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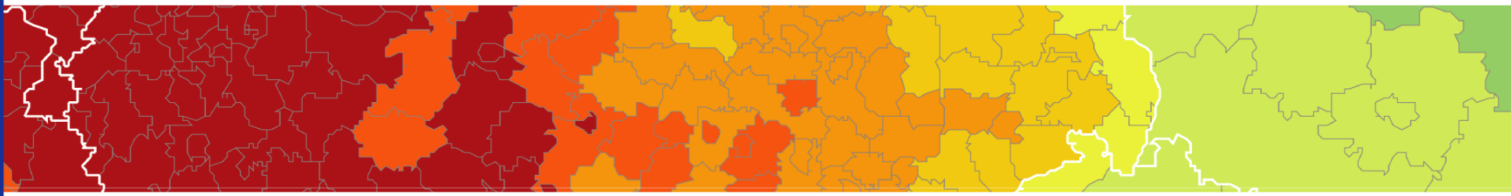
Inspire policy making by territorial evidence



# CIRCTER – Circular Economy and Territorial Consequences

Applied Research

**Final Report**

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**Final Report**

# CIRCTER – Circular Economy and Territorial Consequences

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# Abbreviations

| | |
|---|---|
| B2B | business-to-business |
| B2C | Business to Consumer |
| C2C | Consumer to Consumer |
| CBM | Circular Business Model |
| CDC | Caisse des dépôts et consignations |
| 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 |
| EMF | Ellen MacArthur Foundation |
| 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 |
| PPS | Purchasing Power Standards |
| 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**.

# Executive summary

## A territorial definition of the circular economy

The linear 'take-make-dispose' model has driven the economic system well beyond the coping capacity of our planet (Steffen et al., 2015). In order to reduce the impact of anthropic activities on global ecosystems, a circular economy needs to be implemented. A circular economy significantly reduces material throughputs[1] and increases material efficiency over the long run. In doing so, it offers new possibilities for businesses and communities to create economic (e.g. new business opportunities) and social (e.g. new jobs) value. The idea of a circular economy is rooted on old industrial ecology concepts and approaches.

Presently, there is no single and universally accepted characterization of a circular economy. A very wide-spread definition is the one proposed by the Ellen MacArthur Foundation (EMF), 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 the circular economy as: (1) an *economy* "where the value of products, materials and resources is maintained for as long as possible, and the generation of waste minimised" (EC, 2015), and also as (2) a *development strategy* that "entails economic growth without increasing consumption of resources, deeply transform production chains and consumption habits and redesign industrial systems at the system level" (EC, 2014, Annex I).

If anything, the systemic dimension of a circular economy is the single element emphasized in most definitions. The Circular Economy Communication specifically calls for a "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" (EC, 2014). These transformations can be articulated around a number of circular economic strategies that the Netherlands Environmental Agency (PBL) has proposed 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).

## A system's analysis of the circular economy

The introduction of circular economy strategies has several consequences on the behaviour of the economic system. 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. Further recycling leads to employment creation as well as to (possibly) higher profits, both of which create income and

[1] Material throughput refers to the total amount of matter and energy involved at each and every stage of the economic cycle (extraction, production, use and disposal). In other words, it is the amount of material that passes through the economic system.

lead to more demand and production and hence resource use. As a result, the environmental effectiveness of siloed recycling policies may be challenged by potential 'rebound effects'[2].

Material efficiency could be boosted further if traditional recycling is coupled with interventions that aim at preventing waste and increasing material efficiency, such as public incentives as well as private investments in eco-design and cascade use. Similarly, emissions could be curbed through the introduction of incentives and investments in renewable energy. Given that these interventions reduce costs and increase profits, they still create space for expanding production and consumption and additional rebound effects.

Hence, an even deeper transformation needs to be sought. This is found when demand-side interventions are implemented in conjunction with supply-side policies and investments. Specifically, if taxation, repair, refurbish and remanufacturing are supported, 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[3], interventions implemented by the private sector. With a longer lifetime of products demand declines, the same effect that can be expected from the refusal of consumption, and hence production will not grow as fast, or even decline. In other words, behavioural change, including consumption habits, stands out as a key driver of circular transformations.

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 reuse and recovery of products and materials. In this scenario waste landfilling and emissions would decline, as would environmental and health impacts, leading to lower taxation and improved well-being.

## 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[4] (see Annex 1).

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

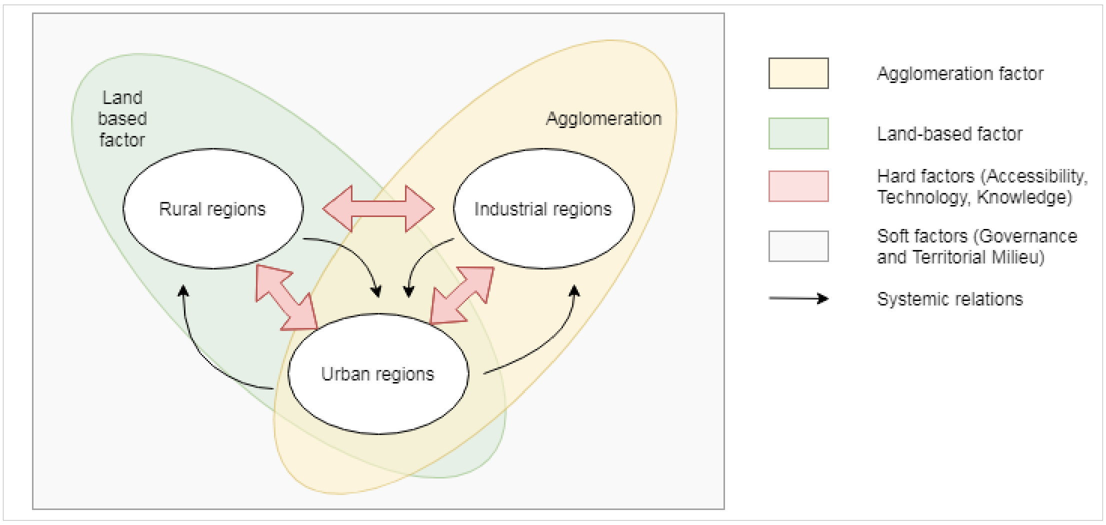
[3] Cascade use refers to the efficient utilisation of resources by using residues and recycled materials sequentially to extend total biomass availability within a given system (Vis et al. 2016).

[4] 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).

**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** are important determinants for a circular economy. Agglomerations 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).

*Figure ES.1: Territorial factors and their interactions in different types of regions*




*Source: own elaboration*

**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.

**Knowledge 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**, 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, if agglomeration and land-based factors contribute to define 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.

## Monitoring a circular economy at sub-national levels

So far, there is no fully established set of indicators on how circular economy performance can be measured at territorial levels. Only recently, the European Commission (EC) has published a proposal for a Monitoring Framework for a circular economy (EC, 2018e). This process has run in parallel to the work done in CIRCTER.

The headline indicator available from Eurostat to monitor **Domestic Material Consumption** (DMC), is calculated by means of simplified mass balances. This implies that the indicator only accounts for the *actual* mass of imported and exported goods. Two factors seem to determine the DMC per capita, namely the use of local natural resources, e.g. through forestry, mining and construction, as well as population density. 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 between 2006 and 2014 are those hit hardest by the global economic crisis in the 2008-2013 period.

Regular statistics on **waste generation and treatment** are hampered by data comparability across countries, and also within individual countries over time. Moreover, available waste statistics do not allow to disclose if effective treatment, material recovery and/or recycling actually take place and where. To some extent, this lack of statistical consistency 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). The amount of total waste excluding major mineral waste is strongly driven by per capita income. Regions with high per capita income and economic size tend to generate higher amounts of total waste excluding major mineral waste. As a consequence, urban regions are those generating higher volumes of total waste on per-capita basis.

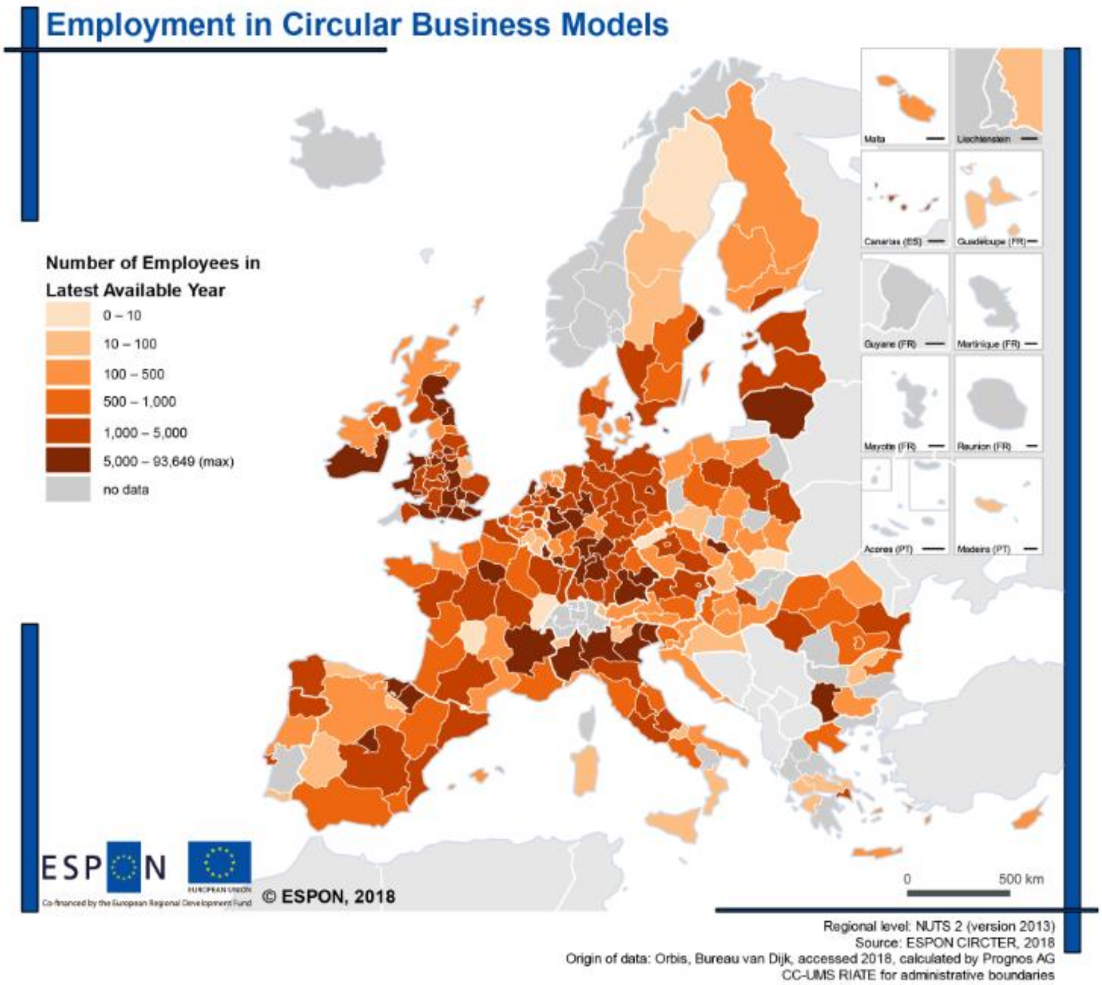
Looking beyond the linear take-make-dispose model entails a genuine shift in perspective towards the use of sustainable raw materials and closed material loops by recycling and reusing products and materials. This implies finding novel ways of measuring, aggregating and analysing such economic activities 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, or ***Potential Users***, are selected industries that adopt or demand new circular business processes, products and technologies that drive the uptake.

The circular economy sectors already make a significant and growing contribution to regions' economies. Measured in terms of employment, nearly 4 percent of the total economy across Europe is already engaged in these circular economy activities alone. *Circular Economy Material* and *Technology Providers* 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 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**. Waste collection and recycling services are a key economic sector 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. However, with dwindling finite resources, growing global demand, technological advancement in the separation and economic provision of secondary raw materials, their overall trajectory is set to grow further.

Although the *Circular Economy Technology* and *Material Providers* show an overall, common trend, each of these show across regions differences in their sectoral composition. Such differences likely express variations in comparative advantages, resource richness, agglomeration forces, specialisation, labour costs, regional and national framework conditions. Results confirm that territorial factors play a role in their location and relative size. **Proximity and agglomeration or economics of scale effects in place, where *Circular Economy Technology* and *Material Providers* tend to follow the respective European patterns** of industrial and rural activities. Proximity allows integrating and connecting flows, people and ideas toward greater resource efficiency. Respectively, the sectoral make up at the regional level varies reflecting bespoke local opportunities.

*Map ES.1: Number of persons employed in companies associated with Circular Economy Business Models (CBM)*




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 in employment** 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.

## Towards place-sensitive policies for a circular economy

The policy landscape of the circular economy is complex. The **EU Circular Economy Action Plan** (CEAP) adopted in December 2015, outlines a series of measures and actions aiming to "stimulate Europe's transition towards a circular economy which will boost global competitiveness, foster sustainable economic growth and generate new jobs" (EC, 2015). The CEAP stresses that "local, regional and national authorities are enabling the transition". Different policy actions are also being taken by a number of regions and cities. Some have already circular economy strategies (e.g. Scotland, Amsterdam); others have been introducing the circular economy narratives in their waste, economic, agriculture, bioeconomy, construction and other policies (e.g. Basque Country, Venlo/Limburg, Lazio), as well as in the Smart Specialisation strategies (e.g. Wallonia, Kymenlaakso). Particularly successful cities and regions with regards to circular economy implementation have already an explicit circular economy strategy in place (e.g. Maribor, Scotland). A systemic shift throughout the value chain should be at the heart of circular strategies. **Regional Innovation Strategies for Smart Specialisation (RIS3)** provide a very good opportunity for integrating circular economy in the regional policy landscape.

The circular economy is relevant for all types of territories. Still, it should be supported in different ways depending on local conditions:

As **cities** accumulate positive factors of viable market demand, accessibility, agglomeration factors and a sense of community, they provide a fertile ground for a circular economy, in particular for the collaborative economy and other circular economy business models related to extending product's life cycle. Moreover, urban areas are particularly well-placed to embark on innovative resource management initiatives because certain material loops and associated policy actions are best addressed at the local level. These include household and food waste or heavy and low-value materials such as construction and demolition waste. Substantial 'leapfrogging' opportunities exist in many areas lacking incineration capacity.

In **rural regions** the prospect clearly lays in the circular bioeconomy. From a territorial cohesion perspective this transformation could yield better results if implemented in a decentralised way.

This requires increased and focused investment in skills, knowledge, innovation and new business models related to the circular, green, and fossil-free economies in rural areas.

**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 those territories where a diverse industrial ecosystem is already in place (industrial symbiosis) or where the products are originally manufactured (remanufacture). Industrial regions in decline, transition or deindustrialization 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 both material storage and transformation/recovery.

The **Cohesion Policy 2021-2027** represents an opportunity to give the circular economy a more prominent role. Future Cohesion Policy will likely mark a significant shift from funding infrastructure towards innovation, broadband and SME support. During the programming process, circular economy priorities should be well-integrated in Partnership Agreements and Operational Programmes. Project selection could include criteria for assessing their contribution to 'circularity'.

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. These efforts could be complemented by additional funding for the circular economy, as a pre-condition for speeding up transition. 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 principles of the EU Strategy on circular economy should be integrated with the **Territorial Agenda post-2020**, especially with the role of regions and cities and the necessary broader commitment from all levels of government for moving towards a circular economy. 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. In this respect, territorial cohesion should also be understood as the need to ensure spillovers from highly developed urban regions leading in the (circular) economy to lagging cities, rural regions and urban peripheries.

## Suggestions for further research

During the implementation of the CIRCTER Project a number of topics for future research have been identified. They are grouped as follows:

**Better metrics for a circular economy**: The lack of indicators for monitoring and to report on progress towards a circular economy can be a main bottleneck for implementing circular economy strategies. New sets of harmonised indicators for a comprehensive characterization of material and waste flows under a *footprint* approach should be developed. These should also allow to track material and waste flows between cities and regions. Indicators to monitor the adoption of circular economy strategies need to be developed as well.

**Deep impacts and long-term effects of circular transformations**: Further investigation is needed to fully understand the potentially *disruptive effects of new and existing 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 are examples of open questions that could not be answered in CIRCTER. Another topic for further research is the *potential contribution of a sustainable bioeconomy to territorial development*. Aspects such as competition for land, market accessibility, availability of technologies and skills, alongside deep sustainability considerations regarding land use, ecosystem services and biodiversity need to be properly calibrated and assessed by future research.

**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.

# 1 Introduction

The ‘take-make-dispose’ model that characterises the linear economy has increased pressure on the world’s resources and environment. It is now widely accepted that the human impact on the Biosphere is well beyond the coping capacity of natural systems. As our civilization trespasses the planetary boundaries, it also lefts behind the safe-operating space of the ‘Earth-System’ (Steffen et al., 2015). In order to reduce the impact of economic activities, a circular economy needs to be adopted. A circular economy significantly reduces material throughputs[1] and increases material efficiency in the economy over the long run. In doing so, a circular economy allows to retain the value of products for longer time. This contributes to create new opportunities for businesses and communities alike.

Deeply rooted on industrial ecology principles developed since the 1970s, the circular economy concept has gained policy momentum worldwide during the first two decades of the XXI century. The circular economy narrative was first adopted in China, where an ambitious Circular Economy Strategy was launched at the National level already in the early-2000s (Yuan & Moriguichi, 2006). The concept was subsequently introduced in European policies though to the EU Action Plan for the Circular Economy (CEAP) of the European Commission (COM(2015) 614). The CEAP is structured around a number of coordinated policy initiatives that address various stages in the extraction-production-consumption-disposal cycle, but focusing notably on resource efficiency, waste management and innovation. The CEAP also emphasises the role of Cohesion Policy in closing the investment gap for improved waste management and supporting the application of the waste hierarchy. Still, the potential impact of the CEAP and its legislative proposals on different types of regions was largely absent both from the CEAP itself as well as from the supporting documentation. The potential influence of territorial factors on the circular economy, and the extent to which specific territorial characteristics make regions and cities more or less optimal to support the circular economy were also to be discovered.

In this report we aim to shed light on these questions. In particular, we aim at providing a **territorial definition of a circular economy** that is based on: (1) a fully-fledged characterisation of resource consumption and waste generation intensities across European NUTS-2 regions and their evolution over time, also in comparison with other socio-economic trends like employment dynamics and economic growth; (2) an evaluation of the territorial factors that are most critical for circular economy transformations; (3) a description of the systemic mechanisms that can facilitate circular economy transitions at territorial levels, leveraging investments and creating synergies between interventions; (4) an illustration of policy approaches and best practices supporting the transition towards a circular economy in various territorial contexts and; (5) guidance supporting local and regional authorities in the definition of circular economy strategies.

The report is structured in nine Sections: Chapter 2 puts forwards a definition of a circular economy that is consistent with the goals of this research. Chapter 3 provides an overview on relevant material patterns and flows, including resources and waste, across European regions over the last decade. Chapter 4 analyses the penetration of circular economy activities and circular business models in the regional economies. Chapter 0 delivers some practical examples on how the circular economy can be practically steered at regional and local levels through a series of cases studies. Chapter 6 combines all the analytical elements developed in the CIRCTER project under a systemic interpretation of a circular economy. Chapter 7 reflects on the circular economy potentials of different types of territories by combining all the analytical elements introduced on previous chapters. Chapter 8 delivers a set of policy recommendations aimed at different territorial contexts and stakeholders. Finally, Chapter 9 provides suggestions for further research on the territorial implications of a circular economy.

# 2 A territorial definition of the circular economy

## 2.1 Conceptualising the circular economy

The circular economy is not a new concept. The idea is rooted in the old industrial ecology theories (Socolow et al., 1994) and child concepts such as industrial metabolism (Ayres, 1989), industrial symbiosis (Frosch & Gallopoulos, 1989), 'Design for Environment' (Graedel & Allenby, 1996), among others. Presently, there is no single and universally accepted definition of a circular economy. A multiplicity of denotations have been proposed according to the diversity of views of different stakeholders. A recent academic review has collected 114 different characterisations (Kirchherr et al., 2017). A very wide-spread definition is the one proposed by the Ellen MacArthur Foundation (EMF). This influential think-tank defines the circular economy as an *industrial system that is restorative and regenerative by intention and design* (Ellen MacArthur Foundation, 2015).

The European Commission (EC) provides a two-folded definition of the circular economy. In the EC Communication 'Towards a Circular Economy: A Zero Waste Programme for Europe' that put the circular economy on the EU policy agenda (COM(2014) 398 final/2), the circular economy is described as an *economic system* that keeps the added value in products for as long as possible by looking beyond the linear take-make-dispose model (EC, 2014); in the Annex to this policy document, the circular economy is characterised as a *development strategy* that "entails economic growth without increasing consumption of resources, deeply transform production chains and consumption habits and redesign industrial systems at the system level" (EC, 2014, Annex I). In the main Communication 'Closing the Loop', that introduces the CEAP (COM(2015) 614), the circular economy is simply described as 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).

