularity and the interactions with horizontal and sectoral approaches. There is need for a clear one problem-one measure relationship, e.g. transition towards a CE. Supply side and demand side policy instruments will need to be linked and bundled consistently (POPP). Examples are top-runner schemes consisting of several elements, e.g. for energy related products: EU energy label, EU Ecolabel, minimum requirements and phasing out of products below a certain threshold, awards for environmental excellence, etc. Top-runner schemes could also be elaborated and tested with regard to CE or resource efficiency, or specific aspects of CE such as remanufacturing (SCOPE2).

[12] COM(2008) 397 final: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52008DC0397.
[13] https://www.un.org/sustainabledevelopment/sustainable-development-goals/.

ICPP should be designed and implemented considering the potential impact of the overall policy mix and specific policy portfolios related to CE priorities and strategies. Policy should seek synergistic effects between a variety of instruments deployed at different governance levels. Policy makers can rarely design entire policy portfolios at a given moment in time, but they can gradually adapt design features of specific instruments, e.g. start date, duration, eligibility, selection and award criteria, etc. to create links between them.

For example, support for research, innovation and deployment of alternatives to single-use plastics (economic instrument) should accompany a ban on single-use plastics in specific products (regulatory instrument) backed by mandatory reporting on phasing out of the single-use plastics (obligatory information). Circular procurement (economic instrument) could be used to create niche markets for alternatives to single-use plastics. The shift would be supported with training and collaboration platforms on alternatives to single-use plastics for companies and procurers (information sharing).

All policy makers need to be clear about goals and timescales when implementing instruments. Trade-offs need to be recognised and minimised.

There is a trade-off between those policy instruments that offer the highest potential for increasing circularity and those that are most easily introduced. There is also a clear trade-off between the predictability of an instrument, and its flexibility.[14] One point in case are instruments for radical reduction or elimination of waste, which offer a great resource efficiency potential but are difficult to implement.

There is a trade-off between the level of specificity (differentiation) of an instrument and its depth. The introduction of instruments that enable mutual benefits with existing instruments, and that aim to reduce the presence of negative interactions or side effects should be a priority (POLFREE).[15] Agreed metrics, indicators and monitoring are a prerequisite for this.

3 Create a level playing field for a circular economy

The Commission together with Member States should investigate ways of introducing a minimum tariff and a maximum tariff for both landfilling and incineration to incentivise waste prevention and eco-design.

Landfilling and waste incineration is too cheap. In many European countries it is still cheaper to landfill or burn waste than to treat it for materials recycling. Some countries have (low) taxes on landfilling and/or incineration (e.g. Austria, Belgium, Denmark, Finland, Ireland, Italy, the Netherlands and the UK). Other countries have no tariff at all and some countries vary their tariffs over the years. These different tax policies for landfilling and burning of waste in different MSs do not provide stable support for a transition towards a CE and also stimulate imports and exports of waste just to avoid taxes.

A system that includes known and increasing tariffs for the next five to ten years could help motivate investors in alternatives to landfilling by decreasing financial uncertainty. The ideal situation would create a stable and balanced tax regime in Europe for landfilling and burning of waste. The EU should agree with MSs on a system of minimum and maximum taxes on landfill and burning of waste. This system could be similar to the current minimum and maximum ranges in other tax policies like the VAT system.

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[14] Cf. Arnold Tukker et al (2013) Policy Options for a Resource-Efficient Economy, Deliverable 2.1 Report about Synthesis of New Concepts: https://www.ucl.ac.uk/polfree/publications/publications-2014/PolfreeTask2_1_Clean240713_logo280514.pdf.

[15] Cf. Henning Wilts et al (2014) Policy Options for a Resource-Efficient Economy, Deliverable 2.6 Synthesis: https://www.ucl.ac.uk/polfree/publications/publications-2014/D2-6-synthesis.pdf.

The Commission should promote the use of Green Public Procurement (GPP) as a means to drive circular solutions with a specific focus on durability, repair, remanufacturing and recycling.

Many authorities in the EU (national, regional and local) have GPP policies designed to procure products and services with lower environmental impacts. Some countries, e.g. Germany, France, Scotland, Italy, Switzerland, Denmark and the Netherlands, are also adding circular procurement elements to their GPP programmes. Although there are good examples of circular procurement, this is still not common in the EU. A stronger European policy on circular procurement with targets could help. The Commission should launch a public awareness campaign targeting public procurers and issue guidelines, criteria documents and evaluation systems for circular procurement within GPP that governments could implement.

Policy makers should provide financial, informational and regulatory incentives to stimulate the repair, re-use and remanufacturing of products.

Products can have their lifetimes extended several times by re-use and repair activities, which has additional resource savings and CO_2 reduction benefits. Product circularity goes beyond materials recycling at the end of the first product life.

In general, durable products with longer lifetimes are more easily re-used. There are indications however that product lifetimes of consumer appliances such as washing machines and refrigerators are decreasing. Product design and business models that do not take into account durability, ease of disassembly and reparability favour premature obsolescence. In some cases, suspicions have been raised that products are purposely designed to break prematurely. This is called planned obsolescence and might even constitute a violation of consumer rights. Horizon 2020 (FP8) addresses this topic in a call for an independent testing programme.[16]

Repair can prolong product lifetime, but the majority of products are not designed to be repaired easily. A lack of availability of spare parts and design information can also make re-use and repair more difficult.

Remanufacturing keeps products and components in use, by restoring their functionality and updating them to keep up with product innovation. Remanufacturing retains the value of products and provides a quality as good as new. By re-using suitable elements of a product, the environmental impact of manufacturing can be significantly reduced. This also means lower component and material costs, which ideally more than offsets the additional work force and testing required to recertify products.

Policy instruments that can incentivise circular solutions include:

- Financial: Tax reduction (e.g. VAT) or even exemption for repair services as well as for re-used or remanufactured products e.g. as being discussed in Sweden;
- Financial: Offering other incentives to the customer e.g. repair vouchers as provided by the City of Graz in Austria[17];
- Informational: Promotion of re-use, repair and remanufacturing standards to establish trust of consumers, business and government procurers;
- Informational: Supporting repair cafes and similar initiatives by providing public locations for free, promotion via public news channels and public information;
- Regulatory: Clarifying the rights and liabilities of third party remanufacturers and re-use companies;
- Regulatory: Clarifying the legal status of products entering the remanufacturing or re-use process;
- Regulatory: Introducing targets in legislation e.g. re-use targets in the WEEE Directive[18], accompanied by a monitoring system.

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16 https://ec.europa.eu/info/funding-tenders/opportunities/portal/screen/opportunities/topic-details/ce-sc5-02-2018.

17 Cf. https://www.graz.at/cms/beitrag/10320656/7765198/Foerderung_von_Reparaturmassnahmen.html and https://www.repaircafe-graz.at/.

4 Support circular practices on the ground

Policy makers should explore new product policy approaches that provide positive incentives for excellence.

Considering the costs and risks of experimenting and implementing innovative circular processes, products, services and business models (e.g. a shift towards durable design), policy makers should explore new policy and regulatory frameworks that actively reward companies that go beyond minimum requirements set by regulations (SUSTAINHUB).

