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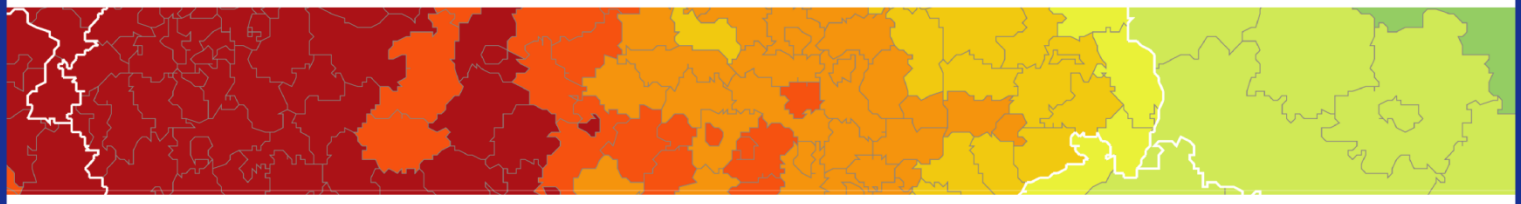

CIRCTER – Circular Economy and Territorial Consequences

Applied Research

Synthesis Report

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Table of contents

List of Figures

List of Maps

Abbreviations

B2B	business-to-business
B2C	Business to Consumer
C2C	Consumer to Consumer
CBM	Circular Business Model
CDC	Caisse des dépôts et consignations
CE	Circular Economy
CEAP	Circular Economy Action Plan
CER	European Remanufacturing Council
CLD	Causal Loop Diagram
DE	Domestic Extraction
DMC	Domestic Material Consumption
DMI	Direct Material Input
EC	European Commission
EEA	European Environmental Agency
EFTA	European Free Trade Area
EMAS	Eco-management and Audit Scheme
EPR	Extended Producer Responsibility
ERDF	European Regional Development Fund
ESF	European Social Funds
ESPON	European Territorial Observatory Network
EU	European Union
GFCF	Gross Fixed Capital Formation
GDP	Gross Domestic Product
GPP	Green Public Procurement
GVA	Gross Value Added
GWR	Geographically Weighted Regression
JRC	Joint Research Centre
IS	Industrial Symbiosis
LMM	Last Minute Market
MBT	Mechanical-Biological Treatment
MFA	Material Flow Analysis
MS	Member States
MSW	Municipal Solid Waste
NACE	Nomenclature of Economic Activities
NUTS	Nomenclature of Territorial Units for Statistics
OLS	Ordinary Least Squares/Linear Regression
OVAM	Public Waste Agency of Flanders
P2B	Peer-to-business
P2P	Peer-to-peer
PPP	Purchasing Power Parity
RIS3	Regional Innovation Strategies for Smart Specialisation
RMC	Raw Material Consumption
RMI	Raw Material Input
ResCoM	Resource Conservative Manufacturing
SME	Small and Medium Enterprises
ToR	Terms of Reference
WEEE	Waste from Electrical and Electronic Equipment

Key policy messages from the CIRCTER project

The circular economy is a *necessary* sustainable development strategy that has a great potential to reduce environmental harm, increase material and energy efficiency and create new opportunities for businesses and communities. The circular economy is relevant for all types of territories, but it is materialised in very different ways depending on local conditions.

Agglomeration economies are a very relevant territorial factor driving circular economies. **Urban agglomerations** enable the diffusion of product-service-systems and sharing economies; economies of scale enable the recovery of significant volumes of low-value materials from waste streams; cities also seem better placed to attract companies developing innovative technologies and circular business models. Tendencies towards the geographical concentration of certain circular economy activities are likely to occur. Cohesion policies should articulate measures to prevent circular innovations from increasing territorial disparities.

For **rural regions** a big prospect clearly lays in the circular bioeconomy. The bioeconomy has the potential to foster the economic development of rural areas by opening up new opportunities for the agricultural and forestry sectors (e.g. food processing, bio-based industries, bioenergy). From a territorial cohesion perspective this transformation could yield better results if implemented in a decentralised way. However, there are uncertainties related to sustainability considerations that need to be properly addressed. Further research is needed to clarify these aspects.

Industrial areas are the only possible setting for several circular economy strategies, ranging from industrial symbiosis schemes to product remanufacturing. These are more likely to spring in territories where a diverse industrial ecosystem is already in place (industrial symbiosis) or where the products are originally manufactured (remanufacture). Industrial regions in decline may also find opportunities in the emerging markets of secondary raw materials thanks to the availability of industrial plots, old factories and other facilities that could host circular processes, including material storage and transformation/recovery.

Responsible **resource management** is essential to enable a circular economy. Regions and cities have a fundamental role in contributing to an *effective* recovery of all materials that are consumed locally. Policy incentives and financial support from the European Union will increase in the years to come. These should meet with ambitious regional and local plans focused on waste prevention via reduced consumption and a new *material hierarchy*: reuse, repair, refurbish, repurpose, remanufacture and, finally, recycling and composting. Biological feedstocks should be used in *cascades*. Incineration should be avoided as far as possible, particularly in those territories where incineration facilities are not already in place.

In the **Future Cohesion Policy** should support circular economy potentials by investing in transformative projects going well beyond compliance with existing regulations. The focus should be on *waste prevention* and *responsible resource management*. Cohesion Policy funds directed at SMEs should be aligned with the circular economy objectives. A systemic shift throughout the value chain should be at the heart of circular strategies. Behavioural change should be promoted as a fundamental strategy for closing material loops. The principles of the EU Strategy on circular economy should be integrated with the **Territorial Agenda post-2020**.