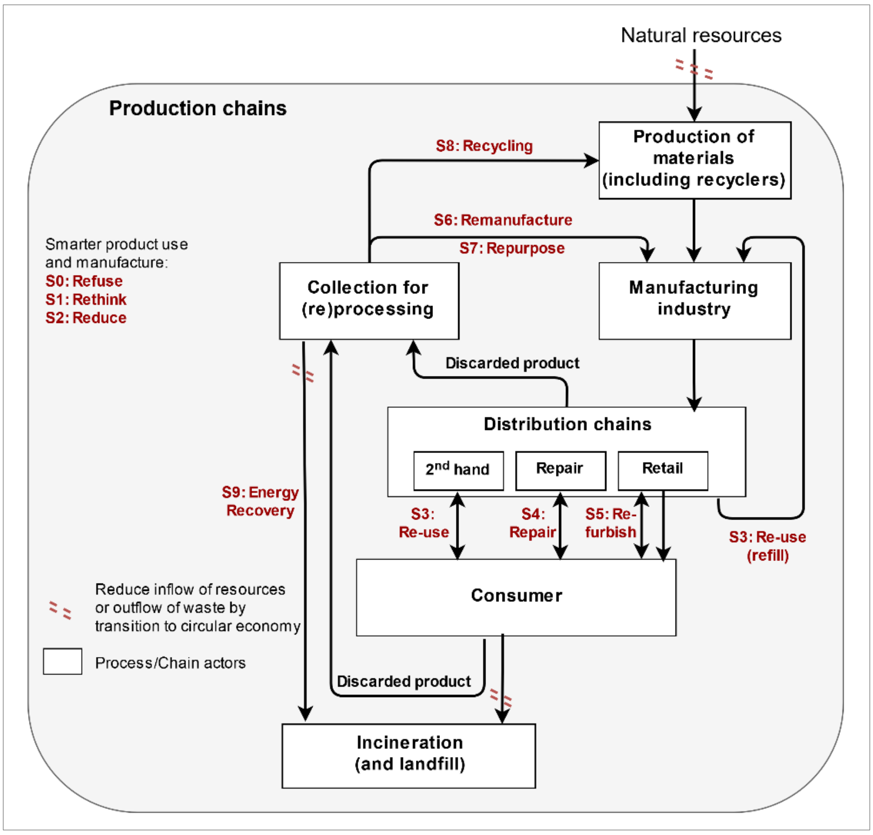
While keeping a tight alignment to the above policy definitions, in this report we rely on a more explicit characterisation proposed by Korhonen et al. (2018b). These authors describe the circular economy as "a sustainable development initiative with the objective of reducing the societal production-consumption systems' linear material and energy throughput flows by applying materials cycles, renewable and cascade-type energy flows to the linear system. The circular economy promotes high value material cycles alongside more traditional recycling and develops systems' approaches to the cooperation of producers, consumers and other societal actors in sustainable development work". This definition emphasises four important analytical elements:

1. The circular economy is presented as a **policy strategy geared at sustainability**, like also the EC's definition also does. Under this principle, the circular economy is to be understood as an aspirational economic model that can be facilitated through direct and indirect policy intervention.
2. It identifies one **key strategic goal**, namely reducing throughput flows generated by economic action, alongside three enabling features: (1) high value material cycles for the technical materials; (2) cascade use of biotic resources, and; (3) renewable energy provision. This goal is also explicitly recognised in both EMF's and EC's definitions.
3. It emphasises the relevance of **cooperation mechanisms** between societal actors. The definition implicitly acknowledges the governance and management implications stemming from the implementation of such mechanisms and recognizes the importance of inter-sectoral and inter-organizational management and governance models. Cooperation within and between value chains is also mentioned in the Communication 'Towards a Circular Economy: A Zero Waste Programme for Europe' as a requisite to support design and innovation for a more circular economy (EC, 2014).
4. It adopts a **system's perspective**. This aspect is evinced by the emphasis that the definition puts on the interactions between production and consumption systems and on their mutual flows and cooperation mechanisms that are established between the different economic actors. The systemic dimension is explicitly taken up in EC's definition and is also mentioned in some EMF's documents.

Yet, none of the elements mentioned above make explicit links to the practical elements supporting the definition of a circular economy. These can be better visualised in the conceptual model proposed by the Netherlands Environmental Agency, PBL (Potting et al., 2017), which is shown in Figure 2.1. This model has been chosen in the CIRCTER project to illustrate the possibilities for the circular transformation of products or services. Several references to this conceptual model will be found across this report.

In the PBL framework, the circular economy is structured around a number of strategies to achieve less resource and material consumption in production-consumption chains and make the economy more circular. These have been labelled S0 to S9 in Figure 2.. Such strategies, usually known as ‘R-strategies’, build on the traditional waste hierarchy (EC, 2010) and illustrate a range of approaches to reduce resource and material consumption throughout the different value chains, rather than relying solely on solutions addressed at the end of life of products. The ‘R-strategies’ are ordered from high circularity (low S-number) to low circularity (high S-number)[5]. These include: Refuse (S0), Rethink (S1), Reduce (S2), Reuse (S3), Repair (S4), Refurbish (S5), Remanufacture (S6), Repurpose (S7), Recycling (S8), energy Recovery (S9). In this study we will make extensive use of the R-strategies to illustrate how the circular economy operates at systemic and territorial levels. Annex 1 and 7 to this report provide a more detailed characterization of the ‘R-strategies’.

*Figure 2.1: Circularity strategies and value chain actors in a circular economy*




*Source: adapted from Potting et al. (2017)*

## 2.2 Territorial factors influencing the development of a circular economy

The *territorial factors* are here defined as the set of spatially-bound assets and features conditioning the way a circular economy is operationalised at the regional and local levels. Hence,

[5] These strategies are originally labelled as R0 to R9 in the PBL classification. We have decided to rename them as S0 to S9 to avoid confusion with the reinforcing loops represented in the diagrams shown in Chapter 6 of this report.

the understanding of how territorial factors, with their socio-economic, environmental and institutional expressions, affect the different closed-loop strategies presented above, becomes crucial to envisage a successful transition to a circular economy at these levels.

Based on a literature review, in CIRCTER we have identified seven territorial factors affecting 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. Figure ES.1 above provide a schematic representation of the territorial factors analysed and how they relate to different types of regions. A detailed evaluation of these factors is provided in Annex 1. An overview of the main interactions of those factors with the circular economy follows below.

**Agglomeration factors** in urban and industrial areas are an important territorial enabler for the circular economy. **Industrial agglomerations** create the right conditions for circular economy planning based on e.g. on industrial symbiosis programmes. Moreover, given the high concentration of industrial companies, these areas can also play a key role in unfolding innovation potentials to enable close-loop strategies. On a different level, **urban agglomerations** ensure the necessary 'critical mass' to e.g. enable low-value material recovery schemes, as well as to develop a range of community-based initiatives necessary to operationalise circular economy strategies. Furthermore, the bigger cities amplify and simplify communication, and consequently increase citizen awareness and engagement to promote consumption and/or behavioural change. However, although agglomerations generate knowledge spillovers, these exhibit spatial selectivity and suffer from strong distance-decay effects (Audretsch & Feldman, 2004). Hence, it is expected that agglomeration forces *per-se* will not contribute to ensure harmonious territorial development under a circular economy perspective. This stresses the need for sensitive territorial and cohesion policies supporting cohesive territorial development.

**Land-based resources** represent the core of the biotic circular flows. Land-based factors have a particular impact on **rural regions** but indirectly also on **urban areas**. The first aspect clearly emphasises the relevance of natural endowment to satisfy the growing demand of biomass feedstock by cities and industries, while the second represents a mostly unexplored opportunity to close the circular loop by feeding organic waste streams generated in economic processing back to soil.

Hence, agglomeration and land-based factors mostly create the right *framework conditions* for specific circular economy strategies to be actionable: They mostly provide the critical mass needed to implement circular economy strategies and implicitly define the sectors that could be susceptible for transformation, according to the economic structure of the different areas. Still, these are not the only factors to affect the circular economy at the regional and local levels.

Indeed, the actual existence and intensity of material flows occurring in closed-loop networks also depends on the **accessibility** of individual economic actors to the resources. The presence of an adequate infrastructures represents an enabling factor for the transition to a circular economy since it makes possible the transport and re-allocation of stocks in an efficient way, being these materials but also human capital. 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 triggering the economies of scale related to e.g. the processing of secondary raw materials (e.g. low-value waste collection-recycling), and in enabling disruptive business models based on e.g. reverse logistics and take-back programmes. The next generation of spatial plans and planning schemes should plan logistic spaces to go beyond traditional linear flows and account for inverse flows and reverse logistics.

The installed **knowledge-base** can also boost the development of a circular economy in various ways. First, expanding the knowledge base within companies could for instance enable businesses to design products with circularity in mind, and also to shift business models towards circular economy strategies based on remanufacturing, product refurbishment, material reuse and recycling, ultimately decreasing the consumption of virgin materials. Second, increasing the technical skills of workers will also be necessary to enable many of the circular strategies. Third, knowledge and awareness can also trigger behavioural change among citizens. Awareness about more sustainable products or consumption models could result in more informed decisions and consumption choices underpinning circular business models. Fourth, territorial knowledge about circular economy processes and actions is crucial for effective regulations. These are strongly influenced by the knowledge and installed-capacity within public administrations at all territorial levels. Local knowledge can be expanded through, inter alia, the participation on exchange schemes with peer actors.

Last but not least, **technological capacity** constitutes another territorial *hard-factor* that 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. In fact, technological innovation holds the potential to improve material efficiency and, consequently, frees up additional resources for production by increasing the amount of end-of-life materials that can be recovered.

However, the extent to which physical assets, capacities and technologies supporting a circular economy will ultimately depend on soft and intangible factors. **Governance** and institutional factors, together with **territorial milieus**, act as transversal forces that facilitate and create the necessary conditions for circular economy transitions to materialise. For example, political vision and leadership embedded in strong institutional governance are essential requirements to put in place ambitious tax and regulation systems. 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). On a different level, cultural and social aspects that express themselves in territorial milieus are possibly even more important. These are intrinsically embodied in the human capital and relational networks in local labour markets, thus having a clear territorial expression. Intangible factors, which are accumulated through slow process of individual and collective learning, are essential factors shaping the innovation capacity of territories. In absence of a good relational network enabling information exchange, cooperation and trust for an optimal resource management, it is likely that the potentials for circular business models will remain unfulfilled, and the existing 'hard' infrastructures, together with physical capacities will remain under-utilised.

# 3 Monitoring progress towards a circular economy: towards materially decoupled regional and local economies

## 3.1 Understanding material and waste statistics and their limitations

So far, there is no fully established set of indicators on how circular economy performance should be measured at territorial levels. Only recently, the European Commission (EC) has published a proposal for a Monitoring Framework for a circular economy (EC, 2018e). This Framework already includes a motivated set of indicators addressing the following categories: (1) product and consumption; (2) waste management; (3) secondary raw materials, and; (4) competitiveness and innovation (EC, 2018b). The EU Framework is complementary to the ones developed by individual Member States (MS). Among these, perhaps the most advanced scheme is the one developed in the Netherlands (Potting et al., 2018).

Given that progressing towards a circular economy should ultimately lead to a measurable reduction on the total amount of primary raw materials that are extracted from the environment, as well as on the total amount of wastes are landfilled or incinerated, most of the abovementioned frameworks propose a subset of headline indicators that focus on material inputs, waste outputs and recycling rates.

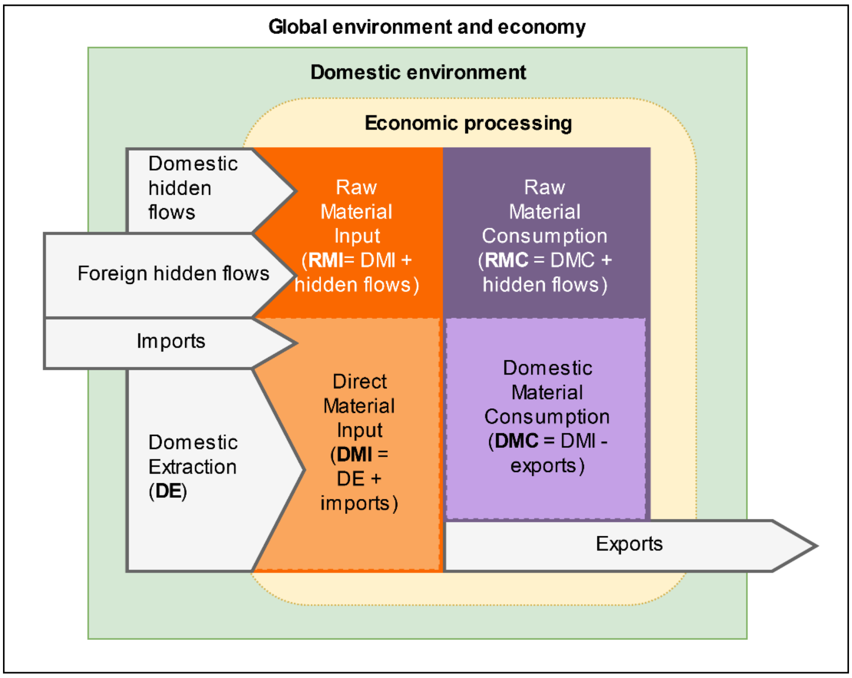
The two headline indicators available from Eurostat to track **material consumption** at territorial levels, namely Direct Material Input (DMI) and Domestic Material Consumption (DMC) are calculated by means of simplified mass balances. This implies that the indicators only account for the *actual* mass of imported and exported goods (either intermediate or end products) when crossing the international boundaries. Remarkably, the resources that were used *upstream* to produce imported goods are not considered in the calculation of the DMC and DMI indicators. These neglected materials are commonly known as *hidden flows*.

This is an important limitation for consumption indicators such as the DMC, especially for territories where the first processing stages take place, as these are penalised by greater material intensity. More comprehensive indicators based on a *material footprint* approach, like Raw Material Input (RMI) or Raw Material Consumption (RMC), are increasingly promoted to measure *final* resource consumption of national economies, as they also take account of the hidden flows

(EPA Network, 2017). However, these indicators are quite difficult to compute and accordingly few RMI or RMC datasets are available at present, even at the national levels. For instance, in the Eurostat system the RMI is available only at the aggregated EU level (env_ac_rme).

Moreover, material intensity indicators in general do not necessarily say much about a circular economy. In order to make clear statements on the degree of “circularity” of a specific economy, more detailed information on the share of secondary material used in relation to total material consumed would be necessary. This information is only now starting to be collected by Eurostat at European level based on estimated recovery rates of specific waste categories (cei_srm030). However, given that the secondary share in the material consumption is still rather low in all countries, it can be claimed that DMC *still* is the best available proxy to how much primary material input flows into the material cycle of a circular economy. Thus, the lower the per capita value of the DMC, the less primary material input is expected to flow into the system.

*Figure 3.1: Simplified overview of material flow indicators*




*Source: own elaboration*

Regular statistics on **waste generation and treatment** are collected from each MS and published every two years following harmonised and regularly updated methodological recommendations established under the Waste Framework Directive of 2008 (Eurostat, 2013). The information on waste **generation** has a breakdown in *sources* (19 business activities according to the NACE classification and household activities) and *waste categories* (according to the European Waste Classification for statistical purposes). The information on waste **treatment** is broken down to five *treatment types* (recovery, incineration with energy recovery, other incineration, disposal on land and land treatment) and in the same *waste categories* mentioned above.

Still, depending on the national waste management framework and related waste data collection systems, the approaches for waste data collection established in each MS vary significantly. This hampers data comparability across countries and also within individual countries over time. Moreover, the available waste statistics do not allow to disclose if effective treatment, material recovery and/or recycling actually take place and where. To some extent, this lack of statistical reliability of waste statistics is a consequence of the increasing complexity of municipal waste management processes across Europe. On the one hand, a growing number of pre-treatment facilities for mechanical and biological wastes have been built in many regions during last years. On the other hand, increasing legal requirements for recovery of certain waste streams have resulted in growing cross-boundary shipments of waste.

All considered, the policy incentive stemming from the Waste Framework Directive (2008/98/EC) has been so far oriented towards diversion of waste from landfill rather than enabling effective re-use of materials (Gregson et al., 2015). This can be illustrated by many examples from different MS. For example, a recent evaluation of plastic packaging waste management in the UK conducted by the Department for Environment, Food and Rural Affairs and Environment Agency shows that more than 60 percent of the plastic that is collected in that country is currently exported *and defined as recycling*. In fact, since 2002 the quantity of packaging waste exported for recycling abroad has increased sixfold while the quantity recycled in the UK has remained the same. The study concludes that “the system appears to have evolved into a comfortable way for government to meet targets without facing up to the underlying recycling issues” (DEFRA, 2018).

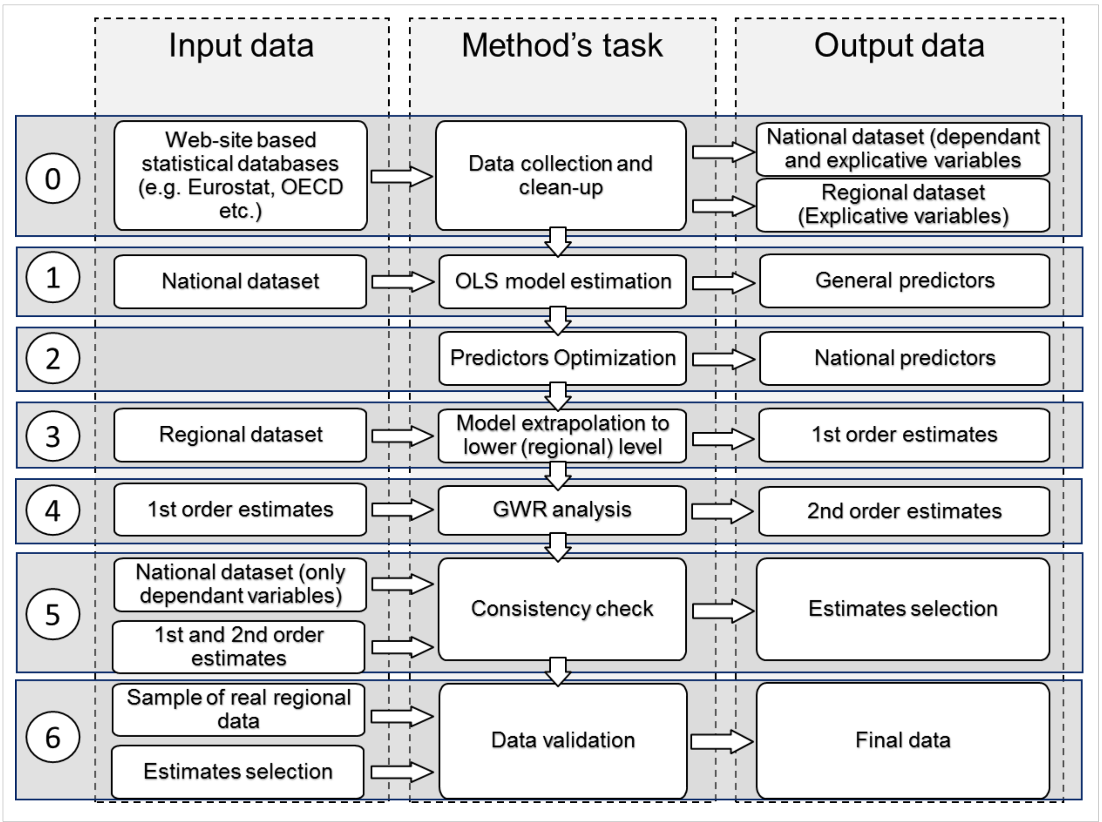
This situation is by no means exclusive to the UK. Most MS face comparable waste management inefficiencies. Ultimately, these translate into enormous amounts of valuable materials being diverted from local economies. A significant share of the materials that are shipped abroad are never recycled, even if they are misleadingly classified as such in the official statistics (Brooks et al., 2018). Even worse, the exported wastes may also contribute to create environmental issues in the regions receiving shipments, as these areas frequently lack appropriate recycling facilities, and even contribute to create global environmental problems, such as marine plastic pollution (Dauvergne, 2018).

Regardless of their credibility, the official statistics on waste treatment only cover a limited subset of the stages in the traditional waste hierarchy, mostly recycling. This represents stage 3 of the traditional waste hierarchy and only stage 9 in the circular R-strategies presented above (see Figure 2.1). Other approaches aimed at waste prevention and the preparation for the reuse of products and materials are much more important under a circular economy perspective. All these aspects are very difficult to measure, nonetheless at regional level. Defining appropriate indicators for waste prevention is currently an important topic in research on the circular economy.

## 3.2 Overview of the data regionalization process

One additional aspect to consider is that the existing data on material consumption and waste generation and treatment is almost exclusively available at national level. Hence, in the CIRCTER project we have produced regional estimates (at NUTS-2 level) for the main material consumption and waste generation and treatment indicators available from Eurostat. Figure 3.2 provides an overview of the stage-based downscaling method that was applied in this research. The figure also highlights the reference data that were used and the output produced at each methodological step. A full description of the methodology is provided in Annex 2 to this report.