Supporting frontrunners is essential for harnessing the full potential of CE. European policies should actively support companies that implement innovative circular solutions that create higher environmental and social value than existing alternatives on the market. Various policy instruments could form a portfolio supporting frontrunner companies. Direct support could be offered by the progressive use of public procurement (e.g. functional procurement), dedicated economic measures (e.g. targeted grants) and fiscal instruments (e.g. tax reliefs for environmental performance consistently exceeding competition). Indirect support could be offered by introducing new and changing regulatory and policy instruments that change framework conditions for businesses. Lessons could also be drawn from Japan's frontrunner initiative related to energy, which could be adapted to CE in general or to specific areas of CE, e.g. remanufacturing.

R&I Policy makers should explore links with policy areas relevant for supporting regional innovation and industrial development.

Key regional policy areas that have CE potential are cohesion policy and cluster policy supporting cross-sectoral innovation collaboration.

Cluster policy should assess the role of EU clusters as test beds and niches for demonstrating and scaling-up CE processes, products, services and business models. There are examples of such projects implemented under the FP7 Regions of Knowledge initiative which explored the potential of transnational learning and sectoral and cross-sectoral collaboration between clusters, which focused on issues related to resource efficiency and CE (S_LIFE, ROK-FOR). One of the conclusions from cluster collaborations was the need to expand sectoral boundaries to seek innovation opportunities in traditional sectors (e.g. forest-based industry; ROK-FOR). The collaboration and exchange of practices between clusters and regions can underpin a common direction for innovation and can stimulate innovative CE activities.

Cohesion policy could provide a unique setting to drive interregional and cross-border innovation collaborations. This might include direct support for collaboration between clusters where CE potential has been identified. Smart specialisation strategies guiding cohesion policy investments in European regions could become laboratories for design, experimentation and demonstration of cross-sectoral CE processes, products, services and business models mobilising actors from across value chain and supply chain. Regions and cities are particularly suitable for demonstrating new approaches to place-based CE models such as industrial symbiosis and business models requiring a strong collaboration across supply and value chain (e.g. remanufacturing).

Clusters, and collaborations between clusters, could become platforms for co-designing and testing new product and process standards. Clusters could also design R&I agendas and roadmaps related to CE. Lessons learnt from smart specialisation strategies and thematic platforms as well as Regions for Knowledge programmes can provide useful reference for designing such collaborative approaches (S_LIFE, ROK-FOR).

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[18] Directive 2012/19/EU of the European Parliament and of the Council of 4 July 2012 on waste electrical and electronic equipment (WEEE): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:32012L0019.

R&I Policy makers should create the preconditions for open experimentation related to circular solutions.

Innovative approaches to more circular production processes, services, products and business models (circular solutions) require a good deal of experimentation and demonstration in specific contexts. Public policies should create a space for open experimentation. The open experimentation culture should be open to a variety of actors in designing, testing and implementing new circular solutions. New business models that include testing of new consumer channels and consumption patterns, e.g. sharing, could particularly benefit from including NGOs, civil society and consumers in the process. This means that whenever relevant, R&I programmes should enable NGOs and civil society organisations (CSOs) to be eligible for funding (DELIBPROCESSSCP).

Horizon Europe and other EU programmes should support collaborative R&I projects focused on experimentation with circular solutions. The programme should also be open to CSOs and NGOs to explore new ways of engaging consumers or citizens on product circularity. One of the areas that may benefit from experimentation is the application of Industry 4.0 enabling technologies e.g. Internet of Things (IoT), artificial intelligence (AI), etc. to CE business models. Public sector, businesses and research organisations can benefit from collaboration with civil society. Collaborations could create a suitable framework for action research and social experimentation, as well as create considerable social and environmental impacts of projects. In the context of CE projects, CSOs can also become important partners for businesses and governments in designing, testing and implementing new standards and certifications. EU R&I policy should also engage closer with new movements e.g. repair cafés, fablabs, makerspaces, hackspaces, local food groups, etc. (DELIBPROCESSSCP).

R&I The Commission should fund research into open innovation for a CE, with a particular focus on knowledge exchange and network building.

Open innovation is characterised by cooperation. Networking is a key asset, but networking needs context, creativity spaces, rooms for exchange. European grants focused on creating networks, platforms, labs and experimental spaces with social enterprises related to CE could strengthen cooperation and collaboration (EU-INNOVATE, EMUDE). Networks are a source of social capital; they facilitate learning and can identify business opportunities.[19] SMEs need strong ties with a dense network of trustworthy relations to be successful.[20] Policy could help create and stimulate the creation of networks related to CE (GREENECONET).

The "outside world" of citizens and CSOs, and "inside worlds" of SMEs and large companies are not used to cooperating. To support mutual learning, exchange programmes between inside and outside worlds could result in a better understanding of the other's position. To start such activities, volunteering schemes or training programmes will be needed that intend to improve professional and communicative skills. Funding for coaching or mentoring might strengthen the skills of CSOs and citizens in such open innovation processes (EU-INNOVATE). Also within businesses, the institutional and multidisciplinary professional skills needed for collaboration and interaction with external actors should be improved (EMUDE, PROSUMER.NET).

The Commission should systematically analyse its open innovation projects with regard to their outcomes and impacts on CE, as well as challenges to their upscaling. The interaction between businesses and users, the consideration of long-term needs and requirements, learning from pilots and the uptake of innovations need to be improved. Various models such as the three-tier model (EU-INNOVATE) should be tested in specific consumption domains, e.g. housing, mobility. A number of research topics might be relevant for further investigation:

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[19] Cf. Päivi Jämsä et al (2011) Sustainable SME network utilization: The case of food enterprises. Journal of Small Business and Enterprise Development, 18(1), pp. 141-156.

[20] Cf. Susanne Gretzinger et al (2010) Cooperation in Innovation Networks: The Case of Danish and German SMEs. Management Revue, 21(2), pp. 193-216.

- Collaborative design, users' experiences and needs, increase of durability and reparability of products, prevention of obsolescence;
- Collaborative design, open innovation and circularity;
- Market transformation potentials of open-innovation products and services;
- Analysis of collaboration structures, with a view to the involvement of minorities and socially deprived groups and networks;
- Transition of collaborative innovations from niches and special market segments to mainstream and mass markets;
- Collaborative financing models (crowd-funding, peer-to-peer) for sustainability innovation including product circularity (EU-INNOVATE);
- Customer collaboration and the risk to undermine the creativity of in-house business innovators;
- Process-related topics like processes for acquiring information from customers, partner selection criteria.

R&I Policy makers should support new circular business models, e.g. product-service systems and sharing platforms.

In certain areas, circularity can be increased through product-service systems (PSS) under which buyers pay manufacturers for the provision of the service a product provides, instead of owning the product (e.g. managed print services). Under such models, in the case of product failure the manufacturer takes back the product and tries to repair or remanufacture it, and by that extends the product lifetime. The manufacturer remains responsible for the functioning of the product throughout its whole life cycle, which incentives a product lifetime extension wherever this is feasible.

Sharing platforms increasingly offer consumers access to products they need without obliging them to buy them. This has a large potential for products that are used only sporadically, such as (power) tools, or expensive products such as cars.

Possible support actions could be:

- Research: Invest more in research to overcome the prejudice of traditional sales people of companies that functional sales will reduce their income;
- Financial: Provide incentives for traditional manufacturing companies for the transition period to become a service provider (bridge financing);
- Informational: Establish a collection of successful product-service-systems (lighthouse projects) in the business to consumer sector and promote this to industry, retailers and to consumers;
- Regulatory/financial: Provide tax or other incentives for services instead of products and co-finance it by higher taxes on primary raw materials and/or energy consumption.