1 A territorial definition of a circular economy

The 'take-make-dispose' model that characterises the linear economy has driven the economic system well beyond the coping capacity of our planet (Steffen et al., 2015). In order to reduce the impact of economic activities on global ecosystems, a circular economy needs to be adopted. A circular economy significantly reduces material throughputs and increases material efficiency over the long run. In doing so, a circular economy offers new possibilities for businesses and communities to create economic (e.g. new business opportunities) and social (e.g. new jobs) value.

The circular economy idea is rooted on old industrial ecology concepts and approaches. Presently, there is no single and universally accepted characterization of a circular economy. A wide-spread definition is the one proposed by the Ellen MacArthur Foundation, which defines the circular economy as an *industrial system that is restorative and regenerative by intention and design* (Ellen MacArthur Foundation, 2015). The European Commission has defined it as: (1) an *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" (EC, 2015).

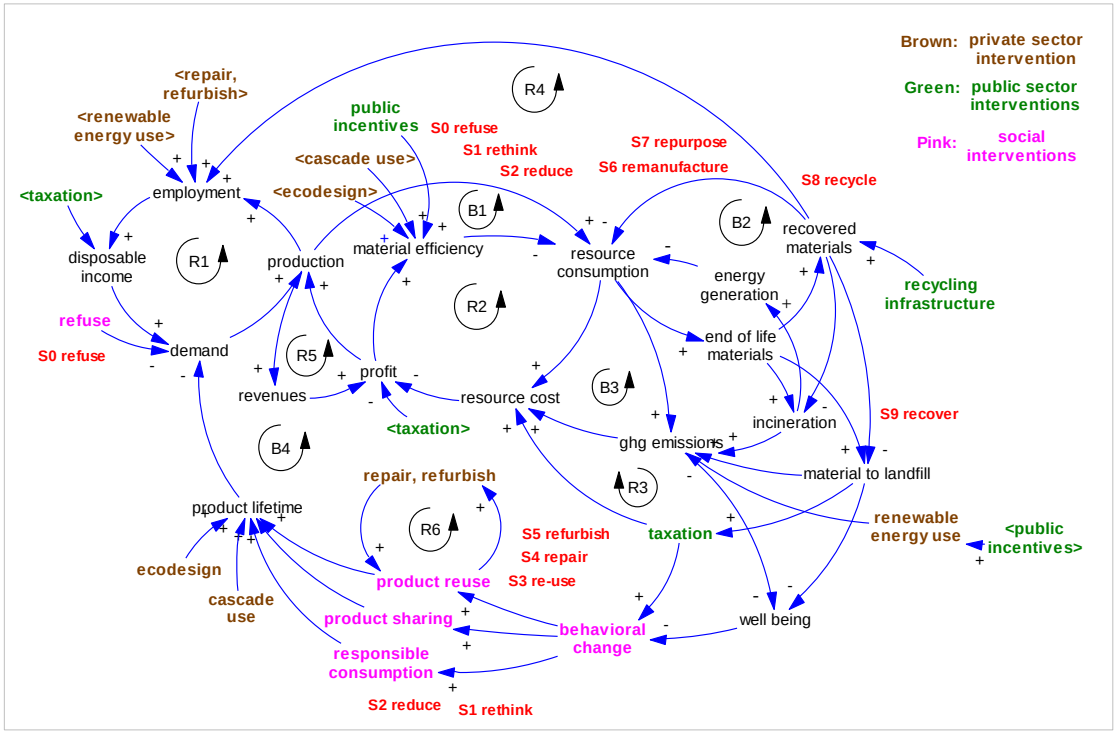
If anything, the systemic dimension of a circular economy is the single element emphasized in most definitions. The Circular Economy Communication stresses that transitioning to a circular economy requires "full systemic change", implying "changes throughout value chains, from product design to new business and market models, from new ways of turning waste into a resource to new modes of consumer behaviour", and "innovation not only in technologies, but also in organisation, society, finance methods and policies" (EC, 2014). These changes can be structured around an number of circular economic strategies that the Netherlands Environmental Agency (PBL) proposes to classify in ten relevant *R-strategies*, including: (0) Refuse, (1) Rethink, (2) Reduce, (3) Reuse, (4) Repair, (5) Refurbish, (6) Remanufacture, (7) Repurpose, (8) Recycling, (9) energy Recovery (Potting et al., 2017).

1.1 A system's analysis of the circular economy

In the CIRCTER project we have explored the systemic component of the circular economy by making use of a Causal Loop Diagram (CLD), or System Map (see Figure 1.1). The CLD indicates that the historical growth of disposable income has led to growing demand and production. There are two consequences of this trend: (1) an increase in employment, which leads to the creation of disposable income and more demand (creating a reinforcing loop, R1), and (2) the increase of resource consumption. Higher resource use has led to three main outcomes (a) more waste generation, (b) higher emissions and (c) growing production costs. These three outcomes create balancing feedback loops (B1, B3) that contrast the initial reinforcing loop. In other words, linear economic growth leads to the emergence of side effects. Specifically, (a) more waste generation leads to higher accumulation into the landfill or incineration, and (b)

higher emissions and human health impacts; (c) growing use of resources leads to higher resource and production costs, which negatively affects profits and the potential expand production, hence limiting the growth triggered by the first reinforcing loop.

Figure 1.1: Detailed integrated Causal Loop Diagram (CLD) of a Circular Economy



Source: own elaboration

The introduction of circular economy interventions has several consequences on the behaviour of the system. First, investments in waste management systems (e.g. new recycling infrastructure) can reduce the accumulation of waste in the landfill and incineration, reducing resource consumption and the cost of production, as well as emissions (B2). However, further recycling leads to employment creation as well as to (possibly) higher profits (R4 and R5), both of which create income and lead to more demand and production and hence resource use. As a result, the environmental effectiveness of isolated recycling policies may be challenged by its positive economic impacts due to potential 'rebound effects'[1].