*Figure 3.2: Sequential flow of the downscaling method*




*Source: own elaboration*

As shown in Figure 3.2, the core of our downscaling method is based on an econometric approach that identifies and estimates the best predictive parameters for each selected indicator. The method bases on the pre-identification of a set of 'explanatory' variables having an empirically known and/or statistically significant relationship with each indicator to downscale. Such explanatory variables, which are already available (or are computable) at both national and regional scales, reflect the following socio-economic and territorial aspects of regions:

- Socio-economic variables: population, Gross Domestic Product (GDP), income, Gross Value Added (GVA) by economic activity (agriculture, forestry and fishing; industry, excluding construction; manufacturing, and; construction), Gross Fixed Capital Formation (GFCF) by economic activity, employment by economic activity, and municipal waste;

- Bio-physical variables: population density, total surface, land-cover (specified for cropland, grassland, forestry, and artificial area), location quotients (for each class of GVA, GFCF and Land-cover), EU geographic sub-regions (Northern, Southern, Eastern, Western).

Most of these data were retrieved from Eurostat's "Regional statistics by NUTS classification" (*reg*) and "Environment" (*env*) databases. Data on European Free Trade Area (EFTA) countries not available in Eurostat were downloaded from OECD's Regions and Cities Database.

The main drawback of this top-down approach is the impossibility to define a set of estimated parameters that simultaneously describe the economic structure of all the 331 NUTS-2 regions considered. Moreover, regional interflows of material and waste within and between countries are only partially addressed by spatial effects. Hence, in our data model regions with large logistic hubs, ports, etc. are more subject to deviations from reality. However, the quality of the regional estimates does not depend solely on the limitations of the regionalisation approach itself but also, and above all, on the quality of the input data available at the national level that, as claimed above, is far from being perfect.

*Table 3.1: Indicators regionalised in the CIRCTER project*

| Indicator | Eurostat code | Expected accuracy of regionalisation* |
|---|---|---|
| **Domestic Material Consumption** | Env_ac_mfa | High |
| Biomass | Env_ac_mfa: MF1 | Medium |
| Metal Ores | Env_ac_mfa: MF2 | Low |
| Non-metallic minerals | Env_ac_mfa: MF3 | Medium |
| **Domestic Extraction (DE)** | Env_ac_mfa: DE | High |
| **Total waste generation, excluding major mineral wastes** | env_wasgen: TOT_X_MIN | Low |
| **Total Waste generated by Households** | env_wasgen: EP_HH | Low |
| Total Waste generated by agriculture, forestry and fishing | env_wasgen: A | Low |
| Total Waste generated by mining and quarrying (NACE) | env_wasgen: B | Low |
| Total Waste generated by manufacturing (NACE) | env_wasgen: C | Low |
| Construction and demolition waste (NACE) | env_wasgen: W12-13 by F | Low |
| Food Waste | env_wasgen: W091+W092+ W101*0.25[6] | Low |
| Plastic Waste | env_wasgen: W074 | Low |
| Electric and Electronical Waste (WEEE) | env_waselee | Low |

** For the details on this classification the reader may refer to Annex 2, Sec. 5.3*

Table 3.1 lists the indicators that have been regionalised in the CIRCTER project and informs on the expected accuracy of our results. Lower accuracies are in most cases due to the low

[6] Following the recommendation on food waste allocation by the EC (see Annex 2 for the details).

quality of the national statistics. Annex 2 (Section A2.5.3) provides additional information on the accuracy classification criteria.

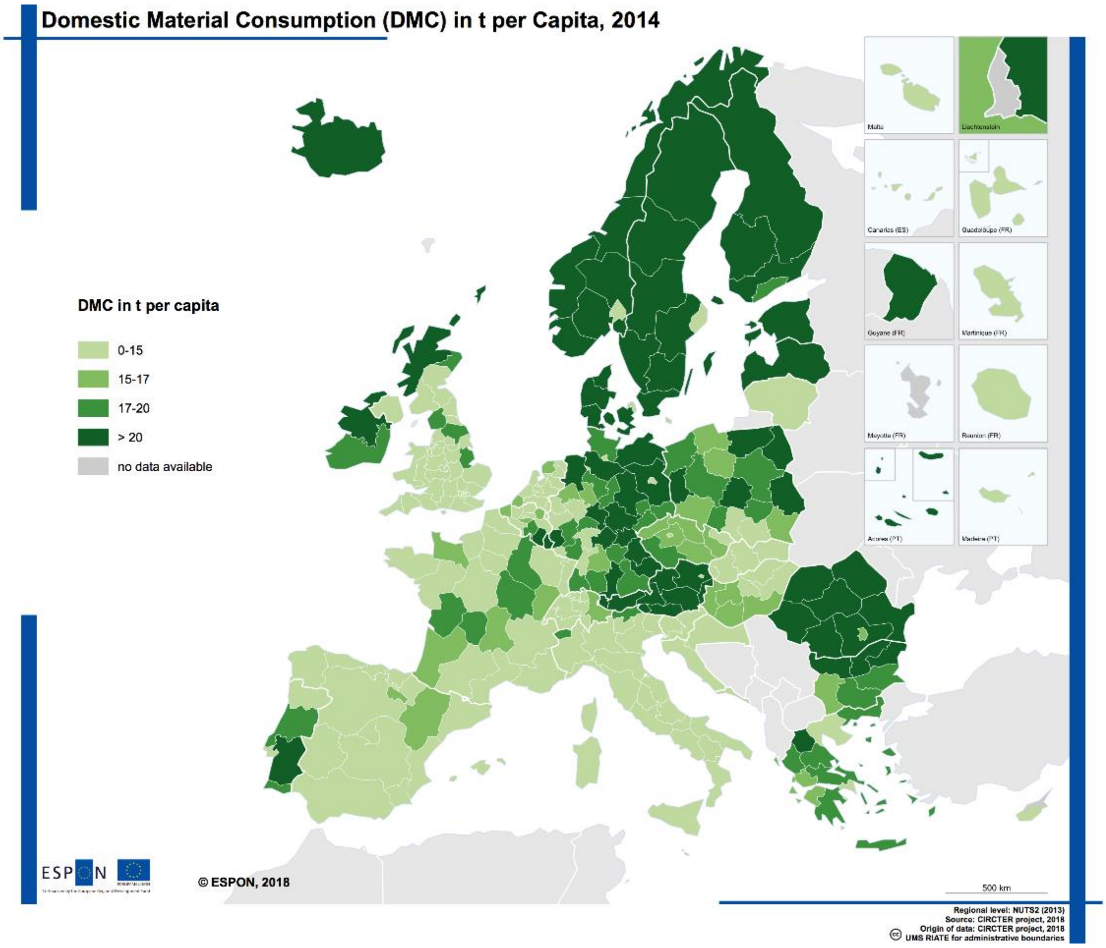
Despite all the above-mentioned limitations, the analysis of the regional data presented in the following subsection provides valuable information on the spatial patterns of the existing indicators for measuring some of the most relevant expressions of a circular economy.

## 3.3 Material patterns and flows

### 3.3.1 Material input

*Material resource use* can be measured in terms of DMC per capita. According to our analysis, material resource use is above average in some regions of Eastern Europe and Scandinavia, but also in the regions of Austria, Iceland, Ireland and some regions of Germany (Map 3.1).

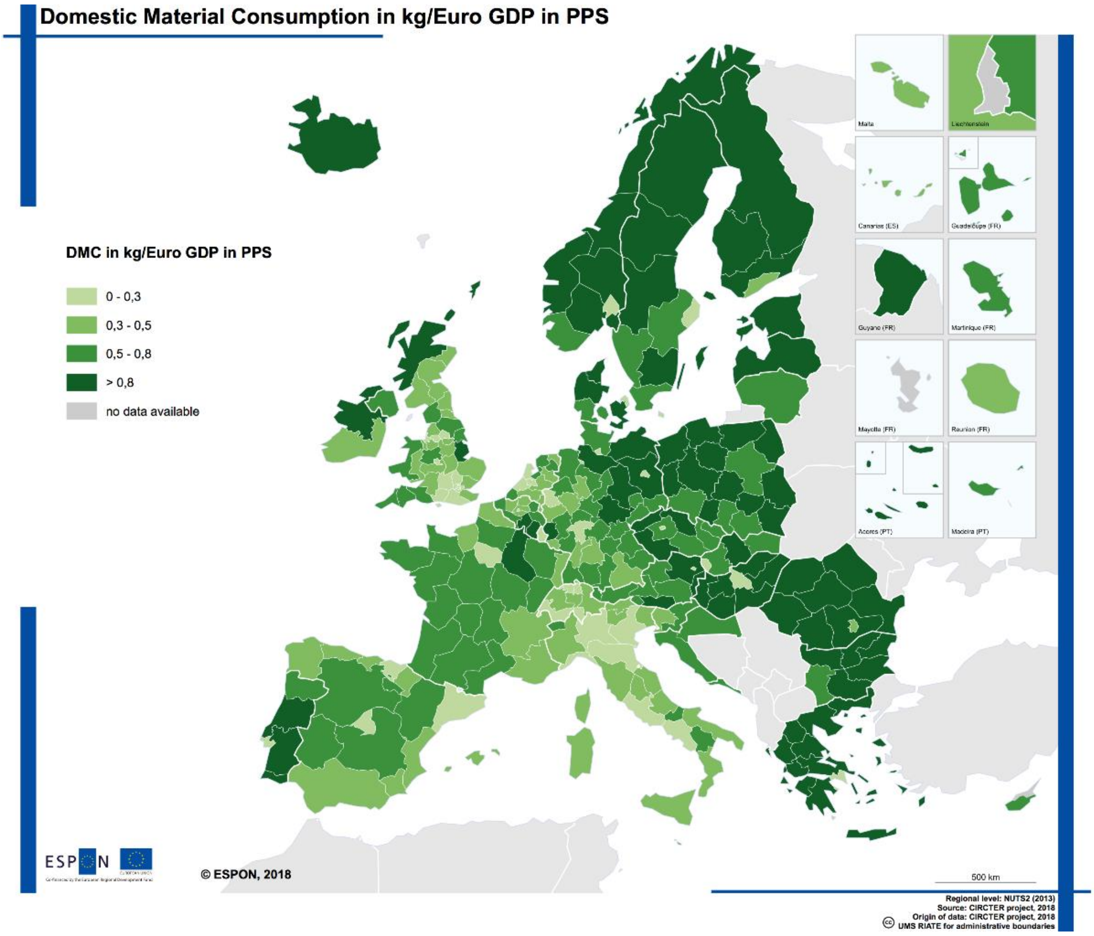
*Map 3.1: Domestic Material Consumption (DMC) per capita in 2014* [7]




[7] The data presented on this map are based on model estimates produced by the CIRCTER project. The expected accuracy of the estimated values is **high** (see Annex 2 for the details)

Two factors seem to determine material resource use: Firstly, DMC per capita is often linked to the use of local natural resources. For instance, high DMC per capita values can be explained by strong forestry and mining sectors, like in many Scandinavian regions and the Western Macedonian region in Greece[8], and/or by intense agriculture activities, like in most Romanian regions. Secondly, material resource use is strongly influenced by 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. As shown in Map 3.1, this effect is particularly evident in regions in Norway, Finland and Sweden, where it is coupled with economies with strong reliance on material-intensive sectors (e.g. wood processing and mining).

*Map 3.2: Material Intensity, measured as Domestic Material Consumption (DMC) in kg/Euro GDP in PPS, 2014*[7]




*Material intensity* of a given economy is usually measured in terms of DMC per GDP unit. *Material productivity* is the reciprocal of material intensity, i.e. GDP per DMC unit. According to our model estimates, the Eastern European regions with an above-average DMC per capita also

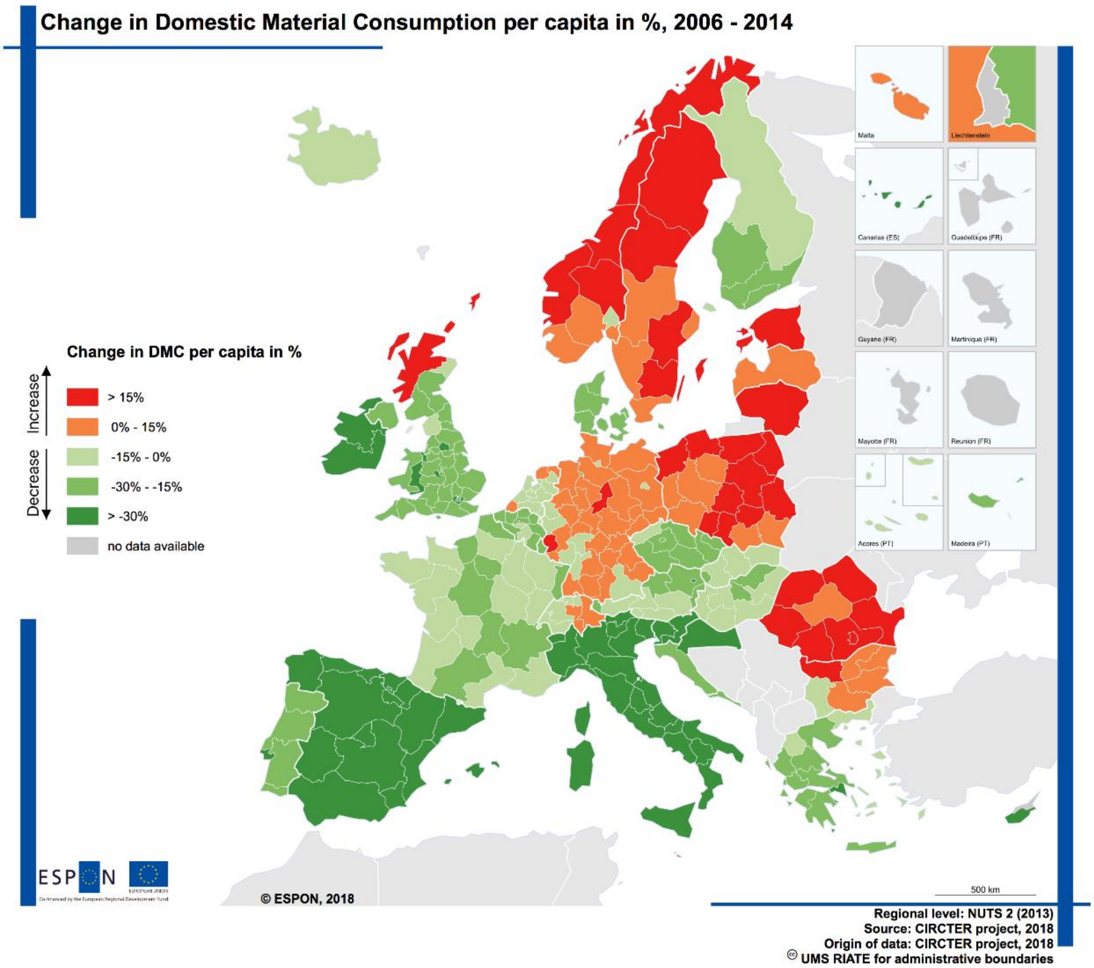
[8] DMC per capita is high in Western Macedonia region mainly due to lignite mining that is used after the mining processes to feed the neighbouring power stations

have a high material intensity due to the comparatively lower per capita income in those areas. On the contrary, in the Scandinavian and German regions with high material resource use, the above-average per capita income helps to reduce material intensity to an average level. However, these areas do not reach the material productivity in the French, Italian or British regions, where low DMC per capita is coupled with relatively high income per capita (see Map 3.2).

Annex 3 provides more detailed information on resource use and material intensity across European regions, disaggregated by types of materials.

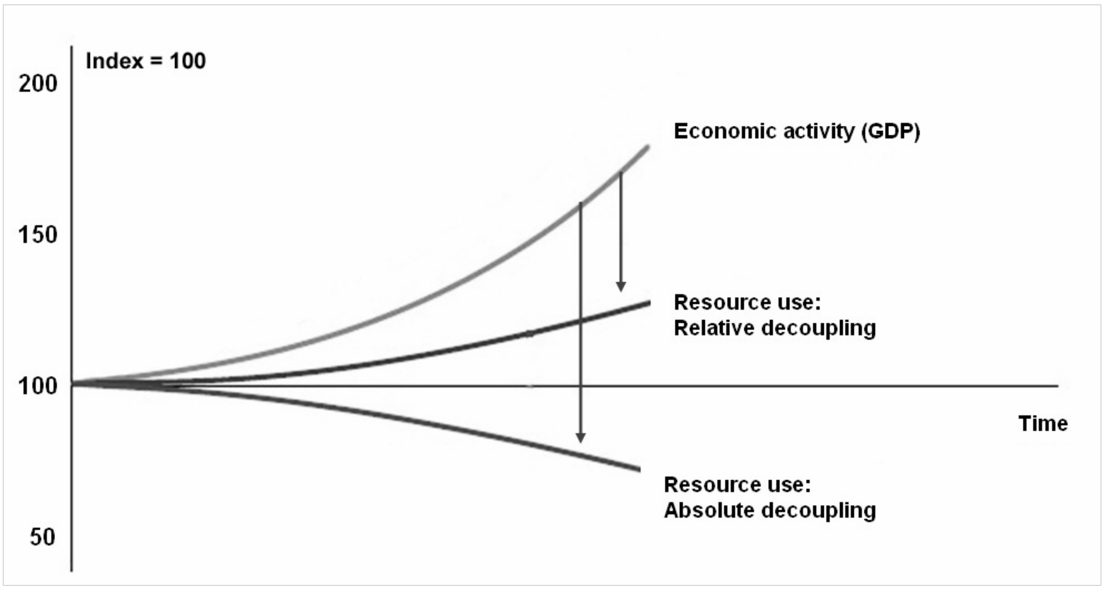
The change in the DMC per capita between 2006 and 2014 again shows the link between material consumption and general economic dynamics (Map 3.3). The observed trends are also very much adapted to the evolution of the building and construction sector. The regions with the strongest declines between 2006 and 2014 are also those hit hardest by the global economic crisis in 2008 and therefore show not only strongly declining DMC per capita values in the period 2006 to 2014, but also declining or stagnating GDP per capita levels. This observation mostly applies to regions in Spain, Italy, Ireland and Greece, where both effects concurred over the observed period.

*Map 3.3: Change in Domestic Material Consumption (DMC) per capita in percentage, 2006-2014*[7]



A comparative analysis of the evolution of socio-economic and material/waste indices informs on the potential ***decoupling*** (or *delinking*) of regional economies from resource consumption. The main assumption behind the decoupling concept is that economic growth is possible without harming the environment or even reducing the negative environmental externalities of economic growth (i.e. when resource consumption decreases and at the same time economic production increases). The opposite to decoupling is *recoupling* (or *relinking*). The literature distinguishes between *absolute* and *relative* decoupling or recoupling (see Figure 3.3).

*Figure 3.3: Absolute vs relative decoupling of economic growth from resource use*




*source: https://oxfamblogs.org/fp2p/hunting-for-green-growth-in-the-g20/*

**Absolute decoupling** is described as economic growth with decreasing resource use. **Absolute recoupling** defines a process where resource consumption increases and at the same time economic production decreases. **Relative decoupling**, on the other hand, is a development in which both indicators have the same sign, but the change rate of the economic production is higher than that of resource use. Inversed logics apply to **relative recoupling**. In this case both indicators have the same sign, but resource use increases faster than economic production. Relative values can be further classified in two sub-categories, depending if the growth pattern is expansive (i.e. both material consumption and economic production grow), or recessive (i.e. both material consumption and economic production decline). Table 3.2 provides an overview of all the possible decoupling scenarios.