Policy makers should set up and promote user-friendly virtual exchange platforms in the context of the sharing economy.

Collaborative economy solutions offer several benefits to consumers: up-to-date products, no storage requirements, no maintenance. The aim of a sharing economy is to extend the lifetime of infrequently used products, such as work tools, and to use them more frequently and intensely through sharing. A respective business model should generate more value per product over its lifetime without compromising on ease of use.

GREENECONET and other R&I projects suggest that setting up virtual exchange sharing platforms would be desirable for a CE and feasible. A user-friendly virtual exchange platform should connect manufacturers, distributors and users, and should host all relevant actors and stakeholders.[21] It will allow users to seek and get the desired object from the potential "next-door" user for temporary use, and to pass it to the next one after.

[21] Regarding the importance of digital tools for CE implementation, see also https://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Intelligent_Assets_080216.pdf.

DEMAND SIDE RECOMMENDATIONS

5. Understand the mechanisms and impacts of markets and consumption

R&I The Commission should intensify research on the relation between SCP and CE, consumption patterns and the role of consumers, with the aim to break the link between consumption and resource use.

Although policy efforts towards SCP have increased over the last decades, the focus has mostly been on sustainable production (ASCEE). The SCP policy field should now also start to address the complex theme of circularity and the different steps consumers could undertake. Key aspects are design, materials and contents of products, maintenance, repair, sharing, remanufacturing, recovery and recycling.

In addition, research should inform the prioritisation of areas where decoupling between consumption and resource use could be achieved easiest. The analysis should also address the impacts of digitisation of products and services on the environment, the economy and society.

Sustainable consumption policy must bear in mind the underlying social practices related to sustainable consumption[22], alongside issues related to consumption patterns and the absolute level of consumption (ASCEE).[23]

The role and potential of policy to influence private consumption patterns in relation to products and circularity has not been sufficiently examined. Research should focus on state of the art knowledge, constraints, experiences with regulatory and soft instruments and experiences with newer approaches like nudges and choice editing, e.g., nudges to stimulate openness towards sharing and repair of products.

Recent nudging strategies[24] intend to design systems that make sustainable consumption choices easier and more attractive for consumers (POPP).[25] Policy could assess the chances and request market actors to apply nudges related to CE, building on experience from research related to mobility, housing and shopping.

The Commission should try to quantify the possible impact of a sharing economy on circularity and GHG emissions.

With regard to sharing schemes, it would be essential to demonstrate and quantify the circularity implications and environmental benefits, i.e. fewer manufactured objects, better control of their life cycle and a resulting reduction of waste and greenhouse gas (GHG) emissions. It is plausible that product-service systems (PSS) have a smaller environmental impact, and this should be demonstrated. GHG emissions are expected to decrease in a sharing economy, due to reduced manufacturing and more efficient logistics, i.e. reduced movements of goods from factories to retail outlets and of customers, who can collect products in their own neighbourhoods.

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22 Cf. Elizabeth Shove (2003) Comfort, Cleanliness and Convenience. The Social Organization of Normality.

23 Cf. the debate on strong and weak sustainable consumption in D. Fuchs, S. Lorek (2005) Sustainable Consumption Governance – A History of Promises and Failures. Journal of Consumer Policy 28, pp. 261-288.

24 According to https://en.wikipedia.org/wiki/Nudge_theory, nudge is a concept that proposes positive reinforcement and indirect suggestions as ways to influence the behaviour and decision making of groups or individuals.

25 Cf. Manuela Bernauer, Lucia Reisch (2018) Green Defaults as Instruments of a Sustainable Energy Demand Policy Project Report: Kopernikus-Projekt „Systemintegration": Energiewende-Navigationssystem (ENavi), Project Grant No. 03SFK4J1, German Ministry of Education and Research; and
Christian Thorun et al (2017) Nudge-Ansätze beim nachhaltigen Konsum: Ermittlung und Entwicklung von Maßnahmen zum „Anstoßen" nachhaltiger Konsummuster. Dessau: Federal Environment Agency.

R&I The Commission should give the consumer side a more prominent role in the conceptualisation and realisation of SCP and CE related research.

NGOs, CSOs and citizens are important yet frequently neglected stakeholders in research and development efforts related to product circularity. Their experiences and practices should be addressed in collaborations that could be a suitable platform for action research and social experimentation (DELIBPROCESSSCP).

The roles of citizens as consumers, investors, prosumers, social networkers or political activists are not very well recognised and understood in relation to CE, e.g. regarding the success of repair cafes. Activating these roles in CE could mobilise citizens and help use their capacities to support policy objectives. Empowerment "strategies" for civil society should be elaborated and tested. Various options for approaching consumers should be evaluated, e.g. advice through independent organisations.[26] Another approach could involve subgroups of consumers, e.g. influencers, as models for a change (GLAMURS).

Knowledge brokerage as information transfer between the scientific community and policy makers could support evidence-based policymaking. Building on past R&I projects[27], its application in policymaking could be strengthened (ASCEE).

6. Create opportunities and markets for circularity

The Commission should create a CE policy that is perceptive, flexible and adaptive.

The implementation of CE policy measures requires a holistic approach and the involvement of different stakeholders (SCOPE2, POPP). Greater stakeholder involvement from the start could strengthen reflectivity and learning (SCOPE2, ASCEE). Policy instruments should be flexible enough to take account of the accelerated dynamics of markets resulting from digitisation and the systemic shortening of innovation cycles. In the "age of acceleration"[28], policy approaches should have a built-in feedback mechanism and learning curves, and the flexibility to adapt to new circumstances.

Policy makers should learn from top-runner approaches used to reduce energy consumption.

The EU Energy label is well established. It is an example of a top-runner scheme[29] (SCOPE2) that has been successful in reducing CO_2 emissions (POPP). A similar top-runner scheme could be developed to stimulate product circularity, e.g. in relation to reparability. The setting of minimum requirements for certain products, referring to features such as recycled content (POPP) could be applied in the context of top-runner schemes (SCOPE2) and would change the market for circular products.

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[26] Cf. Frank Waskow, Sonja Pannenbecker (2013) Empfehlungen für eine verhaltensorientierte Klimaberatung. Arbeitspapier. Düsseldorf: Verbraucherzentrale NRW.

[27] For an overview, see André Martinuzzi, Michal Sedlacko (2016) Knowledge Brokerage for Sustainable Development. London: Greenleaf Publishing.

[28] For an explanation of this term, see Thomas Friedman (2016) Thank you for Being Late: an Optimist's Guide to Thriving in the Age of Accelerations.

[29] For the slightly different and very interesting Japanese approach, see https://www.futurepolicy.org/ecologically-intelligent-design/japans-top-runner-programme/ and https://www.iea.org/policiesandmeasures/pams/japan/name-21573-en.php.

Policy makers should encourage the spreading of new bottom-up practices.

Recently, new governance and cooperative projects like social experiments, regulatory innovation districts, etc. have emerged. They build on innovative and reflective grassroots approaches. Learning through experimentation and collaboration from these "bottom-up" practices has already been successfully tested. This approach has been termed "real world labs"[30], "experiment niches", "real experiments"[31], "living labs"[32], "neighbourhood transition labs" or "urban habitation labs"[33].