Recycling could be coupled with interventions that aim at preventing waste in the first place, increasing material efficiency, such as public incentives as well as private investments in ecodesign and 'cascade use'[2] (B1, R2 and R5). Similarly, emissions could be curbed through the

[1] Rebound effects are a process by which, when efficiency improvements (in this case increased recycling) cause the price of assets to fall, demand of those assets tend to increase, offsetting the positive effects of efficiency improvements. They were first described in the 19th Century by W.S. Jevon (Polimeni & Polimeni, 2006).

[2] Cascade use refers to the efficient utilisation of resources by using residues and recycled materials sequentially to extend total biomass availability within a given system (Vis et al. 2016).

introduction of incentives, and investments in renewable energy. Still, as indicated earlier these interventions reduce costs and increase profits, creating space for expanding production and consumption and further rebound effects.

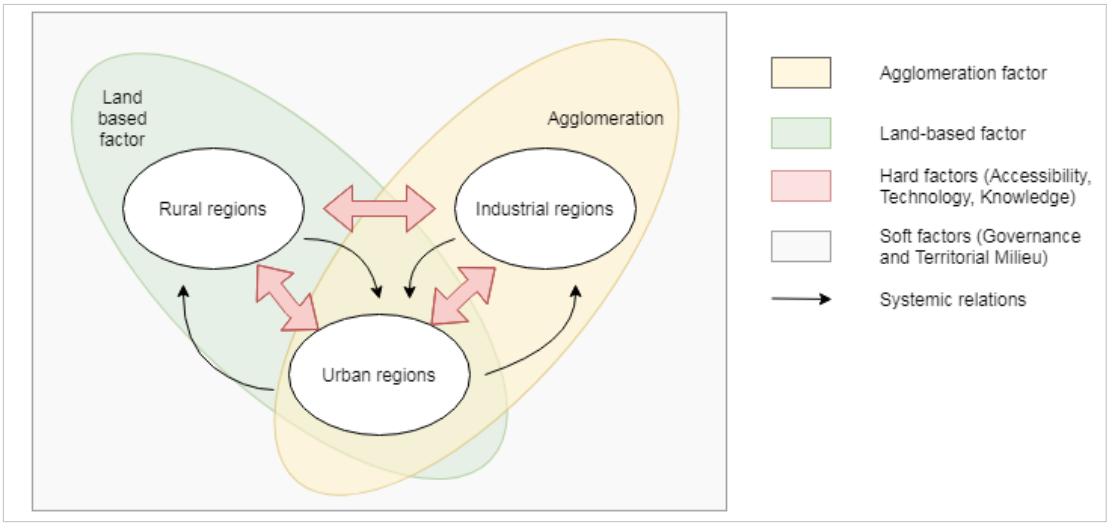
An even more effective synergy is found when demand-side interventions are implemented in conjunction with supply-side policies and investments. The higher effectiveness is depicted by the fact that a strong balancing loop is introduced (B4) with demand-side interventions. Specifically, if taxation, repair, refurbish and remanufacturing are introduced, behavioural change emerges for product reuse, product sharing and responsible consumption. These three factors lead to longer product lifetime, which can also be impacted by eco-design and cascade use, interventions implemented by the private sector. With a longer lifetime of products demand declines, the same effect that can be expected from refuse of consumption, and hence production will not grow as fast, or even decline. In other words, behavioural change stands-out as a key factor minimising rebound effects in the long run.

The simultaneous implementation of demand- and supply-side interventions will lead to a complete shift in the dynamics of the system. In fact, a circular economy is one that strives even if there is no growth in consumption and production, due to material efficiency and the recycling and reuse of materials, as well as products. In this scenario waste landfilling and emissions would decline, as would health impacts, leading to lower taxation and improved well-being.

1.2 Territorial factors affecting the circular economy

In CIRCTER we have identified and analysed seven territorial factors conditioning progress to a circular economy. These include: (1) land-based resources, (2) agglomeration economies, (3) accessibility conditions, (4) knowledge- and (5) technology-based enablers, (6) governance and institutional drivers, and (7) territorial milieus (see Figure 1.2).

Figure 1.2: Territorial factors and their interactions in different types of regions



Source: own elaboration

Land-based factors clearly emphasise the significance of natural endowment to satisfy the growing demand of biomass feedstock in a circular bioeconomy. The bioeconomy has the potential to boost local economies in **rural regions**. However, there are uncertainties related to trade-offs between different sectors and deep sustainability considerations that need to be properly addressed. The relation between competing land functions is complex and policies should address and balance specific land requirements taking into account trade-offs and potential rebound effects. Further research is needed to clarify these aspects.

Agglomeration factors provide circular businesses with the necessary access to resources, knowledge and collaboration as well as a viable demand for circular products and services. **Urban agglomerations** ensure the necessary 'critical mass' to e.g. enable low-value material recovery, as well as to develop collaborative schemes and community-based initiatives for the implementation of circular business models. On a different level, **industrial agglomerations** create the right conditions (e.g. in terms of accessibility and diversity) for circular economy planning based on e.g. on industrial symbiosis programmes. Inertia towards the geographical concentration of certain circular economy activities is likely to occur (Farole et al., 2011).

Accessibility and connectivity play a role in the transition to a circular economy, particularly when considered together with agglomeration factors. High accessibility is especially important for new collaborative economic models such as sharing economies. It is also a factor when industrial symbiosis ecosystems are established. Reuse and repair are directly dependent on the accessibility to the services. As a result, those areas located close to transportation hubs, like airports, ports, railway stations, and/or having in place effective intermodal transportation systems and logistic hubs are clearly advantaged when it comes to e.g. implementing the reverse logistics and take-back programmes needed to recover products and materials. Future spatial plans and planning schemes should plan logistic spaces to go beyond traditional linear flows and account for inverse flows and reverse logistics.