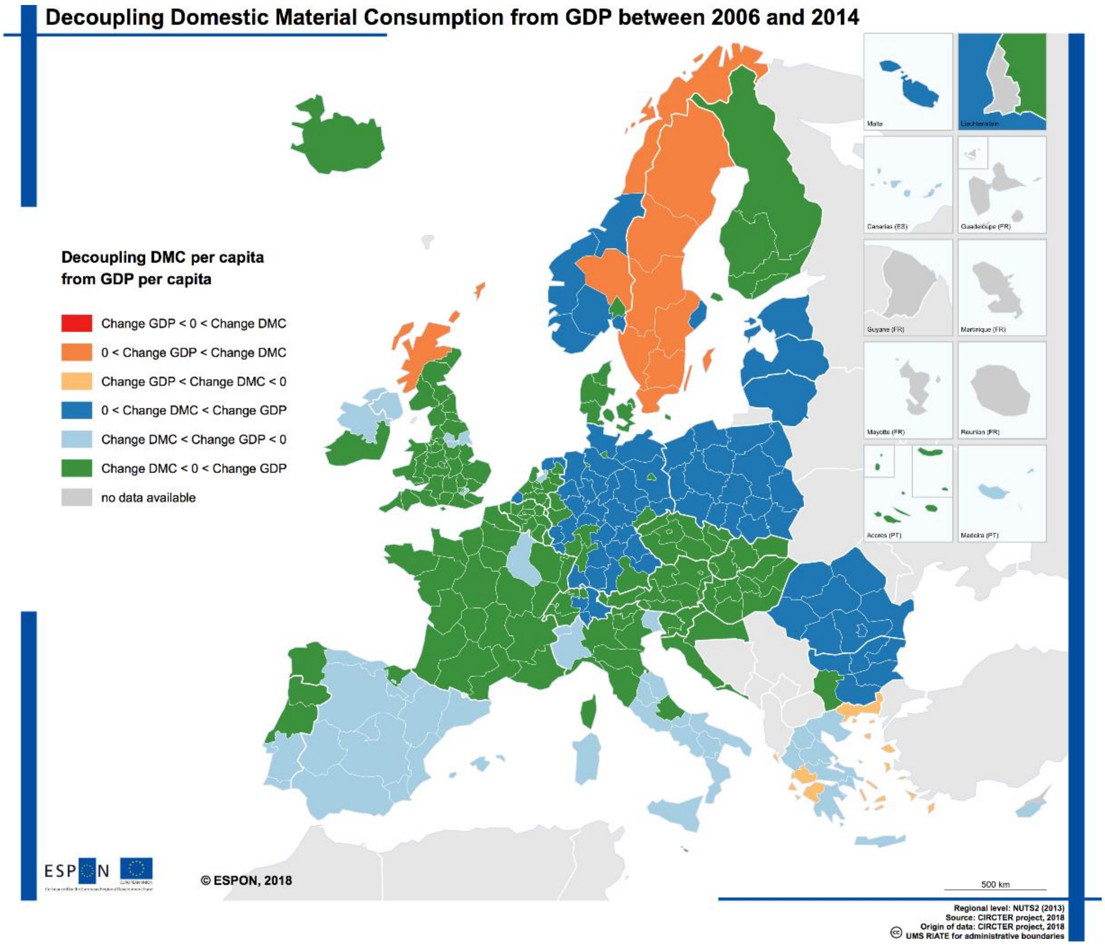
Our decoupling analysis shows that in regions with strongly declining DMC per capita often no absolute decoupling of the DMC from GDP took place (see Map 3.4), but rather a relative decoupling. In the case of some regions in Greece with lower decline in the DMC per capita, even a relative recoupling of the DMC per capita with the change of GDP can be identified. Regions with an absolute decoupling were mostly regions with a moderate decrease of the DMC per capita, like e.g. most Polish, Romanian and German regions. A comprehensive decoupling analysis, looking also at waste and employment variables, is provided in Annex 3.

*Table 3.2: Overview of potential decoupling scenarios*

| Scenario | Resource use change (e.g. change on DMC) | Socio-economic trends (e.g. change on GDP or employ-ment) | Change on resource use (RU) vs change on socio-economic activity (SE) |
|---|---|---|---|
| **Absolute decoupling** | Decreasing | Increasing | RU < 0 < SE |
| **Relative decoupling (expansive)** | Increasing (slower) | Increasing (faster) | 0 < RU < SE |
| **Relative decoupling (recessive)** | Decreasing (faster) | Decreasing (slower) | RU < SE < 0 |
| **Relative recoupling (expansive)** | Increasing (faster) | Increasing (slower) | 0 < SE < RU |
| **Relative recoupling (recessive)** | Decreasing (slower) | Decreasing (faster) | SE < RU < 0 |
| **Absolute recoupling** | Increasing | Decreasing | SE < 0 < RU |

*Source: own elaboration*

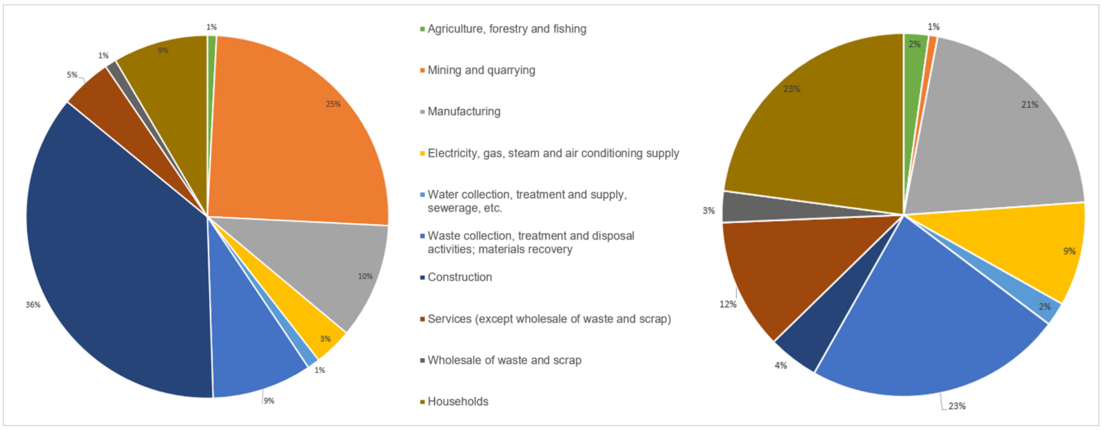
*Map 3.4: Decoupling Domestic Material Consumption (DMC) per capita from GDP per capita[7]*



### 3.3.2 Waste generation and treatment

Looking at the specific waste categories that determine total waste generation in the EU, the composition is mainly driven by household waste, manufacturing waste and waste collection and treatment (Figure 3.4).

*Figure 3.4: Generation of waste by economic sector and waste category as a share of total waste (left) and total waste, excluding major mineral waste (right). Data for EU28 (2016)*

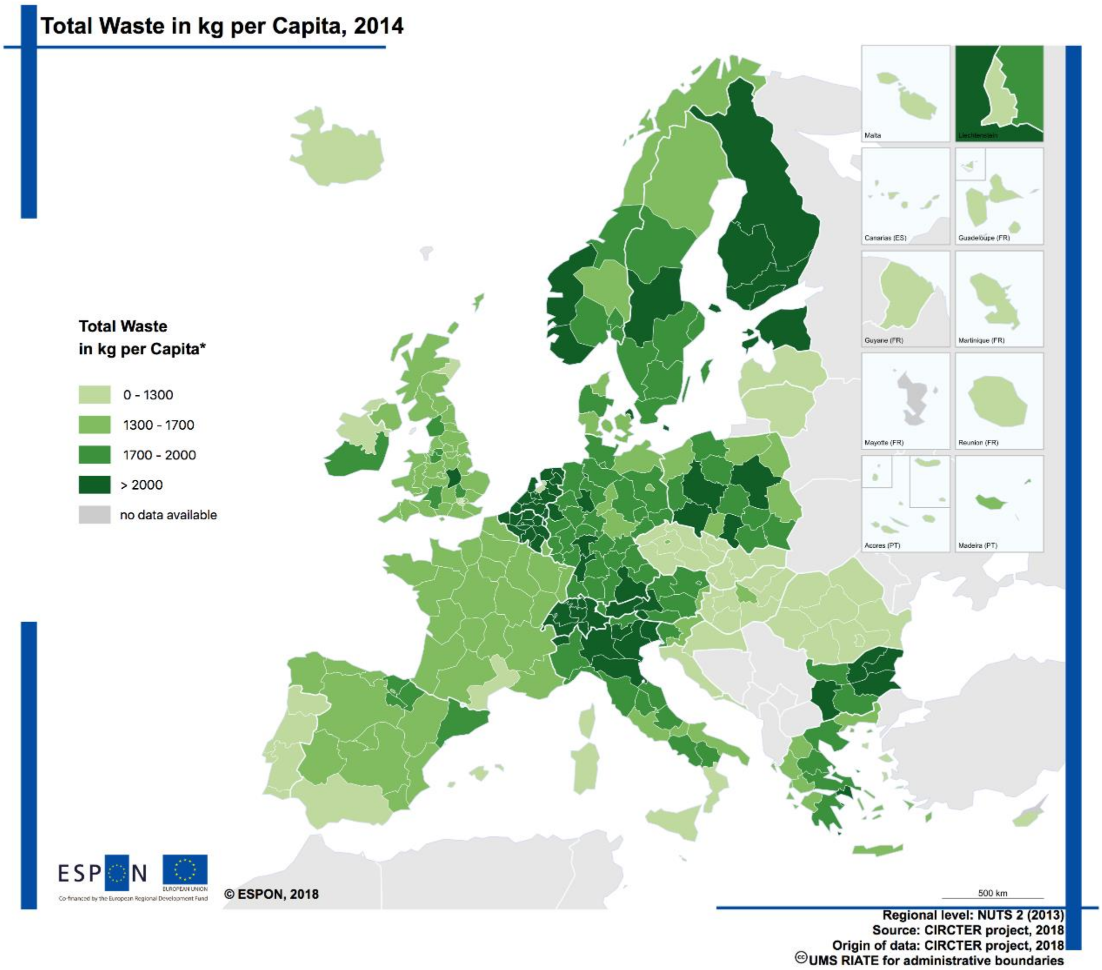



*Source: Eurostat (env_wasgen)*

The quantity of manufacturing waste often makes possible to identify the respective industrial centres of the individual countries, be it Cataluña in Spain, Lombardia in Italy or Noord-Brabant in the Netherlands (see **Error! Reference source not found.**). However, national patterns also s eem to play a role in influencing per capita total and per capita waste levels at regional level, which are likely to be caused by different national waste management regulations or standards. In any case, the limited quality of national waste statistics simply does not allow to develop a robust interpretation of regional waste generation patterns.

The dynamics of change in per capita values in total waste are equally difficult to interpret. For methodological reasons mostly connected to the quality of the input data, different regression models were used for the regionalisation of individual waste categories and for different years, which in some regions led to data that cannot be meaningfully interpreted. For example, there are a few Spanish regions whose total waste per capita increased between 2006 and 2014, although all other waste categories decreased in the same period. These implausible dynamics are also reflected in the decoupling analysis that compares waste generation per capita with per capita income, in which two adjacent regions can exhibit absolute decoupling and absolute recoupling, although their respective changes in per capita income show similar dynamics. For a detailed review of waste statistics, the reader may refer to Annex 3.

*Map 3.5: Total Waste (excluding major mineral waste) in kg per capita*[9]




In addition to the total amount of waste that is generated, an equally important criterion for the assessment of whether a region is progressing towards a circular production and consumption model is how the different wastes are handled. However, data for the treatment of waste are only available for municipal waste until 2013 (env_rwas_gen). These data are produced by Eurostat as part of a pilot project and therefore do not constitute a regular data set. They are provided on a voluntary basis by the national statistical offices and partly differ in their methodology (see Annexes 2 and 3 for details).

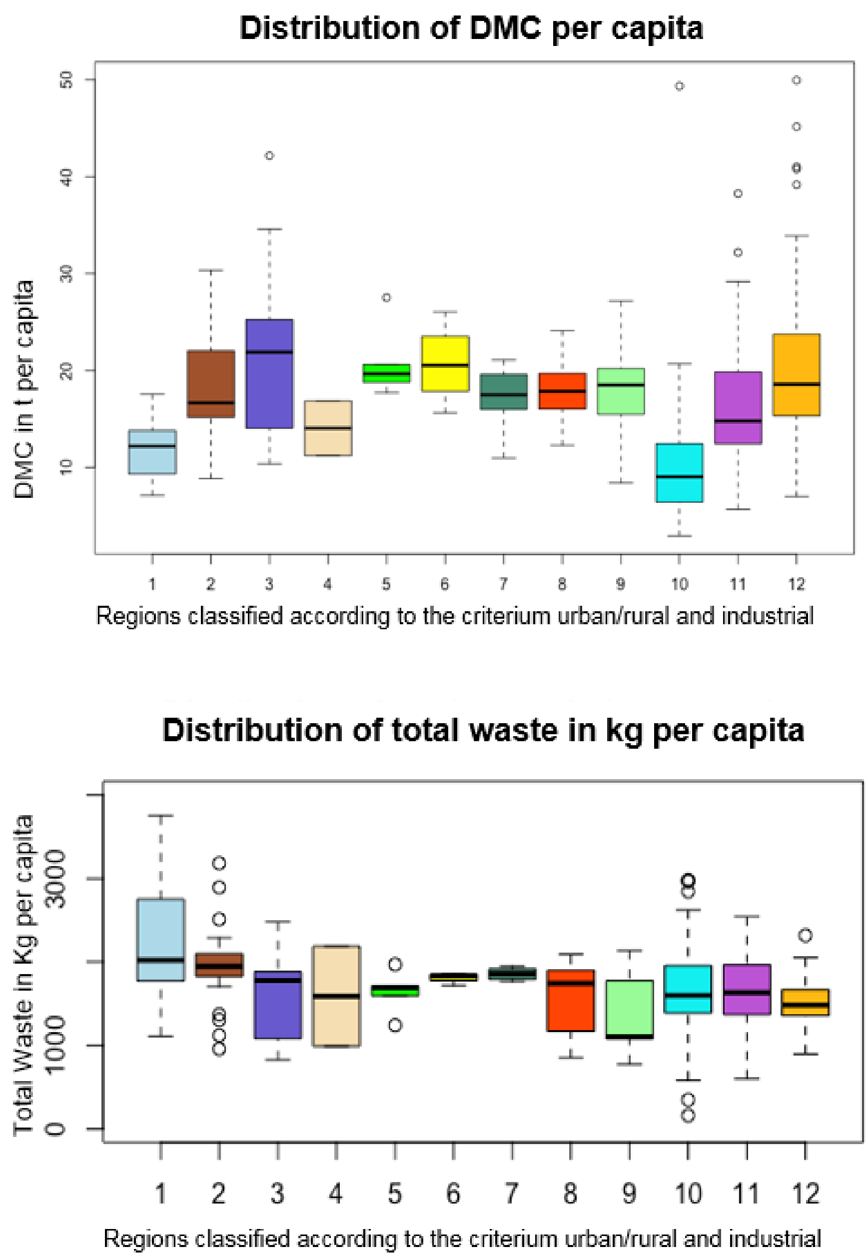
Data limitations illustrate the need for an improved data situation at NUTS-2 level in order to be able to make founded assertions about how a region is progressing towards a circular economy. At the moment, the information value is very limited due to the availability of the existing indicators, the general data quality (already for the initial national data) and the methodically difficulties of the regionalisation approaches.

Regardless of data quality, what emerges from the regional analysis conducted in the CIRCTER is that the spatial aspect of population density is clearly reflected in the studied typologies and

[9] The data presented on this map are based on model estimates produced by the CIRCTER project. The expected accuracy of the estimated values is **low** (see Annex 2 for the details)

their distribution analyses. In principle, the distinction between urban and rural regions is more relevant than the differentiation of regions according to whether a region is industrial or not, both for material input and for waste indicators (see Figure 3.5). Annex 3 provides a more detailed territorial analysis based on materials and waste flows.

*Figure 3.5: Box plot diagrams for urban/rural and industrial typology of regions for Domestic Material Consumption (above) and total waste (below) per capita*



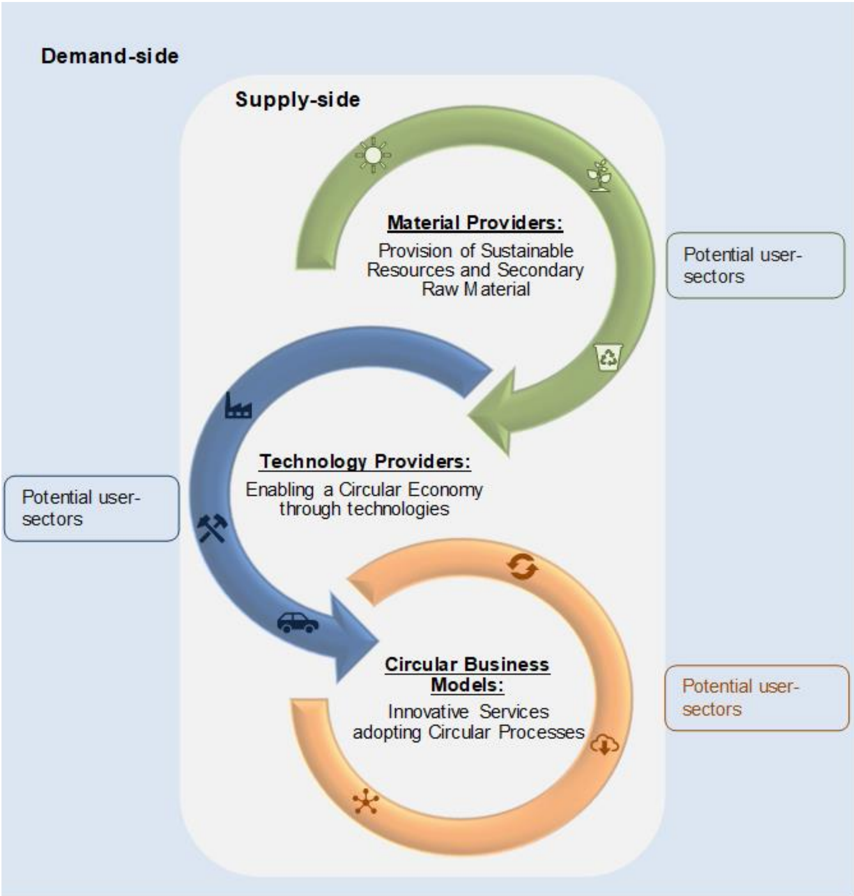

| | |
|---|---|
| 1 = predominantly urban/industrial region losing importance | 7 = predominantly urban/industrial region mixed directions |
| 2 = intermediate/industrial region losing importance | 8 = intermediate/industrial region mixed directions |
| 3 = predominantly rural/industrial region losing importance | 9 = predominantly rural/industrial region mixed directions |
| 4 = predominantly urban/industrial region gaining importance | 10 = predominantly urban/no industrial region |
| 5 = intermediate/industrial region gaining importance | 11 = intermediate/no industrial region |
| 6 = predominantly rural/industrial region gaining importance | 12 = predominantly rural/no industrial region |

*Source: Own elaboration*

# 4 Unlocking circular economy potentials at regional level: a sectoral perspective

As claimed in Section 2.1 above, a circular economy is restorative and regenerative by design. Companies following these principles as part of their business models aim to maintain the value of materials, components and products as long as possible, while reducing the amount of waste that is produced. 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 sectoral perspective. The CIRCTER definition of a circular economy provides a basis for such an analysis by differentiating between the supply-side and demand-side of the economy (see Figure 4.1).

*Figure 4.1: A conceptual visualisation of the CIRCTER circular economy model*




*Source: own elaboration*

The *demand-side* is defined by industries that adopt or rather demand new circular business processes, products and technologies that drive their uptake. These are referred to as *Potential Users*. They provide important opportunities for innovative processes and products to be introduced into their own value chains. Their specific needs and choices tend to foretell those of the general market. The primary focus for analysis of the *Potential Users*, therefore, is focused on the uptake of circular economy processes at the sectoral level. This analysis, not included here, is available in Annex 4.

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*, *Technology Providers* and *Circular Business Models*. Table 4.1 exemplifies the list of products and activities considered in each category. A comprehensive list of examples can be found in Annex 4 to this report.