Policy makers should further encourage these experiments. It would be useful to bring more NGOs, CSOs and citizens directly into such projects. The linkage to local and regional value-chain networks and collaborations would be interesting to explore. The CE topics to explore with CSOs, NGOS, trade unions and local government could include the testing of second life markets and local zero-waste approaches. Action-orientated research with citizens requires additional skills, different evaluation criteria, longer funding periods and long-term monitoring of results (INCONTEXT).

Authorities and policy makers should explore how transition management could support CE at a regional or local level.

Transition management[34] at the local level addresses specific issues in local communities. This might be a promising concept for activating and engaging stakeholders in CE activities at a grassroots level (INCONTEXT). Initiatives such as transition towns, zero-waste campaigns or energy communities often emerge from a regional or local context. It would useful to learn how policy could support the transition to CE in this context.

R&I Policy makers should explore the full potential for circular products and services within green public procurement (GPP).

Public procurement is around one-sixth of the EU GDP and therefore an important demand side policy instrument. GPP is often seen as a promising policy instrument for greening markets, but it is unclear to what extent it can support product circularity and influence individual consumption patterns (POPP). Further research is needed to see how GPP can promote more circular products and services. Challenges should be identified and options for improvement and coordination defined.

Research results should be transferable to private sector procurement. The importance of GPP might be higher in some markets and might trigger multiplier effects by setting a good example to other consumers, e.g. commercial procurers and private consumers (POPP). Policy should seek to stimulate collaboration amongst public procurers and explore cooperative procurement by commercial and public procurers, in order to increase economic leverage and to incentivise increased supply side product circularity.

Circular Public Procurement (CPP) should be communicated as a subset of GPP. A website and helpdesk should be established, helping stakeholders to quickly acquire sufficient knowledge to develop criteria for CPP within a broader GPP framework.

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[30] Rico Defila, Antonietta Di Giulio (2018) Transdisziplinär und transformativ forschen. Eine Methodensammlung.

[31] Matthias Groß, Holger Hoffmann-Riem, Wolfgang Krohn (2005) Realexperimente. Ökologische Gestaltungsprozesse in der Wissensgesellschaft.

[32] Claudio Dell'Era, Paolo Landoni (2014) Living Lab: A Methodology between User-Centred Design and Participatory Design. In: Creativity and Innovation Management, Volume 23, Number 2, pp. 137-154; and Justus von Geibler (2013) Living Labs für nachhaltige Entwicklung. Potenziale einer Forschungsinfrastruktur zur Nutzerintegration in der Entwicklung von Produkten und Dienstleistungen.

[33] Frank Nevens, Niki Frantzeskaki, Leen Gorissen, Derk Loorbach (2013) Urban Transition Labs: co-creating transformative action for sustainable cities. In: Journal of Cleaner Production 50 (2013), pp. 111-122.

[34] Cf. René Kemp, Derk Loorbach, Jan Rotmans (2005) Transition Management as a Model for Managing Processes of Co-Evolution towards Sustainable Development. In: International Journal of Sustainable Development and World Ecology, pp. 1-15; and Derk Loorbach (2007) Transition Management: New mode of governance for sustainable development.

Policy makers should promote the use of the EU Eco-Management and Audit Scheme (EMAS) as a tool for creating a demand for circular products and services.

In some European countries, organisations already use EMAS as a way to adopt CE and resource efficiency principles.[35] EMAS-registered organisations report on six indicators covering energy efficiency, material efficiency, water, waste, biodiversity and emissions. The potential for the incorporation of additional CE criteria should be further explored. In MSs with low or no EMAS penetration, this instrument should be stronger promoted. Best practice examples of EMAS-registered organisations focusing on new circular business models should be highlighted.

7. Make circular products and services a market reality

Policy makers should exploit the role of taxation in increasing product circularity.

Various tax policy measures might help change relative prices and provide incentives for changing consumption towards circularity. Examples are taxes on the extraction of selected virgin materials or on landfilled and incinerated waste (DYNAMIX). Inspiration might be taken from feebate schemes, e.g. in the mobility sector (DYNAMIX), congestion charges (SCOPE2) or fuel taxes (SCOPE2).

The CE potential of VAT has not really been mobilised. Reduced VAT rates for products and services with the smallest environmental footprint could improve circularity of products and favour handcraft (DYNAMIX, SCOPE2). Repair and remanufacturing of products often fail because the level of labour costs, in relation to material costs, is so high that commercial and private consumers opt for new products. Increasing repair and remanufacturing, particularly in EEE, can help to save a considerable amount of energy and resources (ZEROWIN).

Policy makers should support collaborative design initiatives.

Collaboration between businesses (as producers) and citizens (as consumers) would link needs of different target groups, resulting in collaborative design with more user orientation. This could increase product service intensity and lifetimes, and contribute to higher product circularity (CORENET). Policy should support all approaches that bring stakeholders together. There has already been some research in this area, on which policy should follow up now. The best policy instruments for this effort still need to be identified.

Policy makers should work directly with retailers to develop feasible product-service business models.

Retailers and their associations should be engaged in policy discussions related to product circularity. Retailers could suffer financial losses and be resistant to change in relation to new product-service models and new forms of collaborative consumption associated with CE. There is therefore a need to integrate retailers in key areas such as fashion, sport merchandise[36] or electronics at the beginning of the collaborative rental process to improve the match of supply and demand.

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[35] Cf. European Commission (2017) Moving towards a circular economy with EMAS: http://ec.europa.eu/environment/emas/pdf/other/report_EMAS_Circular_Economy.pdf.

[36] For an interesting business example, see http://sustainability.decathlon.com/action-areas/products-services/.

R&I The Commission should intensify research into technologies for tracking information on product circularity.

Having knowledge of the use of a product and how fast or slowly it circulates amongst users is a precondition for creating product-service shifts and setting the right prices. There should be research into track-and-trace shared objects with embedded IoT trackers. This would allow the measurement of use level, optimise lifespan and object location, respond more efficiently to user demands, and analyse and reduce movements with the aim to measure and reduce the environmental impact. Systematic monitoring will also indicate opportunities for preventative maintenance, potentially extending product lives.

The advantages and challenges of the transmission of information on circularity need to be further studied (ASCEE). Once several mature technologies for data tracking and information aspects of product circularity are available on the market, companies will need support in choosing the right technology for their type of product and sector. Therefore, a toolkit should be elaborated. Social media and digitisation play an important role in the process of product choice. The relationship between tracking technologies for product circularity and social media needs to be further investigated.

Policy makers need to distinguish between target groups and types of applications such as business-to-business (B2B) and business-to-government (B2G) with regard to technologies for tracking product circularity. A key issue is the choice between proprietary software and open-source software.

8. Help consumers take informed individual decisions

The Commission should investigate the potential for increased coverage of product circularity aspects in product-related environmental information, including labels.

Several Commission surveys show that consumers are confused by the stream of incomparable and diverse environmental information.[37] A majority thinks that product labels do not provide enough information, and that labels are not clear. About half of European consumers think it is not easy to differentiate between environmentally friendly and other products and only about half of them trust producers' claims about environmental performance. To allow consumers to purchase circular products, which a majority indeed might be willing to do, all environment-related product information must be accessible, clear, and comparable. This requires standardisation and simplification. Therefore, more product-related CE information, e.g. on CRMs, reparability, recyclability and recycled content, should be included in existing environmental information schemes, e.g. in Ecodesign or Ecolabel.[38] The number and types of products covered by these schemes should also be expanded. Research results that could be used in this process, e.g. from JRC, are available.