Technologies may enable the implementation of circular economy processes not only along the value chain (e.g. cleaner production and eco-design), but also by unlocking the market for secondary low-value material streams. Gains in resource efficiency and better recycling are also possible due to improved technologies. Remanufacturing is also dependent on technological improvements. Technology development can be leveraged and supported by means of funded research and innovation tools, such as H2020 program and relevant public-private partnerships. Local and regional stakeholders should make efforts to connect their local innovation ecosystems to those initiatives.

The installed **knowledge-base** and **awareness** are equally relevant at business, institutional and community levels. Collaboration between companies throughout the entire value creation chain enables a shared use of resources and boosts innovative capacity. Together with knowledge promotion among private actors, critical knowledge among citizens is fundamental for the operationalisation of circular transitions. Based on extensive communication strategies,

clarity over circular products and services, and a set of transparent and exhaustive quality criteria for products, consumers can be further integrated in the circular business strategy development.

Governance and institutional factors, together with **territorial milieus**[3], act as transversal forces that facilitate and create the necessary conditions for circular economy transitions to materialise. These not only promote circular economy principles, but also favour the establishment of other territorial factors, such as better accessibility, knowledge diffusion and new technology development (for instance through green procurement, incentives, etc…).

In a nutshell, whereas agglomeration and land-based factors contribute to determine the *framework conditions* of circular transformations at the regional and local levels, the 'hard' territorial factors (accessibility and technologies) contribute to define the *effectiveness* of circular economy strategies, and the 'soft' factors (knowledge, awareness, governance and milieus) contribute to *catalyse* the transformation.

2 Monitoring a circular economy at sub-national levels

So far there is not a generally accepted set of indicators for measuring the progress toward the transition. Only recently the European Commission (EC) published a first attempt to provide a Monitoring Framework for a circular economy (EC, 2018). Some Member States have their own frameworks. Among these, perhaps the most mature is the one developed in the Netherlands (Potting et al., 2018). Most frameworks build on a subset of headline indicators focused on material inputs and waste management. Albeit recognising the relevance of other aspects that contribute to a circular economy, such as new business models, governance and behavioural aspects, the available frameworks still do not provide usable information on these issues.

In the CIRCTER project we cover both dimensions by, first, providing regional data on the core material and waste indicators available from the Eurostat system. These data are regionalised from NUTS-0 down to the NUTS-2 level using a combination of econometric techniques. Second, we provide a sectoral characterization of regional circular economies, considering also Circular Business Models (CBM). This analysis relies on a set of newly developed indicators produced following a bottom-up analysis combining various methods and databases.

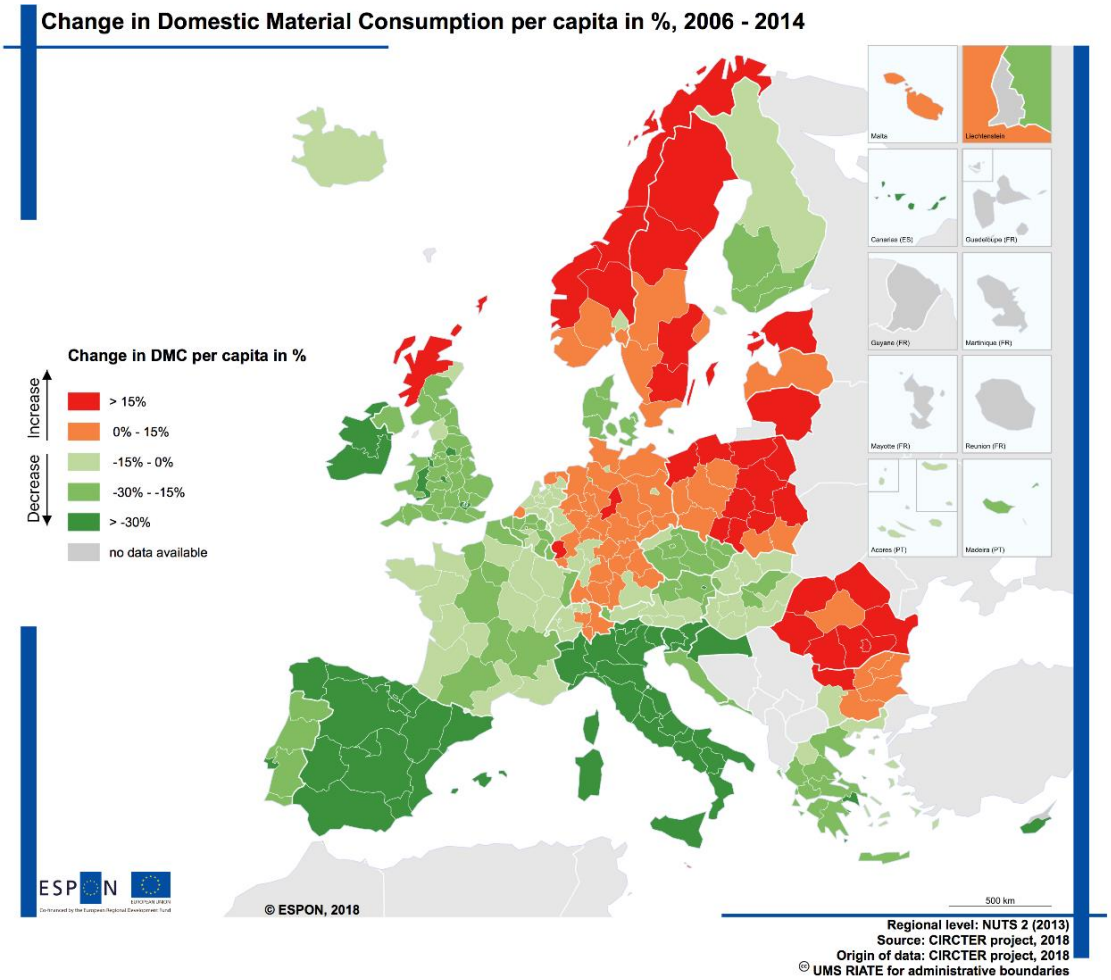
2.1 Material and waste patterns and flows