*Table 4.1: Exemplary list of market segments included in Circular Economy Material Providers (blue) and Circular Economy Technology Providers (red)*

| Sector | Market segment | Examples of relevant products/services |
|---|---|---|
| **Sustainable Agriculture and Forestry** | Organic Farming | Organic agricultural products (e.g. wheat) and livestock (e.g. beef) |
| | Sustainable forestry | Sustainable forestry and logging, forest stocktaking |
| | Wood materials | Provision of and substitution by wood-based materials |
| **Waste Collection and Recycling Services** | Waste collection and treatment | Recovery of sorted materials, collection of recyclable materials |
| | Energy recovery | Landfill gas |
| | Material recovery | Paper/metal recycling within the paper/basic metal manufacturing industry |
| **Renewable Energy** | Bioenergy, geothermal, solar, hydropower, wind | Renewable energy provision from bioenergy, hydropower |
| | Network expansion and operation | Electro-installations and powerlines for renewable energy |
| **Agricultural Technology** | Sustainable agricultural technologies | Ecological fertilizer/pesticides, animal friendly technologies |
| **Eco-friendly Materials** | Materials from renewables raw materials | Natural fibres, bioplastics, composite materials, natural cosmetics / cleaning products |
| **Waste Management Technology** | Waste processing technology | Components and instruments for treatment plants and waste analysis, equipment for agglomeration |
| | Containers for waste collection and transport | Waste bins and refuse containers |
| | Other (R&D) | Research, development and analysis, barriers |
| | Waste vehicle technology | Refuse collectors |
| **Material and Energy Efficiency Technology** | Material-efficient production processes and technologies | Material-efficient processing technologies, information technology and sensors, … |
| | Installation, repair and consultation services | Installation and consultation, instrumentation, control technology |
| | Waste heat utilization | Waste heat recovery systems |
| | Air pressure and pump systems | Compressed air and pump systems |
| **Renewable Energy Technology** | Consultation and research | R&D, energy consultation services |
| | Storage of energy | Electrochemical and mechanical storage technologies |
| | ICT for energy systems | Smart grids or meters |
| | Network technology | Grid technology and measurement |
| | Energy technology | Technologies for renewable energy sources |

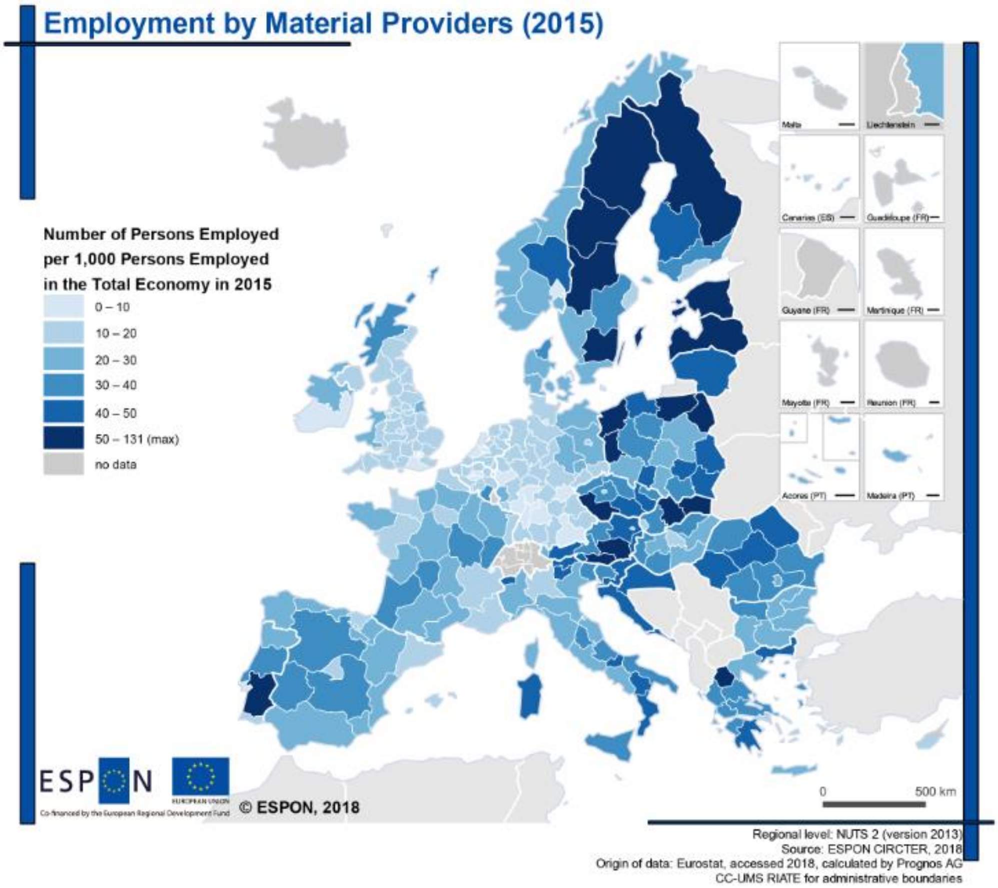
*Source: own elaboration*

This classification captures the direct and indirect effects of identified sectors contributing to a circular economy and identifies the value chains involved in the transition from a linear towards a circular economy. Based on this classification, a sectoral analysis is conducted at the regional level (NUTS-2). It allows assessing the territorial implications of this sectoral distribution, be they economic, environmental or social. This analysis is presented below.

## 4.1 Material providers for a circular economy

*Circular Economy Material Providers* represent mainly the biological cycles but also those essential services that reintroduce wastes as a resource into existing value chains. Simply put, *Circular Economy Material Providers* form the basic input-side by providing materials for a circular economy that are comprised of renewable and recycled materials. Illustrative examples are the market segments forestry, sustainable agriculture and renewable energy along with the production of high-quality secondary raw materials from wastes, namely the collection and recycling services.

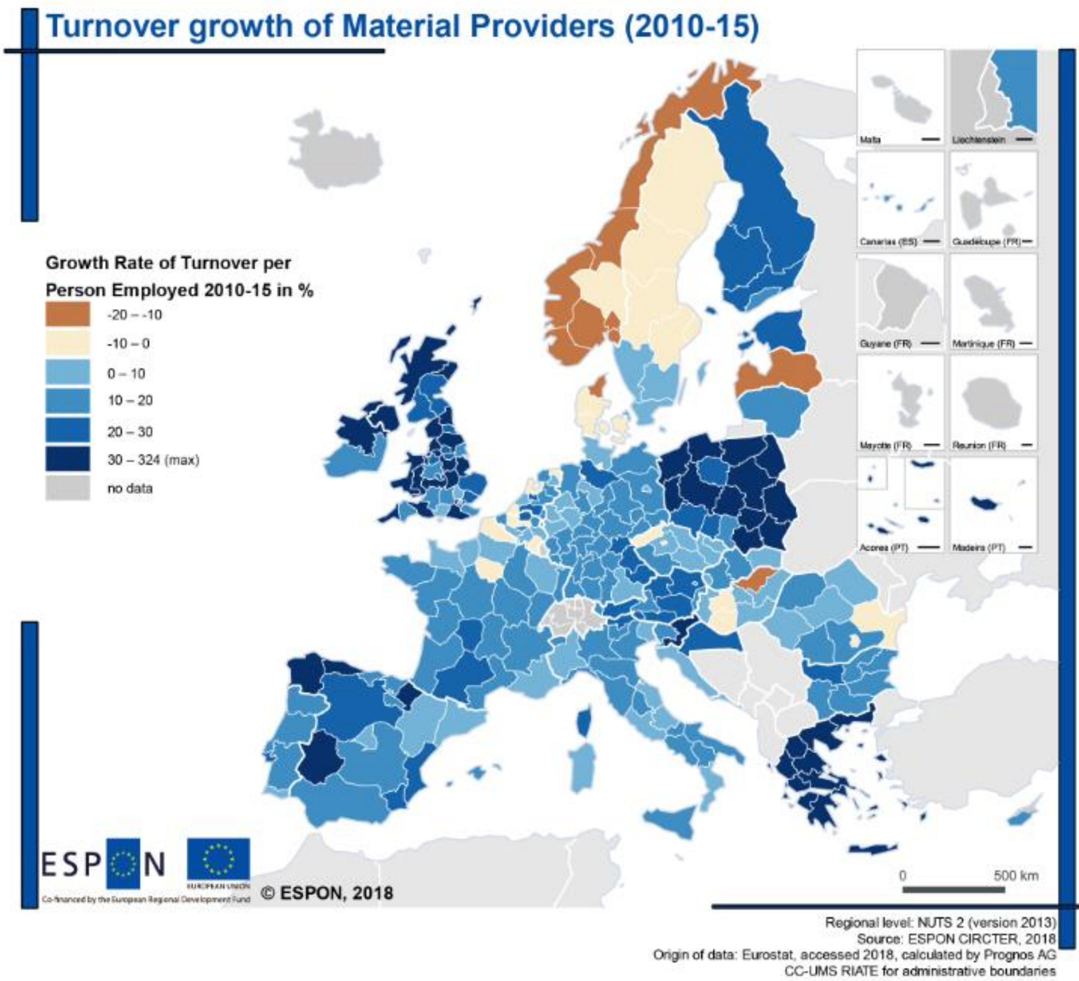
*Map 4.1: Territorial distribution of employment of Circular Economy Material Providers*




*Note: Norway excludes persons employed in forestry and related activities, due to missing data.*

Waste collection, on the other hand, is a core activity of any economy that is continuously undergoing development to enable reuse, recycling and recovery, while efforts are made to reduce waste in the first place. Higher levels of sophistication in recycling allow such services to capitalise on waste streams. At the same time, the secondary resource market is subject to price fluctuations in the primary resource market and is also challenged by the technical difficulties linked to the recycling of specific compounds (particularly the so-called ‘composites’) defined at products’ design stages. Proximity to urban and industrial agglomerations provides a significant input stream of recyclable resources that may allow for greater efficiency.

*Map 4.2: Territorial distribution of turnover growth of Circular Economy Material Providers (2010 - 2015)*




*Circular Economy Material Providers* are an important contribution to regions’ economic structure (up to 13% of total employment in some areas). Overall, *Circular Economy Material Providers* are more present in predominately rural regions, not least due to the dominant role of agricultural and forestry activities. Waste Collection and Recycling Services sectors also play an important role, that may benefit from their proximity to industrial processes and urban centres. Waste Collection and Recycling Services tend to remain more proportionate in size to the overall economy than for example sustainable agriculture and forestry. The territorial distribution of employment of the *Circular Economy Material Providers* in relation to the regions' total employment that is shown in Map 4.1 highlights the important role of sustainable agricultural and forestry activities in the European peripheral regions. Northern Europe stands out for its large areas covered in forests (northern Sweden), while some Baltic regions and eastern European regions are marked by higher shares in agricultural activities of which some have also high shares in organic farming (see Figure 4.2).

Organic farming and sustainable forestry and the provision of wood materials remain the largest employment sector in the *Circular Economy Material Providers* segment. Some regions have grown significantly over the 2010 to 2015 period, even if in accumulated terms organic farming and sustainable forestry have experienced a minor down-turn over the observed period. The positive development in this sector more clearly expressed in the growth rate of turnover per person employed (Map 4.2). Given the comparably low turnover per person employed in peripheral regions, their growth allows them to gain marginal ground against the core. Annex 4 provides a more detailed analysis on the relative behaviour of specific sub-sectors and their territorial implications.

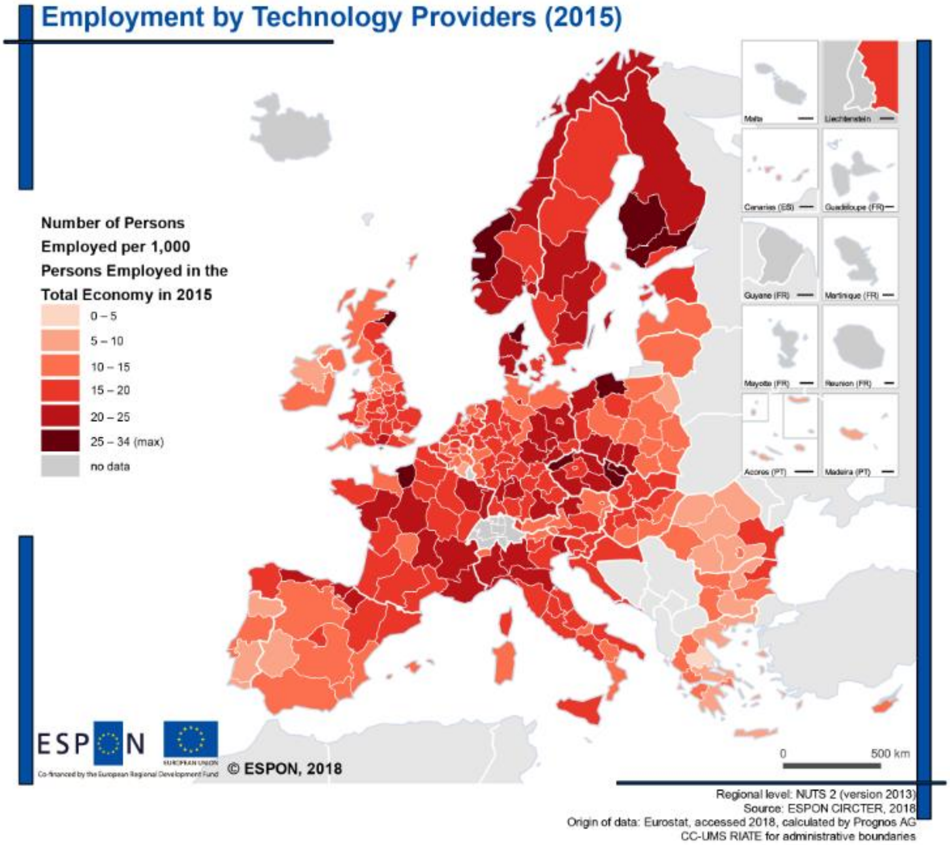
## 4.2 Technology providers for a circular economy

*Circular Economy Technology Providers* offer technologies and key services that enable cyclical resource flows and more efficient use of materials. They also provide intermediate products representing the technological cycle and, in many ways, enable the implementation of circular economy processes through innovative technologies and resource-saving services throughout the value chain.

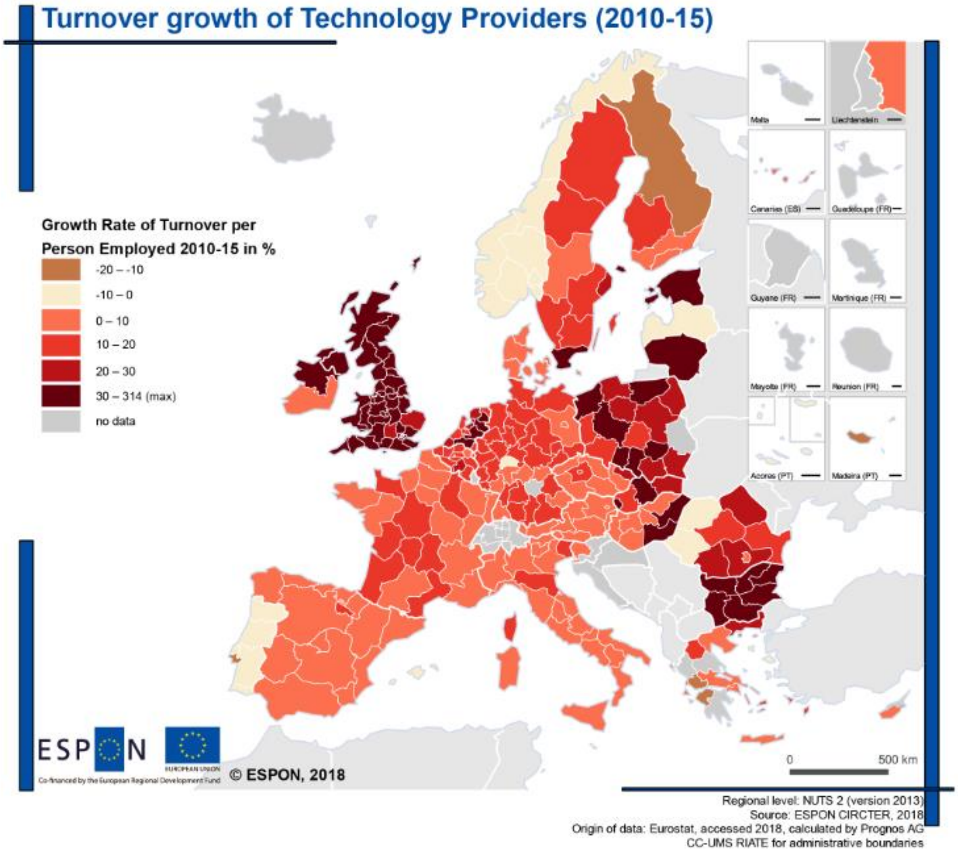
The main contribution of *Circular Economy Technology Providers* in terms of value generation is to recover and restore materials, components and products through the provision of technologies and services that aid the reuse, repair, recycle and remanufacture durables, and that turn wastes into resources. In so doing they provide necessary technologies also for the operation of the *Circular Economy Material Providers*. *Circular Economy Technology Providers* also include the production of consumables from eco-friendly materials, such as natural fibres, bioplastics or composite materials, or technologies for the generation of renewable raw materials or energy, as well as installations and machinery for the treatment of material streams. Table 4.1 provides an overview of the economic activities that are included within the circular economy *Circular Economy Technology Providers* category.

*Circular Economy Technology Providers* are more present in predominately urban and intermediate regions (see Map 4.3). While *Circular Economy Technology Providers* appear to cluster especially near industrial centres, several regions stand out for their high shares in the total economy (see Map 4.4). Their commonality is a large number of persons employed in the repair of fabricated metal products, machinery and equipment.

*Map 4.3: Territorial distribution of employment of Circular Economy Technology Providers*




*Map 4.4: Territorial distribution of turnover growth of Circular Econ. Technology Providers (2010 - 2015)*



## 4.3 Understanding circular economy potentials: the contribution by circular material and technology providers

Across all considered regions, *Circular Economy Material* and *Technology Providers* represent nearly 4 percent of the total European economy, measured in terms of employment, making up almost 5.8 million employed persons and generating a turnover of nearly a trillion Euros in 2015 (940 billion Euros)[10]. *Circular Economy Material Providers* make up almost 60 percent of employment (57%) and turnover (59%) of the combined *Circular Economy Material* and *Technology Providers*. However, *Circular Economy Technology Providers* are developing more dynamically and versatile with an employment growth of 2.6 % between 2010 and 2015. *Circular Economy Material Providers* achieved around 1.7 % as did the total economy (1.7%)[11].

Sustainable Agriculture and Forestry is the single largest employment sector with 30 percent of the combined *Circular Economy Material* and *Technology Providers*. It is followed by the sectors Material and Energy Efficiency Technology (24%) and Waste Collection and Recycling Services (22%)[12]. The sector Material and Energy Efficiency Technology is the largest turnover generator with 23 percent of all turnover of the *Circular Economy Material* and *Technology Providers*. It is closely followed by Waste Collection and Recycling Services, Sustainable Agriculture and Forestry and Renewable Energy Providers (between 21 and 19 percent). The smallest is the sector Eco-friendly Materials (1%)[13].

The regional circular economy structure reflects a region's overall economy in important ways. On the one hand, the *Circular Economy Material* and *Technology Providers* already constitute core activities within the linear economy, such as by providing waste collection and recovery services or technologies for the transport and treatment of wastes. On the other hand, they also provide and enable the transition towards a circular economy through new economic activities, such as by harvesting alternative sustainable construction materials or new technologies to produce renewable energy.

The territorial pattern of these circular economy economic activities reflects some commonalities and specialisation. *Circular Economy Material Providers* are, relative to the total economy, more prevalent in rural regions. In turn, a higher share of *Circular Economy Material Providers* employment correlates with lower scores in the Regional Innovation Scoreboard and the Regional Competitiveness Index's sub-indicators Infrastructure and Business Sophistication. This

[10] With data for persons employed in Technology and Material Providers representing 275 out of the 292 regions in EU Member States and EFTA regions (NUTS 2) and the total economy representing 273 regions and the sectors A01, A02, B-J, L-N and S95. Turnover represents 275 regions.

[11] The growth rates are based on data aggregates for Persons Employed in Technology Providers, Material Providers and Total Economy representing the same 267 regions. It excludes the regions of London and Croatia, Nord-East of Romania, Zahodna Slovenija, Iceland and Switzerland.

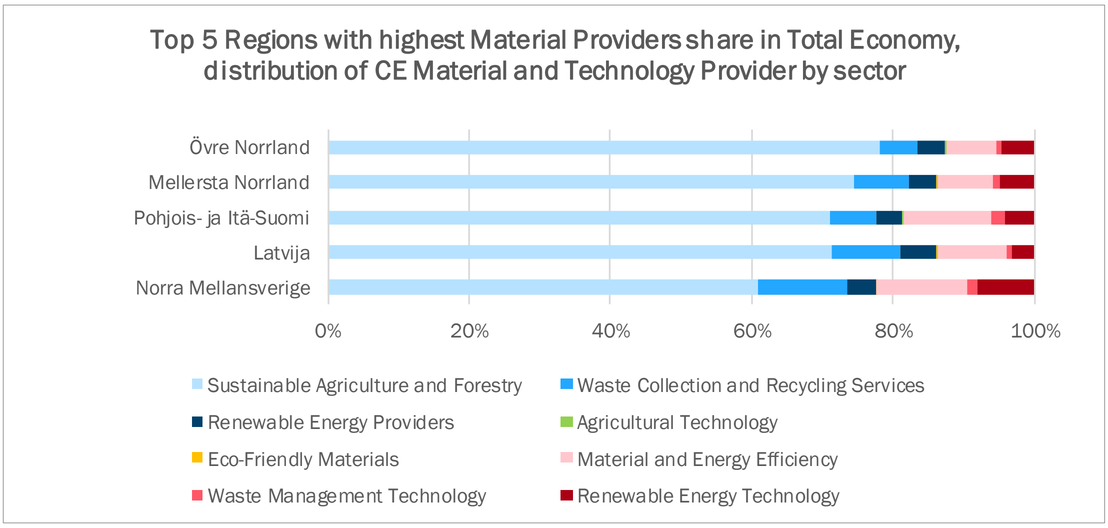
[12] The distributional shares are based on 272 regions.

[13] Distribution shares based on 275 regions.

is a pattern that the revised Bioeconomy strategy (COM/2018 673) should aim at modifying.

Reversely, the share of *Circular Economy Technology Providers* correlates positively with higher Innovation and Labour Market Efficiency scores, yet barely with Business Sophistication and Infrastructure. In comparison to *Circular Economy Material Providers*, the distribution of *Circular Economy Technology Providers* is, even though more prevalent in urban regions, more abstruse and reflects more varied pull and push factors. These could include the ability of industries to re-locate, locate near existing industrial centres to benefit from proximity and agglomeration effects, the long-term investment into places through continuous innovation or, just simply, pre-existing specialisation. In other words, the size of a sector varies not only according to the regional economic structure but also according to a range of territorial factors.