R&I The Commission should support initiatives in developing criteria based on PEF for product groups where labelling or GPP criteria are still missing.

The EU Product Environmental Footprint (PEF) initiative[39] provides a standardised approach for developing comprehensive environmental criteria for product groups that could be used for both labelling and GPP. It should be feasible to highlight specific circularity criteria within the PEF system. For product groups where ambitious sector initiatives have yet to be launched, the implementation process could be initiated or accelerated by targeted research funding.

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[37] See also http://europa.eu/rapid/press-release_IP-13-653_en.htm.

[38] Cf. http://ec.europa.eu/growth/industry/sustainability/ecodesign_en and http://ec.europa.eu/environment/ecolabel/index_en.htm.

[39] http://ec.europa.eu/environment/eussd/smgp/policy_footprint.htm.

SUPPLY SIDE RECOMMENDATIONS

9. Probe the potential for circular products and processes in industry

R&I The Commission should work with manufacturers on the identification of classes of products suitable for PSS.

To the extent that PSS contribute to circularity and dematerialisation, they reduce the environmental impact of consumption. The identification of products or functions that are most suitable for PSS and the collaborative economy has not been done systematically yet, nor with an eye for the manufacturers' needs and concerns. It is necessary to investigate the role and motivation of manufacturers. Their motivation to embark on new PSS should be analysed and strengthened. Systematic analysis should also look into behavioural barriers to sharing and into possible rebound effects, i.e. how and why non-ownership can lead to less responsible consumption patterns.

R&I The Commission should extend research into the role of social innovators and entrepreneurs to CE related areas.

The project EMUDE explored the role of social innovators and entrepreneurs and their impacts on society and economy and considered paths to strengthen them. It would be useful to fund research into the role and societal and economic impact of social innovators and entrepreneurs in areas related to the CE.

R&I The Commission should establish calls for projects related to the impacts of emerging technologies on CE.

Projects should focus on:

- Comprehensive social science research on socio-economic, technical and environmental impacts of various Industry 4.0 emerging technologies (IoT, distributed manufacturing, cloud computing etc.) on CE;
- Support for collaborative R&I and experimentation of emerging Industry 4.0 technologies to enable CE production processes across economic sectors;
- Developing and testing innovative ways of shared use of traditional (e.g. factory lines, machines) and new production tools (e.g. 3D printers, sensors etc.) to enable CE.

R&I The Commission should initiate cross-sectoral collaborations enabling new CE production processes.

There is a need to assess the role of EU clusters as test beds and niches for demonstrating and scaling innovative CE production processes. Cluster policy and related instruments supporting regional industrial development can encourage specialisation in CE in European regions with a strong manufacturing base. Cluster policy can be used to encourage cross-sectoral collaborations enabling CE production processes in traditional and emerging sectors. Cohesion policy could consider clusters and industrial zones as spaces for experimentation, demonstration and deployment of innovative CE approaches to new production processes and production networks. In this way, the potential of Industry 4.0 for enabling CE in production could be explored. Clusters could also be platforms for co-designing and testing new process and product standards.

10. Raise the circularity readiness level in industry

The Commission needs to base CE policy development on a systemic understanding of production processes and infrastructures.

CE policy needs to be based on a systemic understanding of how production processes and infrastructures are organised in specific sectors and value chains. This should take account of how flows of primary and secondary resources move across various regions (ERA-MIN). Production is linked with upstream, e.g. design, material sourcing, and downstream processes, e.g. channels and relations with clients and customers, end-of-life management. Therefore, policy instruments influencing any element of the material cycle are likely to influence the production processes directly or indirectly. Policies supporting specific CE strategies or business models will have different impacts on production processes. Policies can foster recycling, e.g. through improving the uptake of secondary raw materials, but also through substituting or reducing substances of concern, which may constrain the use of secondary raw materials. Policies can also support remanufacture by implementing standards that define warranty conditions.

R&I The Commission should analyse and mitigate the specific challenges that keep SMEs from engaging in circular practices.

Research is required to understand the complex challenges faced by SMEs in embracing the CE. Better knowledge of these challenges will allow policy makers to develop an appropriate supportive policy framework for CE (GREENECONET). In particular, SME-specific challenges for a shift to PSS models, and how to overcome these challenges, should be a research focus. R&I projects on sustainability management, assessment methods and tools should explicitly address CE strategies, business models and processes, particularly for SMEs. These projects need to be demand-led and consider specific needs, capacities and competencies of SMEs in various sectors and value chains. Projects should:

- Explore and validate new methods of data collection relevant for CE, including collaborative platforms, expert-based approaches, new methods making use of natural language processing, big data, IoT, AI, ambient intelligence[40] etc. (SUSTAINHUB, CILECCTA);
- Test and demonstrate innovative approaches and tools enabling data sharing between companies, including data from materials testing (CILECCTA, SUSTAINHUB, MYECOCOST);
- Test and demonstrate innovative methodologies and design-support tools to integrate comparisons between various CE strategies and business models in different sectors and value chains, e.g. remanufacturing versus recycling (CILECCTA);
- Test and demonstrate innovative approaches and tools to incorporate circularity assessments in the case of short-series customised production (FASHION-ABLE);
- Test and demonstrate methodologies and tools with probabilistic approaches for LCA, life cycle costing analysis (LCCA), social LCA and other assessments of CE strategies and processes. Probabilistic approaches take account of risks and uncertainties of future prices and technological trends, which could help assess products requiring a longer-term planning perspective, e.g. construction (CILECCTA);
- Explore the potential of using aggregated data from LCC/LCA platforms as evidence to underpin CE policy design, e.g. evidence on risk-averse choices of companies based on perceived market uncertainty;
- Adapt methodologies and tools to align product testing and assessments with existing and upcoming technical standards and certifications, with a view to CE strategies and processes;

[40] Ambient intelligence refers to electronic environments that are sensitive and responsive to the presence of people. Cf. Emile Aarts, José Luis Encarnação (2006) True Visions: The Emergence of Ambient Intelligence.

- Explore and demonstrate new flexible approaches for establishing CE benchmarks and promoting good practices relevant to companies, especially for those exploring newly implemented innovative solutions.

The Commission should establish financing mechanisms specifically for SMEs that want to engage in CE.

CE start-ups and existing SMEs should get access to potential financial support for engaging in CE practices, and policy makers should look for ways to help start-ups and SMEs take advantage of newly emerging forms of financing (GREENECONET). Possible actions could be:

- Expand European financing for CE start-up ventures, aligning European venture capital financing with corporate venturing related to investment in circular entrepreneurs or recognising new legal enterprise forms that might be more relevant to CE ventures (EU-INNOVATE);
- Promote, e.g. with the European Investment Fund, investment in CE from VentureEU. This could be enabled by agreeing on a common set of assessment criteria to be applied to investments in the area of CE benefiting from VentureEU and other relevant EU funds;
- Consider European grants or funding for social innovations that might result in new types of CE businesses (EMUDE);
- Raise awareness and facilitate access to crowdfunding for CE start-ups and existing SMEs, e.g. by supporting independent intermediary platforms or by funding transfer networks connecting innovators with users and investors (EU-INNOVATE).