The headline indicator available from Eurostat to track **Domestic Material Consumption** (DMC), is calculated by means of simplified mass balances. This implies that the indicator only

[3] Territorial milieus can be defined as the inter-personal and inter-firm networks formed in a limited geographical area as a result of the information and knowledge flowing through trustworthy and repetitive interactions (Maillat, 1995)

accounts for the *actual* mass of imported and exported goods. The resources that are used *upstream* to produce imported goods (*hidden flows*) are not considered in the calculation of the indicator.

*Map 2.1: Change in Domestic Material Consumption (DMC) per capita in precentage, 2006-2014**



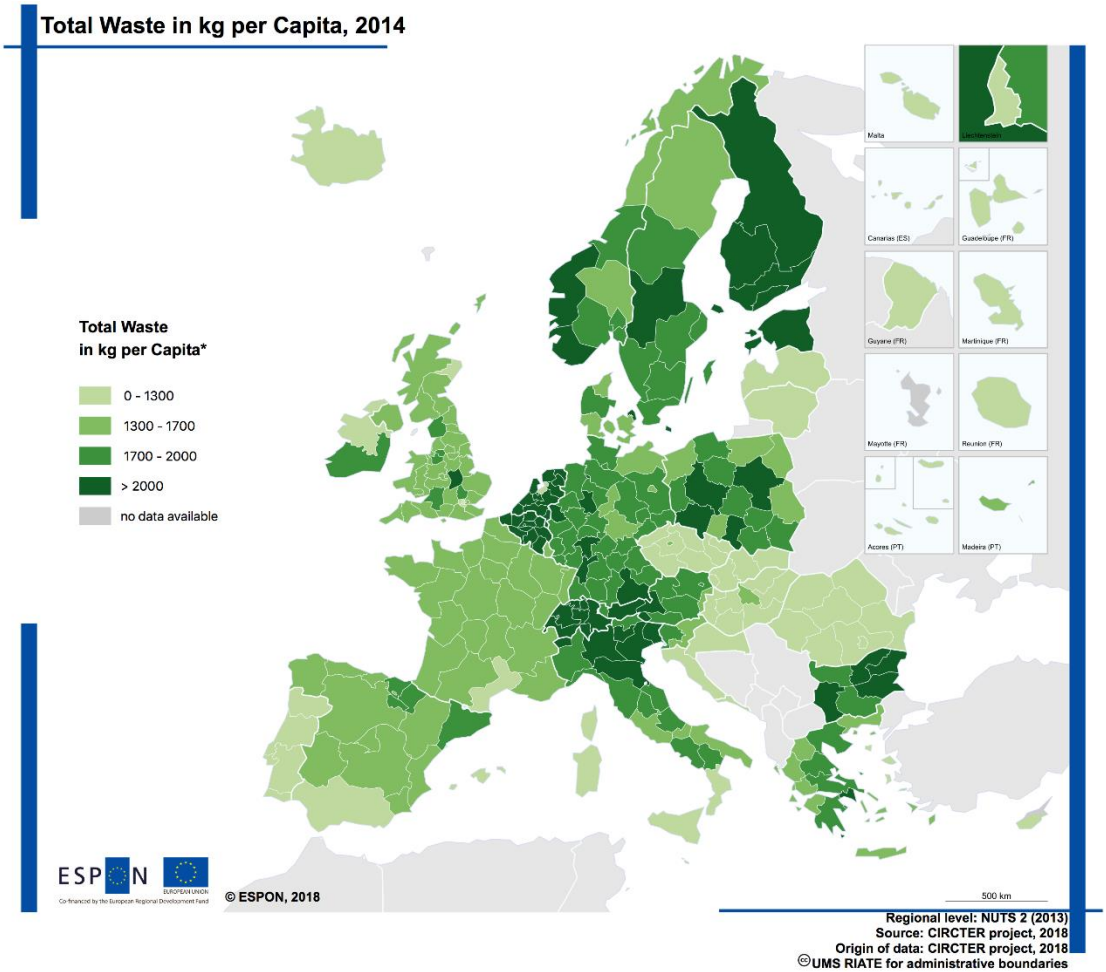
** The data presented on this map base on regional estimates produced by the CIRCTER project. The expected accuracy of the estimated values is **high** (see Annex 2, Sec. A2.5.3 for details)*

Two factors seem to determine material consumption per capita, namely the use of local natural resources, e.g. through forestry, mining and construction, as well as population density. In less densely populated regions, the necessary materials for buildings or infrastructure are distributed among significantly fewer people, so that material consumption per capita increases. Northern and Eastern European regions tend to show higher material consumption per capita than Southern and Western regions. The change in the DMC per capita between 2006 and 2014 shows a link between material consumption and general economic dynamics. Regions with the strongest declines in material consumption between 2006 and 2014 are also those hit hardest by the global economic crisis in 2008-2013 (see Map 2.1).

Regular statistics on **waste generation and treatment** are hampered by data comparability across countries and also within individual countries over time. To some extent, this lack of

statistical coherence is a consequence of a policy incentive that has been so far oriented towards diversion of waste from landfill, mostly based on waste shipments, rather than enabling effective re-use of materials (Gregson et al., 2015). Hence, national patterns seem to play a role in influencing per capita generation of total waste at regional level.