*Figure 4.2: Regions with the highest Circular Economy Material Providers share in total economy by sectors in 2015 (Circular Economy Material and Technology Providers = 100 %)*

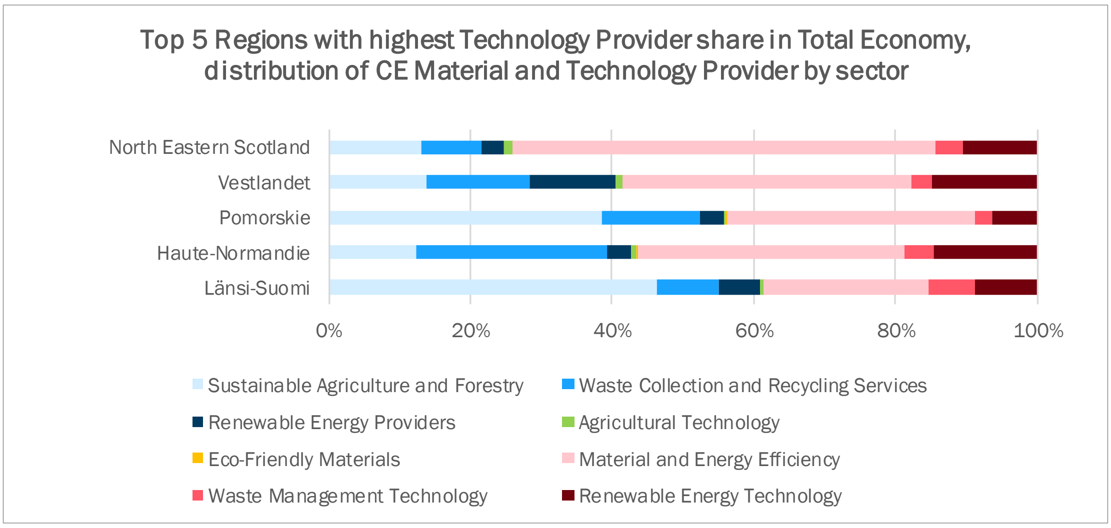



*Source: own elaboration*

The relationship between the number of business units (local units) and number of persons employed provide further indications for economies of scale and agglomeration effects. It is commonly understood that economies of scale and agglomeration lead to higher productivity. The ratio between persons employed per business unit is higher for the *Circular Economy Technology Providers* than the *Circular Economy Material Providers* (not depicted). The overall higher ratio of *Circular Economy Technology Providers* is likely to reflect economic factors such as cost curves. As the employment share of *Circular Economy Technology Providers* to the overall economy across all regions increases (number of employees in *Circular Economy Technology Providers* per 1,000 total economy employees), so does the number of employees per unit. This is a sign of agglomeration and economies of scale forces operating in the *Circular Economy Technology Providers*. In contrast, the same analysis for the *Circular Economy Material Providers* is inconclusive, even though a U-shape trend is notable (See Annex 4 for details). It may reflect territorial differences in the level and direction of agricultural consolidation.

For instance, where the farm size increases, the number of farms decreases.

*Figure 4.3: Regions with the highest Circular Economy Technology Providers share in total economy by sectors (Material and Technology Providers = 100 %)*




*Source: own elaboration*

## 4.4 Circular Business Models: regional pioneers

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).

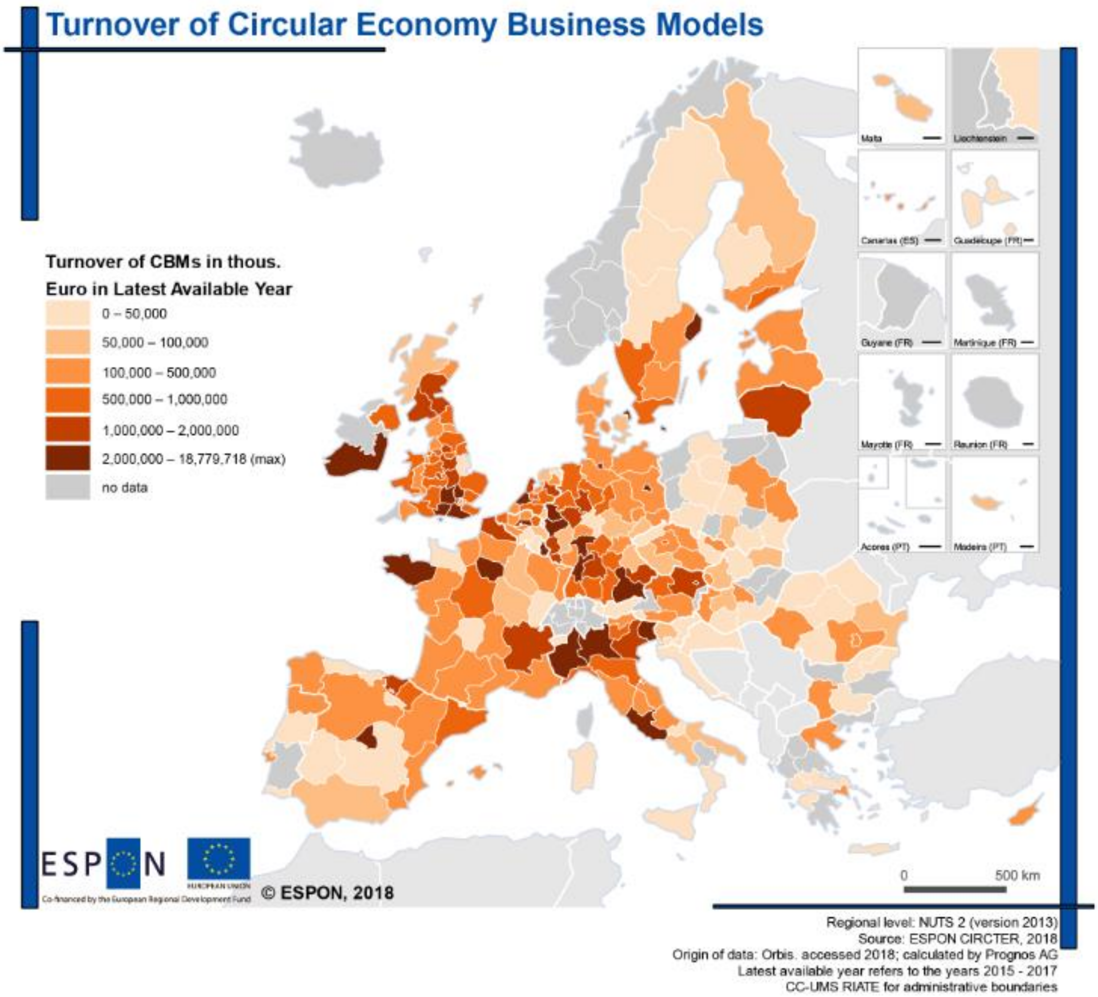
*Table 4.2: The four overarching Circular Business Models*

| CE Business Model | Description | Contribution to a CE | Examples |
|---|---|---|---|
| Long Life Design | Models focused on delivering long-life-products, supporting design for durability and repair. | ▪ Supporting long-life-products through design for repair, refurbishment and remanufacturing – focus on product design.<br>▪ Essential part of the company's normal design ethos, often linked to the concept of eco-design and geared towards disassembly. | Modular Design, Cradle-to-Cradle Design, Eco-Design |
| Extending Product and Resource Value | Exploiting residual value of products. | ▪ Exploiting the residual value of products.<br>▪ Collecting and reselling refurbished products and / or components.<br>▪ Often reffered to as ‚closing the loop'. | Remanufacturing, refurbishment, upcycle, take-back systems |
| Encourage sufficiency and shifting utilisation patterns | Seeking to reduce end-user consumption and delivering utilities virtually rather than materially | ▪ Supporting sufficiency and shifting utilisation patterns – focus on consumers.<br>▪ Digitising business products and services.<br>▪ Shift in demand patterns through technology as consumers choose virtual products or services | Pay-per-Service, Re-commerce, reuse cafés |
| Access, Sharing and Performance Model | Providing the capacity of services to satisfy user needs without needing to own physical products | ▪ Manufacturer or service provider retains ownership of the product.<br>▪ Sharing models seeking to reduce under-utilisation of products, facilitated by digital technology and social platforms. | Car-sharing, Carpooling, tool sharing, office shares |

*Source: own elaboration*

The innovative big data analysis in the CIRCTER project identified over 9000 regional pioneers providing CBMs across all MS (see Annex 4 for details). They comprise 1 Million jobs and EUR 266 Billion in turnover, covering all company sizes: Very large companies, 12%; Large companies, 31%; Medium-sized companies, 27%; Small companies, 30% (per ORBIS definition).

*Map 4.5: Turnover of companies associated with Circular Economy Business Models (CBM)*




Circular Business Models mostly concentrate in highly populated regions, such as capital cities (for instance Paris, Rome, Vienna or Greater London) and urban regions (see sub-regions of Bavaria and Baden-Württemberg, Catalunya or West Sweden in Map ES.1 and Map 4.5). The tendency to be, in absolute numbers, more present in urban areas overlaps with the observation that *Circular Economy Technology Providers* are relatively more present in urban regions. This observation suggests that certain innovative types of circular economy activities flourish especially in urban areas.

Hence, it can be concluded that the implementation and diffusion of CBMs is generally favoured by agglomerations (both industrial and urban), in proximity of knowledge hubs. Agglomeration and proximity factors provide businesses with benefits due to shared access to information, networks, suppliers, distributors and resources. Urban proximity can promote strategies such as take-back programmes, reverse logistics and a reliable stream of secondary materials.

Similarly, knowledge centres, universities or R&D serve as important factors in boosting innovation capacities and can be a decisive factor for the development of disruptive products and/or resource efficient processes. Specialised knowledge of actors within a territory can not only provide a distinct advantage compared to other regions, it can also act as a strong driver for the design and implementation of effective policies towards a circular economy, informed by the territorial characteristics of a city or region.

End-consumers must be incorporated into circular strategies, as they need to be convinced of the reliability of repurposed products as well as prompted to use circular business models at a peer-to-peer level. Similarly, shifting towards circular economy, through a focus on product design and remanufacturing of products, for instance, will result in an increase need for a skilled labour force with specific competences required in new collection, sorting, and remanufacturing systems. Remanufacturing sites, transport, storage and distribution activities are likely to increase close to manufacturing sites, as well as near major population centres and transport hubs.

The digitisation of services, however, is likely to benefit a range of jobs, from local services related to a product or good (customer care services such as return or repair services), though potentially these may follow the current trend towards overseas placement. To enable a successful shift towards a circular economy, territories will have to address emerging opportunities and market developments comprehensively and coherently, similar to Smart Specialisation Strategies with a specific focus on, or incorporating, a circular economy perspective to boost future employability rates end unleash economic opportunities.

# 5 Regional and local approaches to implement a circular economy: lessons from the CIRCTER case studies

## 5.1 An overview to the CIRCTER case studies

The six case studies conducted in CIRCTER represent very different types of territories, geographical and historical contexts, and exemplify a wide range of motivations and approaches to transform the way we produce and consume. Similarly, the cases illustrate diverse leadership and governance, ranging from single to collaborative leadership, as well as various forms of public-private collaboration. Map 5.1 and Table 5.1 provide an overview of the six cases.

*Map 5.1: Spatial distribution of the CIRCTER case studies*

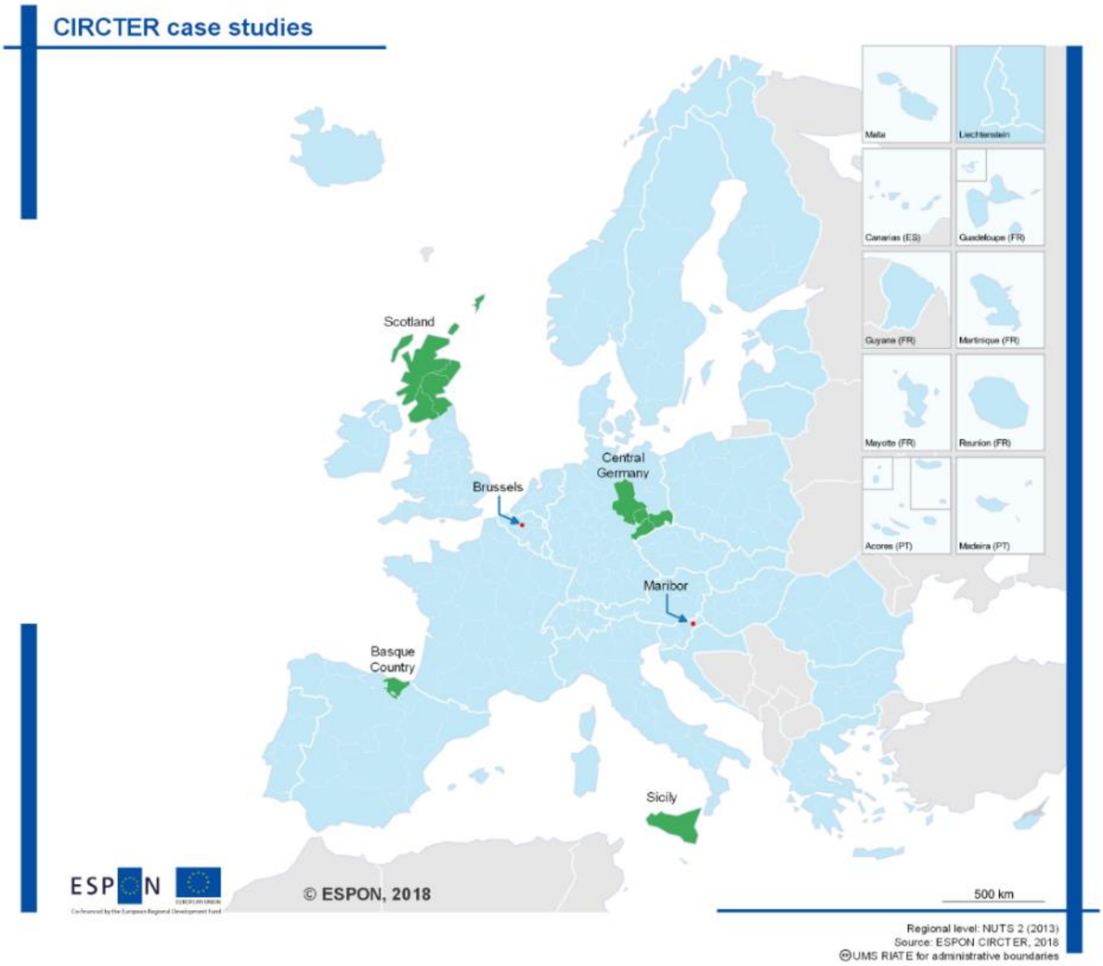


*Table 5.1 Overview of case studies*

| CASE STUDY | START | APPROACH & PRIORITIES | TARGETS | OUTSTANDING MEASURES |
|---|---|---|---|---|
| **Scotland - circular economy strategy "Making Things Last"** | 2010 | -Food and drink, remanufacture, construction, energy infrastructure;<br>-Design<br>-Waste prevention (households and industry)<br>-New skills, and new thinking culture<br>-Longer lifetime for products | -Cut food waste by a third until 2025<br>-Scotland becomes worldwide leader in the sift to a circular economy | -Charter for Household Recycling<br>-Second-hand superstore<br>-'Recycling on the go' to change lifestyles<br>-Circular Economy Investment Fund: circular design projects and services, in collaboration between businesses and academia<br>-Upskilling: Strategic agenda -Scottish Carbon Metric<br>-The Scottish Institute for Remanufacture |
| **Maribor - The WCYCLE strategy** | 2014 | -Cooperation among public utility companies in the processing and re-use of material, energy and water waste resources | -Increase the recycling rate by 30%<br>-Increase the share of reusable waste (from 14% to 44%)<br>-Create new markets for secondary raw materials | -Wcycle Institute to promote cooperation among public utilities<br><br>-New high-tech waste management plant with the capacity to sort ant treat 200 Kilotons per year |
| **Brussels Regional Plan for a Circular Economy 2016-2020** | 2013 | -Logistics, waste, construction, food and retail<br>-Economic opportunities of CE<br>-Place-based economy<br>-Create new jobs | | -Business park<br>-Link academic research in circular economy-work by public and private actors<br>-Networking platforms<br>-Monitoring scheme |
| **Basque Country circular economy initiatives** | 2013 | -Key metals and plastics, composites and rubber -A strong industry orientation<br>-Eco-design, remanufacturing and advanced repair, servitisation and new business models | -Decrease raw material consumption by 6%<br>-Save 2,000 Millon euro | -Green public/private procurement<br>-Standardisation<br>-Grants (eco-design, demonstration, industry 4.0. to drive a circular economy)<br>-Financial support to equipment and infrastructure<br>-Fiscal deductions<br>-Circular economy monitoring framework |
| **Sicily - Industrial symbiosis** | 2011 | -Agri-food and construction<br>-Unlock the potential of industrial symbiosis in Sicily | | -Online platform to launch industrial symbiosis: to analyse material and waste flow and identify potential matches for waste reuse<br>-Guiding documents to implement the matches<br>-Network of local stakeholders and companies - trust |
| **Central Germany - The Bioeconomy Cluster** | 2012 | -To build a bioeconomy leading market | | -Foster joint innovation opportunities, share knowledge and support companies and research projects |

## 5.2 Achievements

**Achievements** of the cases depend very much on the starting date as well as the type of monitoring mechanisms in place and vary depending on the scope and goals of the initiatives. While the initiative in Scotland (the one with the longer trajectory) has already been proved to be effective, and the first circular economy initiatives in the Basque Country have had positive outcomes, the results of the first reporting and assessments in Maribor and Brussels are not ready yet. Some of the most significant initiatives in Maribor have not yet been physically implemented and, by the time of completion of the present report, the first evaluation of the Brussels strategy was not yet available. Likewise, the type of results depends greatly on the kind of initiatives and the actions implemented in each case.

*Table 5.2 Key achievements of the selected cases*

| **Scotland - circular economy strategy "Making Things Last"** |
|---|
| Scotland's overall carbon impact has been reduced by 26% since 2011: Due to a decline in landfilling (the lowest rate, 32.5%, was recorded in 2016) and improved recycling rates (particularly for high impact waste materials, like construction and demolition waste). The recycling rate of non-household materials has increased 26% between 2011 and 2016. |
| The Charter for Household Recycling is gaining momentum and was signed by half of all Scottish councils by July 2016. The Circular Economy Investment Fund have opened-up new revenue streams for companies. |
| **Maribor - The WCYCLE strategy** |
| Positive change in the management of the public utility companies. |
| The first quantitative results will be verified by the end of 2019: The goal is to increase the municipal recycling rate by about 30%, and to shift the share of reusable waste from the current 14% to 44%. Economic benefits are also expected thanks to the future local market for secondary raw materials. |
| **Brussels Regional Plan for a Circular Economy** |
| Innovative governance can be listed as a positive achievement: Under a strong coordination structure, it leverages both offer and demand for circularity (111 actions that provide a holistic and transversal approach). A mix of bottom-up and top-down measures, which provide the necessary amount of political direction with enough flexibility to adapt the measures according to the needs of a wide array of territorial actors. |
| Reporting on progress and potential revisions are foreseen every year and a half. No monitoring report was available at time of writing (October-November 2018). |
| **Basque Country circular economy initiatives** |
| Basque industries are adopting circular strategies and believe that progressing to a circular economy is a competitiveness factor: 59% of the Basque companies interviewed in 2014 considered that eco-design is fundamental to develop a competitive advantage, particularly in international markets; the 87 companies that have participated to the "Circular Economy Demonstration Projects Programme" expect additional 38.7 million euro in direct revenues from the new circular economy solutions |
| **Sicily - Industrial symbiosis** |
| More than 690 potential matches were found between the participating enterprises. More than 80 SMEs were matched for potential collaborations to reuse waste. The online platform is still being used after the end of the project that initially established the network in 2015. Replication of the project in other regions is ongoing. |
| **Central Germany - The BioEconomy Cluster** |
| In 2012 the cluster was one of the winners of the Leading-Edge Cluster Competition held by the Federal Ministry of Education and Research (BMBF). The cluster is able to identify complete value chains and has developed a strong research and development knowledge-base and know-how in multiple areas (e.g. chemical industry and wood sector). |
| Around 500 to 600 direct jobs have been already created, with a potential for at least 5,000 expected jobs in the entire region if a complete circular bioeconomy is developed. |

## 5.3 Enabling and hindering factors

The following conclusions are derived from the assessment of the enabling and hindering factors in the assessed cases:

- Reaching 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-sensitive** 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. These often lead to better designed regulations and incentives that contribute to the transformation of the local economies.
- **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.

## 5.4 Territorial factors matter

The case studies have also confirmed that spatially-bound assets and features condition the way a circular economy is operationalised in various ways:

**Physical endowment:** Nature-based factors (i.e. high availability of biobased raw materials) are crucial to enable a circular bioeconomy (preserve and enhance natural capital through biological cycles) as the case study in Central Germany demonstrates.