Authorities should launch awareness campaigns to support CE regulatory compliance and promote CE production practices.

Awareness raising campaigns could help ensure that companies have access to the most accurate and up-to-date information on relevant CE and related legislation and standards. Awareness-raising activities support the enforcement of the regulatory framework. Campaigns and online platforms could convey a message and highlight case studies, illustrating that CE approaches allow SMEs to meet regulatory requirements and improve their business performance. Best circular production practices and production practices that go beyond regulatory resource efficiency requirements should be promoted, e.g. through competitions and prizes. Prize criteria could focus on applying CE approaches to specific societal challenges and goals, e.g. zero waste production processes. CE prizes could also specifically target groups of companies collaborating to implement CE approaches in production, e.g. through industrial symbiosis, cascades, etc.

Authorities should support SMEs with CE compliance problems and establish dedicated business advisory services (BAS) to support compliance, facilitate collaboration between businesses and identify new circular business models.

Authorities should interact with SMEs that report problems with meeting regulatory and other requirements related to CE. Before imposing fines, business advisory services or training could be offered to these companies to support compliance (SUSTAINHUB). In specific cases, advisory services and training could be followed up with dedicated loans. Services should focus on:

- Business internal resource efficiency;
- Existing and emerging CE related legislation and standards;
- Promoting EU Best Available Techniques (BATs) and BATs reference documents (BREFs);
- Collaboration between businesses along value or supply chain (e.g. industrial symbiosis, remanufacturing);
- CE business models requiring collaboration. These facilitation services could be promoted in clusters, industrial zones and technology parks.

11. Stimulate resource-efficient and circular design, sourcing and manufacturing

The Commission should avoid unintended consequences of the incorporation of circularity into eco-design policy by considering an extended life cycle perspective and potential environmental trade-offs.

Eco-design integrates environmental considerations into product design and development whilst aiming to reduce life cycle impacts. Product circularity is just one aspect of eco-design. There might be trade-offs associated with eco-design decisions, and these trade-offs should be recognised in relation to the aim of reducing the overall environmental impact. In reducing resource consumption per product, companies should also consider how to improve product circularity through appropriate design strategies.[41] When developing circularity criteria for products and services, policy makers should not only use well-established standards such as ISO14040:2006 on life cycle assessment, but also work with standards that are new or in development, e.g. ISO14006:2020 related to eco-design and environmental management systems targeted at environmental managers, and IEC 62959:2019 related to the implementation of eco-design at a product level targeted at designers.

The Commission should investigate how existing tools could be used or adapted to increase product circularity through eco-design.

Although various eco-design and LCA tools have been funded through R&I projects, only few are actually being used by designers or manufacturers. The reasons for this need to be analysed. Available tools do not seem to reflect user needs. Specific tools can however have a significant impact. The project RESOM showed that providing applied tools for different business functions within large original equipment manufacturing companies created awareness and momentum for remanufacturing. This led to a reduction of waste, virgin material use and energy consumption, and a reduction in costs.

R&I The Commission should study options within CE policy to support the substitution of CRMs through incentives for product redesign.

Functional or systemic substitution of CRMs could make an important contribution to reduced EU dependency on imports (ERA-MIN). The Commission should develop a specific R&I agenda and roadmap for the functional and systemic substitution of CRMs that encourages new circular product design and business models. Radical redesign could aim to eliminate the need for parts containing CRMs altogether.

The Commission should integrate the issue of sustainable mining into its CE policy and engage in knowledge sharing outside the EU.

As a net importer of abiotic resources, the EU should engage in knowledge sharing and capacity building abroad, in particular to support the integration of mining into international development policies in a holistic way at local and regional levels. Although the issue of sourcing raw materials in a sustainable way is not a part of the CE, it is closely related, and social, economic and environmental aspects are intertwined. The mining issue is also linked to material needs, product design, and availability and quality of secondary raw materials. Mining should be characterised by high levels of transparency and accountability, dedication to worker safety, and reduced environmental impacts (POLFREE).

[41] Cf. Martin Charter (2018) Designing for the Circular Economy.

12. Stimulate recycling and the use of secondary materials

The Commission should experiment with dynamic process and product standards aimed at increasing product circularity.

The current procedure for setting technical standards is time-consuming. The resulting standards often lag behind innovative industrial practices. New approaches to setting CE standards for production processes and products could differentiate between different levels of environmental performance. Using this differentiation, regulatory minimum compliance requirements could be combined with positive incentives for best performers, e.g. through tax relief or access to finance. Technical standards for the following areas would be useful:

- Processes for improving the quality of secondary raw materials;
- High quality components, which could increase exchangeability of items along the product life cycle and encourage remanufacturing;
- Second-hand components used in production to ensure the liability for parts and components.

The Commission should investigate possible economic and cost benefits of new policy rules to support the transition towards a CE.

The current economic and policy framework in the EU and MSs was developed for a linear economy and does not support a transition to CE. Virgin materials, which are in many cases mined outside the EU, are imported without or with very low import taxes. In addition, the CO_2 emissions from mining and refining these virgin materials are not priced in the EU ETS system.

For many circular options, the economic rules imply a substantial tax on labour for repair, sorting and recycling. For example, in many MSs landfilling or incineration of waste is still the cheapest after-use option. The project SMART concludes that illegal landfilling of tyres in a number of MSs is a problem that hinders recycling of tyres. Moreover, although tyres are 100% recyclable and their chemical and physical properties make them an outstandingly valuable resource, energy recovery still makes for the biggest share of legal end-of-life management. The landfill ban on tyres[42] should be enforced more strictly to stimulate material recycling over energy use from tyres (SMART).

The Commission and Member States should strive to expand the scope of Extended Producer Responsibility (EPR) schemes, including deposit-refund systems, to a broader set of products and consider mechanism to incentivise Individual Producer Responsibility (IPR).

EPR has proven successful in improving recycling figures. For single-use plastics, packaging and a number of other products (e.g. EEE), producers are made responsible for the recycling and waste treatment of their products via sectoral EU legislation. In EPR systems, design for recycling and re-use can be stimulated, although MSs have not generally implemented this in their national legislation. For example, the WEEE Directive is focused on "collective responsibility" rather than Individual Producer Responsibility (IPR), which would incentivise eco-design. For a majority of products on the European market there is no EPR scheme in place yet. As EPR is a strong instrument to stimulate the CE, EPR could be introduced step by step to cover more types of products on the European market. For example, EPR systems for the building and fashion sectors or sub-sections thereof might be interesting starting points. In 2030, the goal could be that all producers will be responsible for all products they put on the European market.

[42] Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste (Landfill Directive): https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:31999L0031.

R&I The Commission should intensify research into the interdependencies of CE, product policy and CRMs.

Europe is largely dependent on imports of raw materials including CRMs. Closed-loop design and the development of CE networks for redefining supply chains should help reduce this dependency (POLFREE). New policy mechanisms for retaining the CRMs used in electronics, low carbon technologies and other sectors within Europe are needed. As most CRMs are mined in a few countries outside Europe, third country politics and policies can have a significant influence on market prices. Research should focus on:

- Improved understanding of the social, economic and environmental impacts of mining and processing. In this context, CE policy should refer more directly to the SDGs;
- Methodologies for improving the traceability of CRMs in supply chains. The resulting approaches need to be communicated to policy makers, businesses and business intermediaries (GREENECONET).