Map 2.2: Total Waste (excluding major mineral waste) in kg per capita



** The data presented on this map base on regional estimates produced by the CIRCTER project. The expected accuracy of the estimated values is **low** (see Annex 2, Sec. A2.5.3 for details)*

The amount of total waste excluding major mineral waste is strongly driven by per capita income. Regions with high per capita income tend to generate higher amounts of total waste excluding major mineral waste. Along these lines, urban regions tend to generate higher quantities of total waste than rural regions (see Map 2.2). Looking at the different waste categories that determine total waste, the differences are mainly defined by household and food waste. In urban regions, the collection infrastructure may simply be better developed, allowing more waste to be collected and treated (and hence classified and recorded for statistical purposes), thus explaining the higher values of food waste and household waste on per capita basis.

2.2 A sectoral characterization of regional circular economies

Looking beyond the linear take-make-dispose model entails a genuine shift in perspective towards the use of sustainable raw materials and closed material loops by recycling and reusing products and materials. This implies finding novel ways of measuring, aggregating and analysing such economic activities from a supply-side and demand-side of the economy. In CIRCTER, the **supply-side** is defined as the provision of materials, technologies and services for a circular economy. It is represented by the *Circular Economy Material Providers*, *Circular Economy Technology Providers* and *Circular Business Models*. The **demand-side** is defined as selected industries that adopt or rather demand new circular business processes, products and technologies that drive their uptake. These are referred to as *Potential Users*.

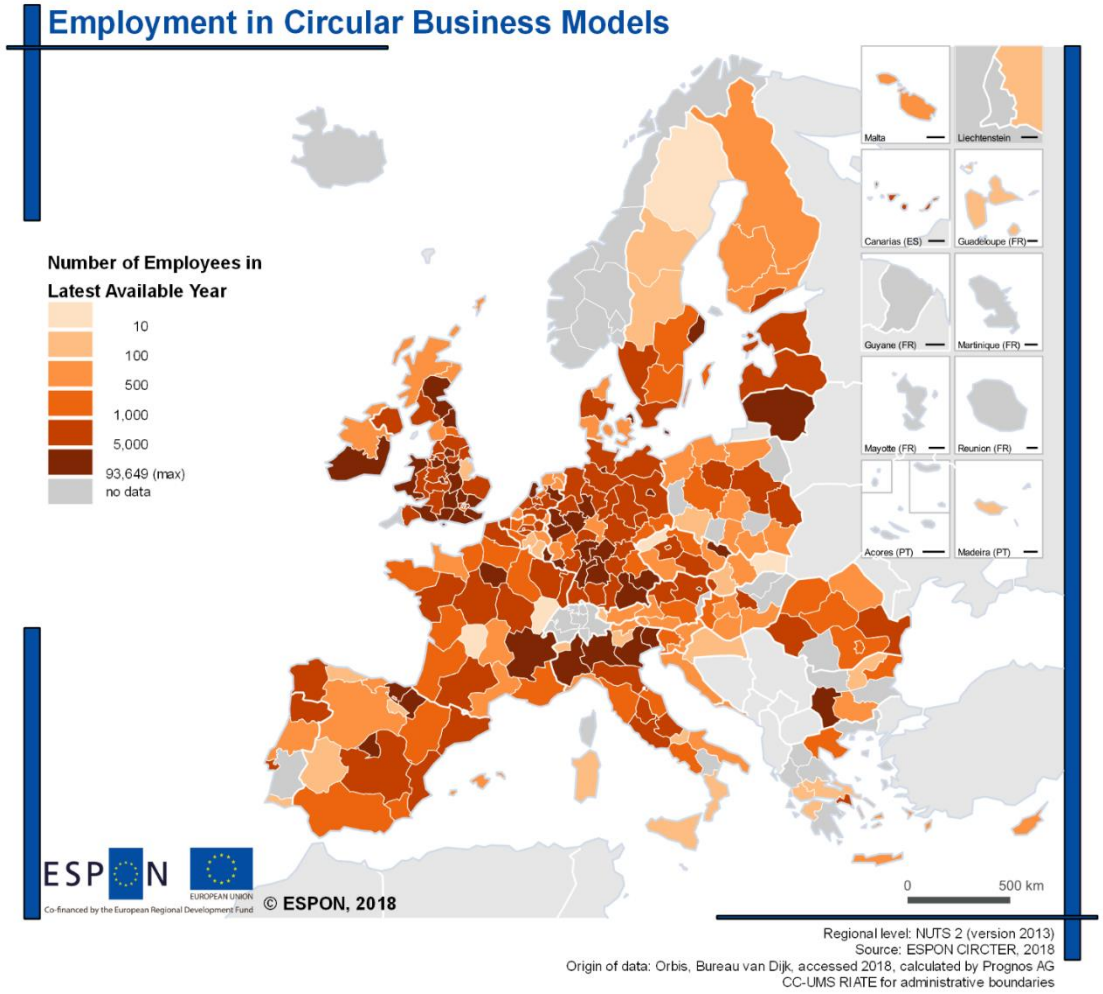
Circular Economy Material Providers comprise economic activities supplying renewable and re-cycled materials. ***Circular Economy Technology Providers*** offer technologies and key services that enable cyclical resource flows and more efficient use of materials. Measured in terms of employment, nearly 4 percent of the total economy across Europe is already engaged in these circular economy activities alone, which **make up almost 5.8 million employed persons and generate a turnover of nearly a trillion Euros in 2015 (940 billion Euros).** In three regions *Circular Economy Material* and *Technology Providers* even make up more than 10 percent of the regional employment. At the European level *Circular Economy Material* and *Technology Providers* sectors are showing a growth rate equivalent or higher than the total economy.