**Agglomeration economies:** Agglomeration factors, both urban and industrial, are an important territorial enabler for the circular economy. **Industrial clusters**, for example, play a key role in unfolding innovation potentials. The Basque Country is one of the main industrial hotspots in Spain and this industrial vocation features the way circular economy is operationalised in this region. The shift to a circular bioeconomy in Central Germany is taking place around the well-established chemical value chain and the unique linkage of the core industries of timber, chemicals and plastics. **Urban agglomerations** ensure the necessary ‘critical mass’ to e.g. adopt low-value waste management approaches, as well as to endorse a range of community-based initiatives around the circular economy. Brussels is pursuing a place-based economy (closing material loop on the territory) by building upon the relational proximity between the actors and by focusing on 10 priority zones and the canal strip.

**Accessibility:** Physical (and perceived) accessibility, proximity and connectivity are key to enable certain modalities of a circular economy. The platform to facilitate industrial symbiosis in Sicily assesses proximity (distance and transport costs) to identify opportunities for process matching (process outputs, typically discarded, used as inputs by other firms). On a different level, the strong ties to Eastern Europe and interlinkages with national and international initiatives to promote a bioeconomy are relevant success factors for the BioEconomy cluster in Central Germany.

**Knowledge and technology-based enablers:** Strong knowledge and technology basis are highlighted as a meaningful driver by all the case studies. This embodies not only in the presence of scientific and technical knowledge, infrastructures and networks (e.g. the access to leading research institutions with laboratory, pilot and demonstration facilities located in Saxony-Anhalt, and high potential of skilled workers through universities and vocational training form the basis for establishing a circular bioeconomy in Central Germany), but also in other factors such as building a strong evidence base before strategic decisions are made, like a detailed urban metabolism study in Brussels, the circular economy diagnosis in the Basque Country, or the new method to analyse and measure waste reductions in Scotland.

**Governance and institutional drivers:** All the case studies stress the relevance of governance and institutional factors for successful transformations. These may include clear political vision, engaging a wide array of actors, public-private partnerships, stable long-term framework, targeted actions, monitoring frameworks, networking and coordination mechanisms, etc. For example, the success of the Brussels Regional Plan for a Circular Economy lies in its innovative governance, materialised in a strong coordination structure that prevents siloed policies, and ensure political buy already at an early stage. The leading role of public authorities in shaping a circular economy strategy and pushing it forward (through e.g. green public procurement, grants, fiscal deductions, etc.), the establishment of a monitoring framework and the embedding of the environmental sustainability in the overall regional strategy, are the main governance drivers in the Basque Country. In Scotland the leading role of government to identify specific sector opportunities, raise awareness through successful public consultation and implement common municipal approaches are being crucial to transition to a circular economy.

## 5.5 Lessons for transferability

The relevant role played by territorial specificities, whereby comparable features might act as enablers or barriers depending on the specific territorial context, challenges the **transferability and replication potential** of the cases. There is no “one-size-fits-all” solution emerging from the CIRCTER case studies. Understanding the territorial specificities, with their socio-economic, environmental and institutional realms, is crucial to envisage a successful transition to a circular economy. A sound assessment of the above listed territorial factors is the first step that any territory should take to shape **place-based circular economy strategies**. This should be complemented with more technical assessments such as urban metabolism studies (as in Brussels), or other pre-assessment tools (like the circular economy diagnosis in the Basque Country, or the new method to analyse and measure waste reduction in Scotland).

The case studies emphasise that the materialisation of a circular economy requires an **integrated and long-term system change**. All actors in the economic circuits are required to adopt a prone-to-change attitude to re-organise around new ways of production, value creation, and consumption patterns: Direction setting, through the definition of adequate boundary conditions and incentives, is the main task attributed to public authorities at all levels; R&D organisations provide the relevant scientific and technological know-how; industrial actors may shift to more responsible forms of production and contribute to transform the value creation system; and citizens may modify their lifestyles and consumption habits contributing to boost CBM.

All the case studies prove that **policy has a fundamental role to play in steering the transition to a circular economy**. First, the potential for implementing the circular economy may be encouraged or limited by related policy imperatives embedded in the local context. This highlights the inherent iterative nature of planning for circularity and the importance of improving the coherence of the circular economy goals with other priorities. Local agreements defining shared goals and well-established monitoring mechanisms are powerful instruments in this regard. For example, the innovative coordination mechanisms in Brussels whereby all administrations have the formal obligations to cooperate in implementing the circular economy strategy and finding synergetic actions proved to be fundamental to align local policy agendas. Second, innovative products that follow circular economy principles can be promoted, by e.g. supporting research and development and the creation of niche markets through public procurement, awareness raising, incentives, etc., like in the Basque Country. Third, thee right policy framework also provides a level playing field for products and consumption modes that follow the circular economy principles, as evinced for example from the Scottish experience.

**Awareness and education** offer enormous potential to change business and consumer behaviour, and hence, transform the consumption and production patterns. The cases proved that effectively raising awareness and actively involving a broad range of actors can be a fundamental ingredient enabling circular transitions. However, the case studies have also demonstrated that there still is significant room for improvement in this field. Companies are not sufficiently aware of the market opportunities that are missed under 'business as usual'. Unawareness make companies perceive risk in the new CBMs, and this factor discourages innovation. Consequently, mainstream product design does not yet account for circularity principles, and new ways of value creation around CBM are not sufficiently exploited. This barrier is acknowledged in four out of the six cases. Moreover, as the Scottish and Maribor cases clearly show, a sensitised society is also essential to transform the economy. The success of e.g. high-durability products, remanufactured goods, etc. ultimately depends on consumer behaviour. As the real benefits of awareness and education are unleashed in the longer run, these should be complemented by regulatory measures and market and fiscal incentives targeting consumers and companies alike. To some extent, these incentives are already in place in the Basque Country. Incentivising consumer acceptance is also one of the planned measures to drive a circular bioeconomy in Central Germany.

Similarly, the German case study stresses the relevance of **networking, collaboration and cooperation** among all policy actors participating in the production chain, both within and across specific territories. Networking becomes an essential argument to build trust and enable locally-organised value creation systems (e.g. industrial symbiosis in an industrial park, biomass district heating, etc.). The experience of the BioEconomy cluster in Central Germany also emphasises the relevance of international cooperative frameworks. The cluster has joined forces with other leading clusters in France, the Netherlands and the UK to form Europe's Bioeconomy Intercluster (3BI) that aims to help European companies make the most of new markets and opportunities from the bioeconomy. This cooperation has strengthened the competitive edge of European bioproducts, helping European companies to reach overseas markets.

Interested readers may collect additional information on the CIRCTER case studies from the longer synthesis report provided in Annex 5, and from the single case studies available in Annex 5.

# 6 A system's perspective on the circular economy

The core strategy adopted in CIRCTER to build consistent territorial narratives around complex circular economy systems is knowledge integration. This approach allows to analyse a systems' complexity and identify potential upcoming challenges as well as circular economy opportunities. Further, knowledge integration is crucial to assess the extent to which territorial characteristics can amplify or dampen the effectiveness of circular economy interventions. The results of this analysis are presented using Causal Loop Diagrams (CLD), also called system maps that highlight key variables in the system and their interrelations (see Text Box 6.1).

**Text Box 6.1: What is a Causal Loop Diagram (CLD)?**

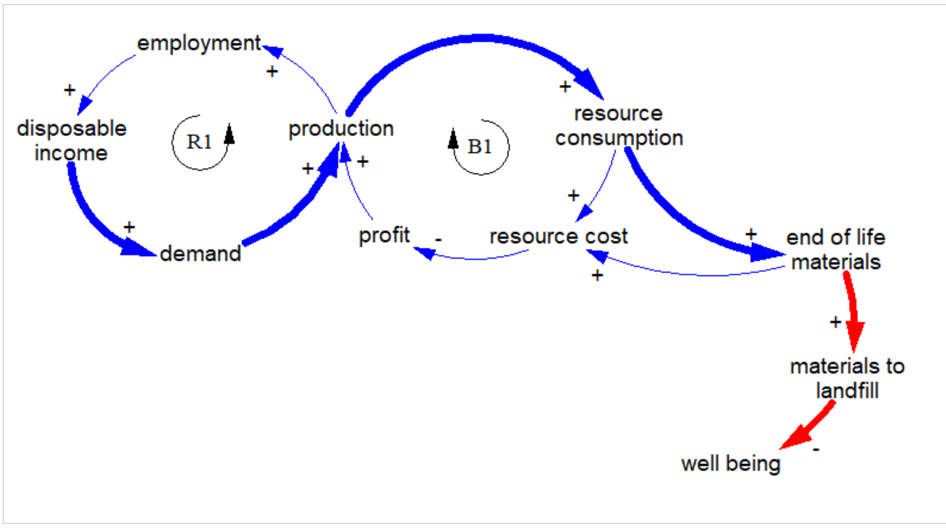
A ***Causal Loop Diagram (CLD)***, or *system map*, is a map of the system analysed, or, better, a way to explore and represent the interconnections between the key indicators in the analysed sector or system (Probst & Bassi, 2014). The creation of a CLD supports the selection of relevant indicators, the determination of causality among these variables, and the identification of critical drivers of change (e.g. feedback loops, or circular relations) that are the primary responsible for the past, present and future behaviour (or trends) of the system.

The use of CLDs is proposed because, when developed to integrate knowledge and through a group model building exercise, a CLD elicits knowledge and creates a shared understanding of the key drivers of change of a system, and hence on the possible outcomes of policy implementation across sectors and actors. CLDs highlight the boundaries of the analysis, supporting the inclusion of social, economic and environmental indicators in a single framework of analysis to fully capture the benefits of a circular economy. Moreover, by visualising the how variables in the system are interconnected, CLDs allow all stakeholders to reach a basic-to-advanced knowledge regarding the systemic properties of the issues analysed.

## 6.1 What territorial narrative emerges from the CIRCTER systems' analysis

The objective of the circular economy is to shift the current economic production setup from a linear to a closed-loop and more sustainable system. Still, with the current production setup we move from demand, to production, to resource consumption.

*Figure 6.1: Simplified Causal Loop Diagram (CLD) of the current production system*

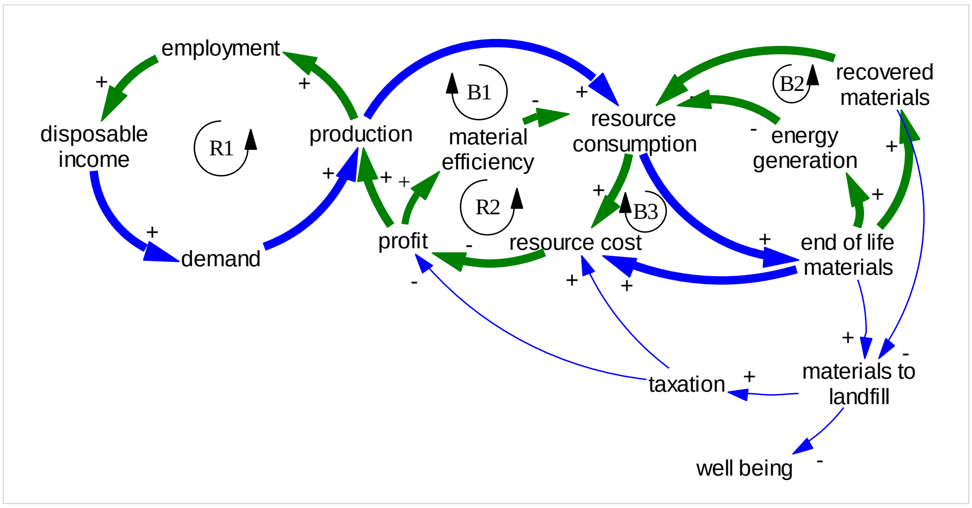



*Source: own elaboration*

Specifically, under the current economic paradigm the growth of income drives the demand for goods and services, which influences production; production in turn leads to resource consumption, resulting in the generation of products and end-of-life materials, as well as pollution; end-of-life materials are then incinerated or accumulated in landfills, which negatively impact well-being (e.g. through air, water and noise pollution) and lead to higher taxation to cover growing waste management costs. This process is illustrated in the Causal Loop Diagram

(CLD) in Figure 6.2. The casual relations that represent the current linear approach are presented using thick blue arrows, while the negative impacts of having end-of-life materials are highlighted with red arrows.

*Figure 6.2: Introducing recycling in the current production process*

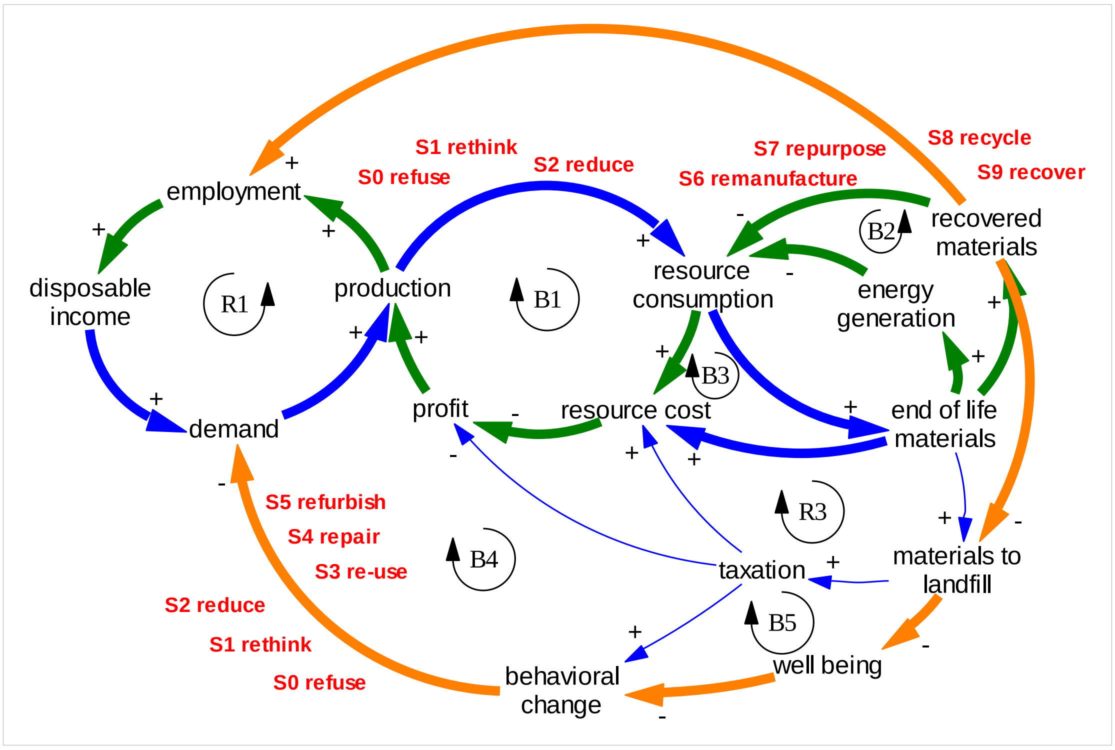



*Source: own elaboration*

Waste recycling and material reuse allows to reduce resource consumption, which reduces costs and allows production to increase, leading to higher demand and resource consumption. Specifically, we see two dynamics at play: (1) the reduction in material use and landfilling due to waste recycling and reuse, and (2) the increase in material use due to the economic growth triggered or enabled by waste recycling and reuse. It results that the actual net reduction in materials use and ultimately waste landfilling is likely to be smaller than expected because of the balancing effect of item (2) previously mentioned. As a result, siloed recycling policies may contribute to an unsustainable production and consumption system that, through increasing demand of raw materials and waste generation (albeit recycling), drives the economic system beyond the coping capacity of global ecosystems. This emerging dynamic is known as 'rebound effect'[2]; green arrows highlight the impact of circular economy interventions potentially leading to rebound effects.

Full circularity can only be achieved when consumption is curbed through system change, putting the emphasis on demand-side policies, including behavioural change (Figure 6.3, orange arrows). In other words, strategies for system change involve both (1) industries and (2) citizens. Economic opportunities emerge through maintenance and repair, refurbishing, repurposing and remanufacturing, but also through the modification of consumption habits through rethinking, refusing and re-using (see Figure 2.1). This makes full use of the three dimensions of circularity: (a) demand, (b) production and (c) resource management.

*Figure 6.3: Integrated Causal Loop Diagram (CLD) including strategies targeting businesses and citizens*




*Source: own elaboration*

## 6.2 Reading and interpreting the Causal Loop Diagram

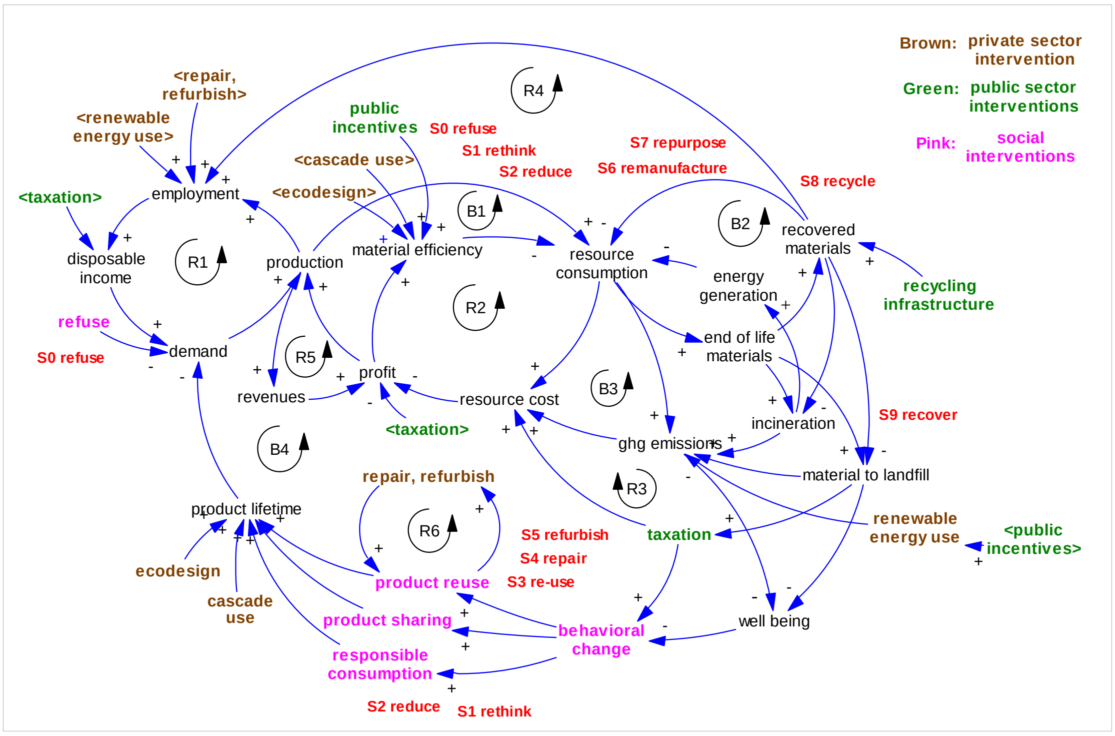
A more detailed version of the CLD shown above is presented in Figure 6.4, and a brief description of this diagram follows below. Additionally, a full documentation is available in Annex 6 to this report.

### 6.2.1 Reading the Causal Loop Diagram

**First**, the CLD includes several variables, such as "production" and "material efficiency". The former is an indicator, while the latter is an intervention. The interventions are presented in different colours, to identify actions that can be taken by the government (green), private sector (brown) and citizens (pink).

**Second**, the CLD shows casual relations between variables and interventions. As an example, an increase in production leads to an increase in material consumption, all else equal (and hence a "+" sign is added to the arrow linking these two variables); on the other hand, an improvement in resource efficiency could reduce material consumption, possibly even in absolute (in addition to relative) terms.

*Figure 6.4: Detailed integrated Causal Loop Diagram (CLD)*




*Source: own elaboration*

**Third**, the CLD includes notations for feedback loops, either reinforcing **(R)** or balancing **(B)**. An example of reinforcing loop is represented at the centre of the diagram: production > employment > population (and disposable income) > demand > production. Feedback loops change in strength depending on local circumstances, and hence local customisation is required. As a result, the CLD can show why certain policies may be more effective in certain regional context than others (e.g. in one case the feedback loop representing resource scarcity may be very relevant, while in other cases not at all).

**Fourth**, to ease interpretation of the diagram and illustrate the potential strategies that can be adopted to enable a circular economy, this specific CLD includes all nine circular strategies **(S1 to S9)** proposed by PBL (Potting et al. 2017), which are also shown in Figure 2.1 above.

**Fifth**, the CLD also shows ***casual links*** or *relations* between variables. These are represented as arrows and mathematical symbols. A *causal link* from *variable* 'x' to *variable* 'y' is *positive* if a change in 'x' produces a change in 'y' in the same direction. Reversely, a *causal link* from *variable* 'x' to *variable* 'y' is negative if a change in 'x' produces a change in 'y' in the opposite direction. As an example, an increase in production leads to an increase in material consumption, all else equal (and hence a plus ['+'] sign is added to the arrow linking these two variables); on the other hand, an improvement in "resource efficiency" could reduce "material consumption" (in this situation a minus ['-'] sign is added to the arrow linking both variables).

### 6.2.2 Interpreting the Causal Loop Diagram

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, the past economic growth has led to the emergence of side effects. Specifically, (a) more waste generation leads to higher accumulation into the landfill or incineration, leading to higher (b) emissions and human health impacts; (c) the 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.