The Commission and Member States should augment funding for bridging the "valley of death" for recycling technologies.

Various R&I projects show that promising recycling technologies, e.g. for the extraction of secondary CRMs, get stuck at the laboratory or pilot scale and have not been commercialised (COLABATS, HYDROWEEE, RECLAIM, RECYVAL-NANO, REECOVER, REMANENCE, BADANA, C2CA, ENCORE, SMART, CU-PV). This is mainly due to market prices and a lack of perspective. Due to third country policies, market prices for certain raw materials are currently too low to ensure a profitable recycling. In addition, political uncertainties make long-term planning difficult and large investments in recycling facilities very risky for private businesses, in particular for the many SMEs in the recycling sector. Possible solutions could be:

- Strategic EU or regional investment promotion subsidies for upscaling of already existing recycling processes on lab or pilot scale in order to bring them to the market (REECOVER);
- Targeted financial incentives for the recycling of CRMs and issuing of subsidised CRM recycling certificates if the low market price does not allow profitable recycling irrespective of technology and scale (HYDROWEEE, RECLAIM, RECYVAL-NANO, REECOVER, REMANENCE).

The Commission should amend the WEEE Directive to incentivise the recovery and recycling of CRMs.

The WEEE Directive sets recycling rates as weight of recycled material per collected waste. This approach does neither reflect that CRMs are used in small quantities nor that they have a much higher value than non-CRMs such as steel, aluminium or glass. The mass-focused recycling targets of the WEEE Directive can easily be reached with non-critical materials such as base metals, plastics, glass, etc. The recycling of CRMs is currently not mandatory, although the criticality of various raw materials will become even more pressing with the coming energy and mobility transition.[43] Policy makers should ensure that CRMs already embedded in products are recovered and not lost during recycling. Possible solutions could be:

- Recycling targets for specific CRMs to make the recovery mandatory within the EPR schemes (HYDROWEEE);
- Specific collection targets for products that are rich in CRMs, e.g. in the information technology and telecommunication sector;
- Incentives tackling the scale-up and profitability issues.

[43] For an updated list of CRMs, see the Commission Communication on the 2017 list of Critical Raw Materials for the EU: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52017DC0490.

METHODOLOGY

Projects

All projects that were utilised for this report were selected, grouped and allocated to a team of experts by the Commission. The starting point was a keyword search in RTD web application CORDA for potentially relevant FP6 and FP7 projects. Horizon 2020 was excluded as a first trial showed that many relevant projects were still ongoing. Older Framework Programmes were excluded due to possible report accessibility issues. More than fifty root words were used for the search, from materials, product types and applications to technologies to life cycle, consumer and environmental aspects. The projects' full keyword descriptions already allowed for a discrimination between relevant, potentially relevant, and irrelevant projects.

For around 500 potentially relevant projects, the abstracts were scrutinised. Although abstracts in CORDA are not fully coherent and some of them are clearly wanting, this made for a reduction to a draft 158-entry list, which was communicated to the experts. The further selection was based on a thematic prioritisation process. Although energy efficiency contributes to the overall environmental performance of products, projects were eliminated if the abstract suggested that material choices were only driven by energy performance considerations. Projects with an exclusive focus on food production and products were also excluded from the scope, while novel applications for biomaterials from food production were defined as being in scope. Overlaps with a recently published evaluation exercise on plastics, which also looked into FP7 projects and had a strong focus on packaging[44], were minimised.

After a discussion with the experts, all ongoing projects without a final report were eliminated, as a proper analysis of various non-standardised interim reports per project would have been too time-consuming. In a next step, experts' recommendations regarding the remaining shortlist were taken into consideration. Other relevant criteria were project size and readiness level, and the anticipated potential for general recommendations. The remaining 112 projects were distributed amongst the four expert teams for a detailed analysis. Experts also suggested a limited number of other information sources in agreement with the Commission.

Research questions

71 detailed research questions were presented to the experts, who had to choose the most promising questions for their respective project portfolios. Questions relate to material choices, product design, production processes, life cycle assessment, consumer behaviour, waste issues, and scientific, technological and legislative aspects. Experts were allowed to adapt questions. Each expert tried to match and answer at least ten questions. The result was a matrix of questions and projects that allowed a thematic aggregation of findings.

Synthesis

The rapporteur validated the results on materials/design, production/consumption, markets/business models/consumers, afterlife/recycling, and aggregated and grouped them as crosscutting, demand side and supply side recommendations.

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[44] https://ec.europa.eu/info/publications/circular-economy-plastics-insights-research-and-innovation-inform-policy-and-funding-decisions_en.

LIST OF EU FUNDED PROJECTS

N°	Project Acronym	Project ID	Project Call Identifier	Framework Programme
1	ALTITUDE	606210	FP7-SME-2013	FP7
2	ANAGENNISI	603722	FP7-ENV-2013-two-stage	FP7
3	ASCEE	44191	FP6-2005-SSP-5-A	FP6
4	BADANA	232287	FP7-SME-2008-1	FP7
5	BEST	230846	FP7-PEOPLE-IRSES-2008	FP7
6	BIOBUILD	285689	FP7-2011-NMP-ENV-ENERGY-ICT-EeB	FP7
7	BIOCELSOL	505567	FP6-2002-NMP-1	FP6
8	C2CA	265189	FP7-ENV-2010	FP7
9	C2GE3E	272206	FP7-PEOPLE-2010-IEF	FP7
10	CASTLE	316020	FP7-PEOPLE-2012-ITN	FP7
11	CILECCTA	229061	FP7-NMP-2008-LARGE-2	FP7
12	COLABATS	603482	FP7-ENV-2013-two-stage	FP7
13	CORENET	260169	FP7-2010-NMP-ICT-FoF	FP7
14	CU-PV	308350	FP7-ENV-2012-two-stage	FP7
15	DELIBPROCESSSCP	217784	FP7-SCIENCE-IN-SOCIETY-2007-1	FP7
16	DEMAT	246020	FP7-NMP-2009-SME-3	FP7
17	DESIGN4CHILDREN	243719	FP7-SME-2008-2	FP7
18	DESIRE	308552	FP7-ENV-2012-one-stage	FP7
19	DURABROADS	605404	FP7-SST-2013-RTD-1	FP7
20	DYNAMIX	308674	FP7-ENV-2012-one-stage	FP7
21	ECO-PCCM	509185	FP6-2002-INCO-WBC-1	FP6
22	ECOBIOFOR	605215	FP7-SME-2013	FP7
23	ECODIS	500779	FP6-2002-SME-2	FP6