Their territorial and sectoral distribution varies across regions. *Circular Economy Material Providers* play a particularly predominant role in rural regions, not least due to the dominant role of agricultural and forestry activities. Another relevant sector is waste collection and recycling services, which also plays a relevant role across most regions. *Circular Economy Technology Providers* are more concentrated in urban regions. Several regions show a relatively high degree of specialisation in the repair of fabricated metal products, machinery and equipment. Across many states and regions employment in *Circular Economy Material* and *Technology Providers* is growing, but not in all.

Transitioning from a linear economy towards a circular economy requires not only a shift in the materials used and technologies provided, but also a systemic change in the way materials, components and products are offered and consumed. **Circular Business Models (CBM)** facilitate the up-take of circular processes through innovative services and new forms of consumption by connecting businesses to businesses (B2B), businesses to consumers (B2C) and consumers to consumers (C2C).

According to our analysis, **circular business strategies and CBMs are responsible for EUR 266 Billion in turnover and EUR 1 Million jobs** across Europe. The implementation and diffusion of Circular Business Models is favoured by agglomerations (both industrial and urban), knowledge hubs and established territorial milieus. This fully confirms the territorial definition provided above.

Map 2.3: Number of persons employed in companies associated with Circular Economy Business Models (CBM)



3 Evidence from the CIRCTER case studies

The six case studies conducted in CIRCTER represent very different types of territories, geographical and historical contexts. Our case studies include:

- Scotland - The circular economy strategy “Making Things Last”
- Maribor - The WCYCLE strategy
- Brussels Regional Plan for a Circular Economy 2016-2020
- Basque Country circular economy initiatives
- Sicily - Industrial symbiosis
- Central Germany - The Bioeconomy Cluster

These cases exemplify a wide range of motivations and approaches to transform the way we produce and consume and illustrate diverse leadership and governance, ranging from single to collaborative leadership, as well as various forms of public-private collaboration. The evidence from the CIRCTER case studies fully confirm the insights gained from the top-down analyses:

- Achieving a **critical mass** is fundamental in the initiatives that take place at smaller geographical scales, such as the WCYCLE strategy in Maribor, the Brussels Regional Plan for a Circular Economy, the circular economy initiatives in the Basque Country and the Industrial symbiosis project in Sicily.
- All the case studies recognise the relevance of **knowledge factors** and networks as crucial to drive local circular economies at lower territorial levels. Softer knowledge factors seem to be more important than hard technologies for circular transformations.
- **Political vision** and commitment to engage with a wide array of actors, including the academic sector, are key governance factors stressed in all the case studies.
- **Place-based policy approaches** that take account of the installed capacities within each territory, together with inclusive and participatory policy design and implementation processes, are crucial to unlock territorial potentials for a circular economy.
- **Incremental work**: The existence of previous studies such as urban metabolism study in Brussels, the circular economy diagnosis in the Basque Country, the new method to analyse and measure waste reductions in Scotland or the background assessment (of local industries, related material flows and waste generation and costs) in Sicily provide a good evidence base to shape and implement fit-to-purpose measures.

4 Designing place-sensitive policies for a circular economy

4.1 A complex policy landscape

The circular economy has been organically fostered upon the earlier resource efficiency related policy developments, namely Europe's **Roadmap to a Resource Efficient Europe (EC, 2011).** The **EU Circular Economy Action Plan** (CEAP) adopted in December 2015, provides the backbone of **Europe's Circular Economy Package**. The CEAP is structured around a production and a consumption section. It outlines a series of measures and actions which aim to "stimulate Europe's transition towards a circular economy which will boost global competitiveness, foster sustainable economic growth and generate new jobs" (EC, 2015). Importantly, the CEAP underlines that **"local, regional and national authorities are enabling the transition".**

Policy actions to facilitate transition towards circular economy have also been taken by selected regions and cities. Some have already adopted their circular economy strategies (e.g. Scottaland or Brussels); others have introduced the circular economy narratives in their sectoral policies (e.g. Basque Country, Venlo/Limburg, Lazio, Kalundborg), as well as in the Smart Specialisation strategies (e.g. Wallonia, Kymenlaakso, etc). **Regional Innovation Strategies for Smart Specialisation (RIS3)** provide a very good opportunity for integrating circular economy in the regional policy landscape.

4.2 Policy recommendations for different types of regions and cities

From a policy perspective, a circular economy is relevant for all types of territories. Still, it is implemented in different ways depending on local conditions:

Cities are particularly well-placed to embark on **innovative waste management** initiatives. Certain material loops (and associated policy actions) are best addressed on urban level. These include household and food waste or heavy and low-value materials such as construction and demolition waste. Substantial opportunities for 'leapfrogging' exist in those areas without incineration infrastructures, which should be avoided as far as possible. As cities accumulate positive factors of viable market demand, including accessibility, agglomeration factors and a sense of community, urban regions are also best placed to engage in various forms of **collaborative economies** and circular economy business models extending products' life cycles. These opportunities can be capitalised by adopting a systemic approach to assess and implement their real potentials. Strategies should adopt a consumption perspective and introduce specific measures promoting behavioural-change to avert potential environmental rebound effects.

Rural regions are in the position to explore the opportunities presented by the **bioeconomy**, in all its variations. The bioeconomy has the potential to foster the economic development of rural areas by opening up new opportunities for the agricultural and forestry sectors (e.g. food processing, bio-based industries, bioenergy). But this requires increased and focused investment in skills, knowledge, innovation and new business models, as well as cautious evaluation of the alternatives to avoid rebound effects. Regional bioeconomy strategies can contribute to identifying priority resources for the territories and settle conflict of usage (e.g. competition between food crops and energy/biochemical crops), promoting a genuine shift towards sustainable bioeconomies.