24	ECOMETEX	280751	FP7-NMP-2011-SMALL-5	FP7
25	EMC2-FACTORY	285363	FP7-2011-NMP-ICT-FoF	FP7
26	EMUDE	505645	FP6-2002-NMP-1	FP6
27	ENCORE	295283	FP7-PEOPLE-2011-IRSES	FP7
28	ENVIRO-TEX-DESIGN	213903	FP7-NMP-2007-SMALL-1	FP7
29	EOUNETWORKS	256535	FP7-PEOPLE-2009-RG	FP7
30	ERA-MIN	291870	FP7-ERANET-2011-RTD	FP7
31	EU-INNOVATE	613194	FP7-SSH-2013-1	FP7
32	EUNICE	285688	FP7-2011-GC-ELECTROCHEMICAL-STORAGE	FP7
33	FASHION-ABLE	284871	FP7-2011-NMP-ICT-FoF	FP7
34	FESCOLA	505281	FP6-2002-NMP-1	FP6
35	FIBRE+	315633	FP7-SME-2012	FP7
36	FIT4U	229336	FP7-NMP-2008-SME-2	FP7
37	FOFDATION	260137	FP7-2010-NMP-ICT-FoF	FP7
38	FURNITREUSE	262337	FP7-SME-2010-1	FP7
39	G.EN.ESI	280371	FP7-NMP-2011-SMALL-5	FP7
40	GLAMURS	613420	FP7-SSH-2013-1	FP7
41	GREENECONET	603939	FP7-ENV-2013-one-stage	FP7
42	GREENELEC	296127	ENIAC-2011-1	FP7
43	GREENET	269122	FP7-PEOPLE-2010-IRSES	FP7
44	H-HOUSE	608893	FP7-2013-NMP-ENV-EeB	FP7
45	HVRCFM	296722	SP1-JTI-CS-2011-01	FP7
46	HYDROWEEE	231962	FP7-SME-2008-1	FP7
47	ILLUMINATE	603667	FP7-ENV-2013-two-stage	FP7
48	IMAGINE	285132	FP7-2011-NMP-ICT-FoF	FP7
49	INCONTEXT	265191	FP7-ENV-2010	FP7

50	INNOBITE	308465	FP7-ENV-2012-two-stage	FP7
51	INNOVATION FOR BEECH	508137	FP6-2002-SME-1	FP6
52	IRCOW	265212	FP7-ENV-2010	FP7
53	LCA TO GO	265096	FP7-ENV-2010	FP7
54	LCE4ROADS	605748	FP7-SST-2013-RTD-1	FP7
55	LIMOWOOD	314294	FP7-SME-2012	FP7
56	LINKEDDESIGN	284613	FP7-2011-NMP-ICT-FoF	FP7
57	LIVING LAB	212498	FP7-INFRASTRUCTURES-2007-1	FP7
58	MINEPEP	623744	FP7-PEOPLE-2013-IOF	FP7
59	MSEE	284860	FP7-2011-NMP-ICT-FoF	FP7
60	MYECOCOST	308530	FP7-ENV-2012-two-stage	FP7
61	OPEN-BIO	613677	FP7-KBBE-2013-7-single-stage	FP7
62	OPEN GARMENTS	213461	FP7-NMP-2007-SME-1	FP7
63	OPEN HOUSE	244130	FP7-ENV-2009-1	FP7
64	OSIRYS	609067	FP7-2013-NMP-ENV-EeB	FP7
65	PERFORMWOOD	319132	FP7-NMP-2012-CSA-6	FP7
66	PERSUADE	226313	FP7-ENV-2008-1	FP7
67	PHBOTTLE	280831	FP7-NMP-2011-SMALL-5	FP7
68	POLFREE	308371	FP7-ENV-2012-one-stage	FP7
69	POPP	212236	FP7-ENV-2007-1	FP7
70	PREMANUS	285541	FP7-2011-NMP-ICT-FoF	FP7
71	PRESTO	217429	FP7-SME-2007-3	FP7
72	PRIME	243409	FP7-SME-2008-2	FP7
73	PROSECO	609143	FP7-2013-NMP-ICT-FOF(RTD)	FP7
74	PROSUMER.NET	266970	FP7-NMP-2010-CSA-4	FP7
75	PSIE	29529	FP6-2005-MOBILITY-4	FP6

76	REBORN	609223	FP7-2013-NMP-ICT-FOF(RTD)	FP7
77	RECLAIM	309620	FP7-NMP-2012-SME-6	FP7
78	RECYVAL-NANO	310312	FP7-NMP-2012-SME-6	FP7
79	REECOVER	603564	FP7-ENV-2013-two-stage	FP7
80	REFFIBRE	604187	FP7-NMP-2013-SMALL-7	FP7
81	REFINE	289253	FP7-PEOPLE-2011-ITN	FP7
82	REMANENCE	310240	FP7-NMP-2012-SME-6	FP7
83	RELCD	508212	FP6-2002-SME-1	FP6
84	RESCOM	603843	FP7-ENV-2013-two-stage	FP7
85	RISKCYCLE	226552	FP7-ENV-2008-1	FP7
86	ROK-FOR	245437	FP7-REGIONS-2009-1	FP7
87	S_LIFE	285811	FP7-REGIONS-2011-1	FP7
88	S-MC-S	260090	FP7-2010-NMP-ICT-FoF	FP7
89	SCOPE2	44256	FP6-2005-SSP-5-A	FP6
90	SEES	506075	FP6-2002-TRANSPORT-1	FP6
91	SEMEAI	509911	FP6-2002-MOBILITY-6	FP6
92	SENTRY	632487	SP1-JTI-CS-2013-02	FP7
93	SMART	286465	FP7-SME-2011	FP7
94	SMARTPRODUCTS	231204	FP7-ICT-2007-3	FP7
95	SOPHIED	505899	FP6-2002-NMP-2	FP6
96	SORT IT	211888	FP7-ENV-2007-1	FP7
97	STAR CITY	516617	FP6-2002-MOBILITY-4	FP6
98	SUN	604305	FP7-NMP-2013-LARGE-7	FP7
99	SUPERBUILDINGS	244087	FP7-ENV-2009-1	FP7
100	SURETE	20888	FP6-2004-MOBILITY-2	FP6
101	SUS-CON	285463	FP7-2011-NMP-ENV-ENERGY-ICT-EeB	FP7

102	SUSTA-SMART	319055	FP7-NMP-2012-CSA-6	FP7
103	SUSTAIN-MS	237136	FP7-PEOPLE-IEF-2008	FP7
104	SUSTAINCOMP	214660	FP7-NMP-2007-LARGE-1	FP7
105	SUSTAINHUB	283130	FP7-ENV-2011-ECO-INNOVATION-TwoStage	FP7
106	SUSTAINVALUE	262931	FP7-NMP-2010-SMALL-4	FP7
107	T-REX	609005	FP7-2013-NMP-ICT-FOF(RTD)	FP7
108	TOP-REF	604140	FP7-NMP-2013-SMALL-7	FP7
109	TYGRE	226549	FP7-ENV-2008-1	FP7
110	WASTE PREVENTION	254835	FP7-PEOPLE-2009-IIF	FP7
111	WISE	45669	FP6-2006-MOBILITY-4	FP6
112	ZEROWIN	226752	FP7-ENV-2008-1	FP7

Structured project information can be found on the CORDIS website.

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The circular economy is a concept that not only can help us reach climate neutrality and reduce environmental burden, but also support European economy to be innovative and competitive. This report presents the findings from more than one hundred EU-funded research and innovation projects, highlighting product circularity ideas related to design, manufacturing, use and afteruse.

Nine independent experts identified key lessons for policy makers with regard to possible future research and policy action.

These findings may help in the implementation of the second Circular Economy Action Plan, which develops a vision for an innovative circular material policy in the context of the ambitious climate mitigation objectives of the European Green Deal, and which has a landmark concept for a sustainable product policy framework at its heart.

Studies and reports

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