Industrial areas, particularly those in transition and deindustrialisation should focus on circular industrial strategies, ranging from industrial symbiosis schemes to product remanufacturing. Regions and cities can contribute to reduce legal and administrative barriers for the **remanufacturing** of consumption and capital goods, including industrial equipment. They can also play an important role in the creation of good business environments, simplifying access to credit by companies in these sectors. Similarly, economic and regulatory instruments introduced by regional and local authorities can directly and indirectly drive **industrial symbiosis** through ad-hoc programmes and interventions. **Industrial regions in decline** may also find opportunities in the emerging markets of secondary raw materials thanks to the availability of industrial plots, old factories and other facilities that could host circular processes.

4.3 Enhanced territorial policies for a place-sensitive circular economy

Territorial policies should articulate measures to prevent circular innovations from increasing territorial disparities.

Cohesion policy in the 2021-2027 Programming Period: The Post-2020 Cohesion Policy should contribute to keep the momentum and concretise the CEAP by investing in transformative projects going well beyond compliance with existing regulations. During the programming process, circular economy should be well-integrated in Partnership Agreements and Operational Programmes. Project selection could include criteria for assessing the 'circularity'. The approach could also be integrated into the RIS3 Strategies, when relevant.

Post-2020 Cohesion Policy should support a new approach on **resource management** founded upon a set of well-defined combination of circular economy strategies, including: reuse, repair, refurbish, repurpose, remanufacture and, finally, recycling and composting. **Waste prevention** should be the main strategic goal of regional and local waste management strategies, as no waste should be 'wasted'. Regions and cities should make any effort to ensure proper material recovery and de-incentivise all forms of burden-shifting through e.g. waste shipments to third countries lacking the required recycling facilities. There is a need for integrated waste management planning that goes beyond end-of-pipe solutions (Wilts & von Gries, 2015).

Availability of **funding** for the circular economy is a pre-condition for speeding up transition. Thematic concentration will require a special spending focus on Policy Objective 1 (Smarter Europe) and Policy Objective 2 (Greener, low-carbon Europe) that are relevant for the circular economy. European Regional Development Funds (ERDF) channelled to innovation should increasingly incorporate circular economy criteria. However, the uptake and mainstreaming of circular economy funding in other financial instruments and in the activity of private actors would provide an even more substantial leverage effect. This would require policy measures to develop an enabling environment for the deployment of private-to-private finance mechanisms, as well as a consistent set of fiscal incentives for firms implementing circular business models.

The Circular Economy and Territorial Agenda post-2020: At the heart of the Territorial Agenda is the notion of **territorial cohesion** and the recommendation to take the territorial specificities and local endowments into consideration in planning and policy processes. This is highly relevant also for the circular economy. The principles of **the EU Strategy on circular economy should be integrated with the post-2020 Territorial Agenda**. It should be recognised that regions and cities can develop circular economy strategies and planning taking into consideration agglomeration and land-based factors as well as knowledge and governance and territorial milieus. The roles of the regions as well as the impact and potentials of various territorial specificities in developing circular economy could be given even more attention.

5 Suggestion for future research

During the implementation of the CIRCTER Project a number of potential topics for future research have been identified. These can be grouped as follows:

Better metrics for a circular economy: The available metrics and monitoring systems have been designed for the characterization of traditional (i.e. linear) economic systems. The lack of

indicators for monitoring and reporting progress towards a circular economy can be a bottleneck for implementing circular economy strategies (The Circular Economy Partnership, 2018). A new generation of circular economy metrics is needed. These metrics should rest on an agreed and harmonised set of indicators for a comprehensive characterization of material and waste flows at all relevant territorial levels (including regions and cities). These should allow to quantify the actual *material footprint* of territories and elicit material flows between regions. Indicators monitoring circular economy strategies at all levels are also needed.

Deep impacts and long-term effects of circular transformations: Further investigation is needed to fully understand the potentially *disruptive effects of circular economy value chains*: Where are European cities and regions positioned in global value chains of circular materials and technologies and how can the different regions capture their value added, including cross-regional dynamics, are examples of topics requiring further research. Another relevant topic is the *potential contribution of a sustainable bioeconomy to territorial cohesion*. Aspects such as competition for land, market accessibility, availability of technologies and skills, alongside deep sustainability considerations regarding land use, ecosystem services and biodiversity impacts are understudied. These aspects need to be properly assessed and calibrated to fully capitalise on the opportunities provided by a sustainable bioeconomy in Europe.

Quantitative evaluation of policy effectiveness: The CIRCTER policy analysis has been mostly conducted on a qualitative level. A quantitative analysis based on numerical models could assess the impacts of specific policy interventions in selected locations. It could also unveil the extent to which policy coherence between regions contributes to generate synergies and validate the ramifications emerging from potential policy inconsistencies between areas.

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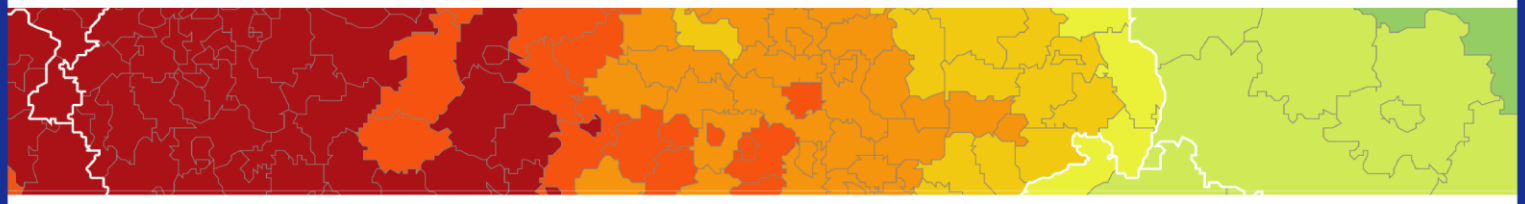

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