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). 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.

Recycling could be coupled with interventions that aim at preventing waste and increasing material efficiency, such as public incentives as well as private investments in eco-design and cascade use (B1, R2 and R5). Similarly, emissions could be curbed through the introduction of incentives, and investments in renewable energy. On the other hand, as indicated earlier these interventions reduce costs and increase profits, creating space for expanding production and consumption.

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, refurbishment 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. Longer lifetimes cause product demand to decline, the same effect that can be expected from the refusal of consumption, and hence production will not grow as fast, or even decline.

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.

## 6.3 Insights from territorial analysis and case studies

The CLD presented above summarizes available knowledge on the circular economy. The starting point was the review of relevant literature and the collection and analysis of relevant data. As an example, the CLD explicitly includes the nine circular strategies **(S1 to S9)** introduced in the circular economy policy report by the Netherlands Environmental Assessment Agency - PBL (Potting et al. 2017). The CLD was further validated against the policy assessment framework presented in Potting et al. (2018) Subsequently, a customized CLD was created for each of the six case studies analysed by the consortium partners. The lessons learned, including key drivers of change and opportunities and challenges for the circular economy at the territorial level were then summarized in the general CLDs presented above, for which a simplified and a detailed version were developed.

Concerning the case studies, two main types of insights were gathered for the creation of the circular economy CLD: drivers of change and circular economy strategies. Some case studies are comprehensive (e.g. Maribor, Scotland and Basque Country) and cover consumption, production and materials management; other case studies are instead more focused on one of these strategies. For instance, the case of Central Germany emphasizes production, Brussels prioritizes behavioural change and the case of Sicily focuses on end-of-life materials for industrial symbiosis. The general CLD includes all these strategies, which are detailed in Table 6.1.

*Table 6.1: Overview of the circular economy strategies found in the six case studies.*

| | General | Maribor | Central Germany | Scotland | Brussels | Basque Country | Sicily |
|---|---|---|---|---|---|---|---|
| **S0: Refuse** | **x** | x | | x | x | x | |
| **S1: Rethink** | **x** | x | | x | | x | |
| **S2: Reduce** | **x** | x | x | | x | x | |
| **S3: Re-use** | **x** | x | x | x | | x | |
| **S4: Repair** | **x** | x | | x | | x | |
| **S5: Refurbish** | **x** | x | | x | | x | |
| **S6: Remanufacture** | **x** | x | | x | | x | |
| **S7: Repurpose** | **x** | x | x | x | | x | |
| **S8: Recycle** | **x** | x | x | x | | x | x |
| **S9: Recover (energy)** | **x** | x | x | x | | x | x |

*Source: own elaboration*

Table 6.2 shows instead the main feedback loops, or drivers of change that have emerged from the analysis of the case studies. Several reinforcing (R) feedback loops, which amplify change, and balancing (B) loops, which counter change, were identified across consumption, production and materials management. This also allowed to characterize the circular economy strategies of the case studies, with the circular economy strategy of Maribor and Central Germany being conceived for addressing known challenges such as health and industrial competitiveness (both characterized by balancing loops). Brussels and Scotland instead developed circular economy strategies to create new opportunities, triggering new reinforcing loops.

Our systems' analysis concluded by exploring the impact that each territorial dimension considered in CIRCTER can have on the system (i.e. enabling the effective implementation of circular economy interventions). Indirectly and in combination with the case studies, this may also lead to the identification of the potential effectiveness of circular economy interventions in different territorial contexts. Specifically, we identified the following mechanisms (see Annex 6 for a detailed description):

- **Agglomeration** factors affect both strategies directed at industries as well as strategies aiming at changing citizen behaviour. Agglomeration affects three key feedback loops, namely material recovery (B2), resource consumption and material efficiency (R2), and repair, refurbish and reuse (R6). In practice, it enables a circular economy transition across consumption, production and materials management.
- **Land-based resources** affect feedback loops related to material use (R2) and recovery (B2) as well as the potential for using renewable energy. As a result, land-based resources primarily enable interventions on production and materials management.
- **Accessibility** affects the resource consumption (R2) and recovery (B2) loops, and citizen-driven circular actions related to the reuse, sharing and consumption of goods (B4). Effectively, it enables a circular economy transition across consumption, production and materials management.
- **Knowledge** as a territorial factor impacts five key feedback loops of the system. Given the relative novelty of the circular economy concept, the installed knowledge-base at territorial levels becomes a fundamental ingredient of successful transitions. It affects material consumption (R2) and recovery (B2), waste management policies (R3), and behavioural change for both citizen (B4) and businesses (R4), most enablers of the circular economy.
- **Technology** can have significant impacts on the demand for products and employment creation (R1), material efficiency and consumption (R2), material recovery and resource consumption (B2), and behavioural change (B4). It therefore impacts all key stages of a circular economy transition.
- **Governance** and institutional systems are key enablers for the transition to a circular economy. Governance affects the regulatory environment and has the potential to influence industrial sectors or whole regions in favour of (or against) circular practices, e.g. by disincentivizing unsustainable practices, or stimulating sustainable ones (R2) or by contributing to generating vast amounts of end-of-life materials through sorting

and recycling infrastructure (B2). Regulations and policy frameworks could contribute to providing a clear sense of direction concerning economic policy in the coming years, which potentially provides enough security for businesses to make investments with longer payback times.

- **Territorial milieu**: a strategic and shared vision of a region is a major driver for achieving ambitious techno-economic transitions (Preston, 2012). Territories where such factors are embedded in the local culture and business models tend to have a high degree of innovative capacity and are more dedicated to collaboratively realize disruptive changes. The territorial milieu enables feedback loops related to material efficiency (R2) and recovery (B2) (as seen in various industrial districts and clusters worldwide, but also through behavioural change, leading by example), as well as the regulatory environment (R3), creating a trust relationship and a favourable business environment.

Readers interested in collecting more information on the system analysis performed in the CIRCTER project may refer to Annex 7.

*Table 6.2: Main feedback loops emerged from the assessment of the six case studies.*

| B/R | Feedback loops | General | Maribor | Ger-many | Scot-land | Brus-sels | Basque Country | Sicily |
|---|---|---|---|---|---|---|---|---|
| **B** | Production leads to (i) resource use and emissions, (ii) higher costs, (iii) reduced profits | x | x | x | | | x | x |
| **B** | Resource consumption leads to (i) waste generation and (ii) waste re-cycling | x | x | x | x | | x | x |
| **B** | Resource consumption leads to (i) landfill, (ii) more taxation and lower income and (iii) reduced demand and production | x | x | | | | | |
| **B** | Resource consumption leads to (i) landfill, (ii) more taxation and (iii) behavioral change, reducing (iv) demand and production | x | x | | | | | |
| **B** | The cost of non-renewable resources leads to (i) higher willingness to pay for bioproducts, (ii) reduced waste generation and (iii) reduced costs | | | x | | | | x |
| **B** | Environmental degradation (emissions and landfill) lead to (i) aware-ness raising and political will | | x | x | | | x | |
| **B** | Product reuse leads to (i) lower demand and resource use, (ii) lower health impacts and awaeness, (iii) reduced behavioral change | x | x | | | | x | x |
| **R** | Demand leads to (i) production, (ii) employment, (iii) income | x | x | x | x | | x | |
| **R** | Efficiency leads to (i) less consumption, costs and (ii) higher profits | x | x | x | | | x | x |
| **R** | Recycling leads to (i) less landfill and taxes, (ii) more income and de-mand, (iii) production and resource use | x | x | | | | x | x |
| **R** | Recycling leads to (i) more employment, (ii) more income and demand, (iii) production and resource use | x | x | x | x | x | x | |
| **R** | Production leads to (i) revenues and (ii) profits | x | | | | | | |
| **R** | Product reuse leads to (i) more repair, refurbish and remanufacturing | x | x | | x | x | | |
| **R** | Product reuse leads to (i) product appreciation and (when quality is en-sured) and (ii) behavioral change | x | | | x | | | |
| **R** | circular economy transition efficiency leads to (i) education and behav-ioral change and (ii) well-being and political will | x | | | | x | | |
| **R** | Multi stakeholder involvement leads to (i) higher circular economy effi-ciency and (ii) political will | | | | | x | | x |

# 7 Interactions between territorial factors, circular business models and circular economy strategies in different types of regions

As claimed several times across this report, a circular economy is the result of a complex and dynamic network of relationships occurring between a multiplicity of agents (e.g. material providers, technology providers, consumers, etc.) located in unique contexts (i.e. characterised by specific combinations of territorial factors). Complexity can sometimes lead to confusion and fuzziness.

Hence, for the sake of clarity, we have conducted a cross-analysis of the different analytical elements in the CIRCTER project. Table 7.3 summarises the results of this analysis. The table is by no means comprehensive, nor totally free of subjective judgment. Nevertheless, it provides an overview of relevant business models and strategic areas of a circular economy against the various territorial factors, scales of implementation and regional typologies. The table combines and synthesises in a single glance the main analytical building blocks in the CIRCTER project.

The first column lists the four CBMs identified in the project (see Section 4 for details on how these have been defined). The second column presents the main circular economy strategies, according to the conceptual model developed by PBL (Potting et al., 2017), and connect those strategies to the CBMs. The third column provides illustrative examples of innovative approaches as key enablers and innovators for a circular economy. Based on these elements, the fourth column distributes the various approaches according to their main scale of operation, distinguishing between micro-, meso- and macro-levels[14]. The fifth column links the circular economy enablers to the different type of regions for which the various circular economy strategies and business models are likely more relevant (e.g. agricultural vs industrial and rural vs urban). Finally, we highlighted some important linkages between our circular economy strategies and the territorial factors, according to the literature review performed in CIRCTER (columns 6 to 11). For a detailed review of these factors, readers may refer to Annex 1 to this report.

[14] The scale classification is as follows: micro level refers to single firms, rural communities and small cities; meso refers to industrial clusters, intermediate and large cities, regions; the macro level covers national, international and global scales.

*Table 7.3: Overview of relevant territorial factors for a subset of circular economy strategic areas*

| ***Circular Economy Business Models*** | **Main circular economy *strategies*** | **Illustrative examples of circular economy *enablers and innovations*** | **Main *scales* of operation*** | **Main *types of regions*** | **Key *territorial factors*** | | | | | | | **Relevance** |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | **Agglomeration** | **Land- based resources** | **Accessibility** | **Knowledge** | **Technology** | **Governance** | **Milieus** | |
| Access, Sharing, and Performance Model | S0 (Refuse) | Non-transactional forms of consumption (e.g. freecycling movement, repair-cafes, allotments, maker collectives, etc.) | Micro, Meso | Urban, Industrial | x | | x | x | | x | x | Holmes (2018), Charter, (2018), Prendeville et al. (2018) |
| | S0 (Refuse), S1 (Rethink), S2(Reduce) | Socially responsible consumption, collaborative consumption (e.g. sharing platforms) | Micro, Meso, Macro | Urban, Rural | x | | | x | x | x | x | Jurgilevich et al. (2016), Edbring et al. (2016), Ghisellini et al. (2016), Marra et al. (2018) |
| Encourage sufficiency and shifting utilisation patterns | S1 (Rethink), S3 (Re-use), S4(Repair) | Second-hand markets, access-based consumption (e.g. renting and leasing), product-service-systems | Micro, Meso | Urban | x | | x | x | | x | x | Hobson (2016), Prendeville et al. (2018), Edbring et al. (2016) |
| Long Life design | S1 (Rethink), S2 (Reduce) | Cleaner Production & eco-design (including material substitution and energy efficiency/reduction) | Micro, Meso, Macro | Industrial | x | x | | x | x | x | x | Stewart et al. (2016), Breure et al. (2018), Braun et al. (2018), Stahel (2013), Henning et al. (2015) |
| | S4 (Repair), S5 (Refurbish) | Upgrading maintenance, repairing and restoration | Micro | Industrial | x | | x | | x | x | x | Franklin-Johnson et al. (2016), van Rhijn (2017) |
| | S6 (Remanufacture), S7 (Repurpose) | Design for modularity, circular design | Micro | Industrial | x | | x | x | x | x | | Den Hollander et al. (2017), Lieder et al. (2015) |
| Extending Product and Resource Value | S3 (Re-use), S4 (Repair), S5 (Refurbish), S6 (Remanufacture), S7 (Repurpose) | Remanufacture, refurbishing, take-back systems, reverse logistics | Micro, Meso | Urban, Industrial | x | x | x | | x | x | | Singh and Ordoñez (2016), Accorsi et al. (2015), Chen et al. (2012), van Buren et al. (2016), Gregson (2015) |
| | S1 (Rethink), S7 (Repurpose), S8 (Recycle), S9 (Recover) | Urban/(eco)industrial symbiosis (cross-sector linkages) | Meso | Urban, Industrial | x | | x | x | x | x | x | Lombardi (2017), Chen et al. (2012), Accorsi (2015), Breure et al. (2018) |
| | S8 (Recycle) | Upcycling, recycling, composting | Micro, Meso, Macro | Rural, Urban, Industrial | x | x | x | | x | x | x | Bahers et al. (2017), Corvellec et al. (2013), Chen et al. (2012), Preuß & Ferber (2005), Borrello et al. (2017) |
| | S9 (Recover) | Energy recovery systems | Micro, Meso, Macro | Rural, Urban, Industrial | x | x | x | | x | x | | Malinauskaite et al (2017), Corvellec et al. (2013), Ingrao et al. (2018) |

*Source: Own elaboration based on Kalmykova et al. (2018), Su et al. (2013), Potting et al. (2017) and Vis et al. (2016)*

# 8 Designing place-sensitive policies for a circular economy

With the policy work within CIRCTER we aim at providing, in a synthetic way, an overview and an analysis of different types of circular economy policies and initiatives. We also try to make a link between policies for the circular economy and different types of territories and territorial factors. The main goal is to provide more clarity as to the potential leverage of different types of territories, both in terms of policy making and policy implementation. Our policy analysis is based on a comprehensive but not exhaustive review of policies that have been contributing to the transition towards circular economy on different administrative levels.

Annex 8 delivers a complete analysis of the groups of policies identified during the policy mapping exercise, which have been analysed from a territorial as well as from a circular economy perspective. Annex 9 provides concrete examples of relevant policies. The CIRCTER Policy Guide in Annex 11 provides detailed guidance for the design and implementation of circular policies and strategies at regional and local levels.

## 8.1 A complex policy landscape in the EU

The policy landscape of the circular economy is complex. There is not always an agreement as to which policies and/or measures could be called 'circular' but nevertheless a growing body of policies is more and more frequently referred to as *circular economy policies*.

The concept of circular economy was given a high profile in the EU policy discourse during 2010-2014. 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).** As mentioned in the Introduction, the **EU Circular Economy Action Plan** (CEAP) adopted in December 2015, provides the backbone of **Europe's Circular Economy Package**. The CEAP 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).

The CEAP is structured around a number of coordinated policy initiatives that include: (1) an updated Ecodesign Directive that encourages reparability, upgradability, durability, and recyclability of products; (2) further guidance on waste management and resource efficiency through the updated reference documents on Best Available Techniques in industrial sectors; (3) updated waste regulations that set long-term recycling targets for municipal waste and packaging waste, promote use of economic instruments, define general requirements for extended producer responsibility schemes, simplifies and harmonises waste definitions and calculation methods, and clarifies rules on by-products to facilitate industrial symbiosis and help create a level-playing field across the EU; (4) definition of new regulations, quality standards and targets for secondary raw materials, fertilisers, water use, chemicals and biobased resources; (5) a monitoring framework for the circular economy, designed to measure progress effectively on the basis of reliable existing data (SWD(2018)17).

**Waste management related policies are central to the Circular Economy** are an integral part of the CEAP. Important aspects of waste legislation in terms of circularity include: (1) the principle of the **waste hierarchy** (meant to transcend all policy action); (2) the importance of **increasing recycling targets** (incl. for packaging materials), and; (3) boosting the market for **secondary raw materials**. Priority areas for waste management with regards to the circular economy (picked by the CEAP) include plastics, food waste, critical raw materials, construction and demolition waste, and biomass and biobased products.

Importantly, the CEAP underlines that **"local, regional and national authorities are enabling the transition".** The assumption is therefore made that there is a role and an obligation for all levels of governance with regards to adopting and implementing/enforcing policies. Naturally, CEAP also acknowledges the roles to be played by businesses and citizens.

**Regions and cities** have a significant leverage on circular economy policies in a number of countries, particularly when it comes to waste management . Many are elevating the level of their ambitions and strive to become zero waste territories. The CIRCTER case studies illustrate a number of relevant measures that cities and regions are taking to boost circularity across Europe. For example, the **Maribor case study** shows how the city set a 30% increase of the recycling target as well as an increase of the target share of reusable waste. On a different level, the Scottish circular economy strategy ***Making Things Last***, revealed waste-related measures such as Charter for Household Recycling, and *Recycling on the go* to change lifestyles and consumption choices of local populations. Furthermore, a **Circular Economy Monitoring Framework** has been launched to support in tracking the progress towards the circular economy objectives through a set of indicators. Similar frameworks for monitoring the circular economy were developed within the **Brussels Regional Plan for a Circular Economy 2016-2020** and within the **Basque Country Circular Economy Initiative**. The reader may refer to Section 0 and Annex 5 for a detailed overview of the CIRCTER case studies.

## 8.2 Policy recommendations/guidance for different types of regions and cities

It is very clear that when regions and cities plan their strategic approach to the circular economy place-based considerations will have to be taken into account. These also need to build upon existing regional strategic documents such as regional waste management plans, regional energy strategies, smart specialisation strategies, etc. Voluntary initiatives such as the **EU Covenant 2022 - Circular Economy** that aims to focus on an efficient use of natural resources in a collaborative economy at territorial level, can be very useful to share best practices and exchange knowledge around critical circular economy topics such as resource and waste management.

**Waste prevention** should the main strategic goal of regional and local resource management policies, as no waste should be 'wasted'. Regional and local authorities can favour that products are used for longer through specific recovery schemes. However, a certain volume of residues will still be produced by households and companies. Regional and local administrations should strive to increase awareness on how such streams are actually managed until they are re-introduced in the economic system in any form (e.g. as second-hand or recycled products), or alternatively incinerated or landfilled. 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). Decisions on the best waste management methods should be taken basing on life-cycle considerations, as with current technologies specific types of materials still cannot be recycled or require so much energy as to be undesirable (Allwood, 2014).

### 8.2.1 Regions as policy actors within a circular economy

**Regional areas (mesoscale) may be the right level for closing material loops and creating sustainable industrial ecosystems** (Sterr & Ott, 2004). Therefore, there are numerous policy interventions that could be taken up on regional level by regional authorities or other regional actors. There are many regions which have bundled up these policy intervention possibilities into regional circular economy strategies (e.g. Flanders, Lazio, Basque Country, Wallonia, etc.). **Regional Innovation Strategies for Smart Specialisation (RIS3)** provide an excellent opportunity for integrating circular economy in the regional policy landscape. This not only formalises and gives priority to the topic, but it also guarantees regional, national and European financial flows towards circular economy projects. In addition, it ensures a higher stakeholder buy-in into necessary innovative actions and projects. An additional benefit for the regions comes from the fact that by including circular economy priorities in the RIS3 strategies they are forced to apply a monitoring framework.

### 8.2.2 Urban level policy interventions

Cities are well-placed to embark on innovative **waste prevention** initiatives. For example, in France territories (mostly cities) can be the label Zero Waste, Zero Wastage Territories (Territoires Zéro Déchet Zéro Gaspillage - TZDZG), i.e. Bordeaux, Roubaix, etc. Substantial opportunities for 'leapfrogging' may exist in those areas where incineration capability has not been yet installed. Once constructed, the long pay-back periods for those facilities may lead to technology lock-ins and contribute to path-dependencies (Corvellec et al., 2013). Currently, some areas show incineration overcapacities whereas other areas still lack of such infrastructures (Wilts & von Gries, 2015).

An interesting example of the territorial limitations of the circular economy in the waste sector is the **construction and demolition waste** reuse issue. Because of its high volume and high transportation costs leading to potentially negative environmental impacts, the reuse of construction and demolition (if all other obstacles are removed) is economically and environmentally viable on a very local level.

Other waste streams relevant for an urban area include textiles, plastics, electronics, etc. In the case of **textiles**, it would be possible to explore product-as-service approaches; fibre recycling through take-back schemes; green procurement; longevity actions; and textile environment design (London's Circular Economy Route Map)

**Food waste** is another sector best tackled on urban level. Cities could adopt policies for food waste prevention both on household and business level. Surplus food could be redistributed to deprived people through different platforms and initiatives at the same time addressing a social problem as well. Cities could also act on consumer behaviour shifting consumer patterns to food types with lower environmental impact. The food-related material loops could be shortened by optimising possibilities for urban food growing.

At the EU level, **repair and reuse** legal requirements remain limited, and have not, until recently, been the main focus of policy-makers. However, there is more and more the realisation that the vicious circle of buy-use-throw (after first problem) needs to be broken. Cities are well-placed to work on strengthening their local reuse and repair ecosystem, by supporting the local organisations involved and informing citizens. In Scotland, a second-hand superstore was launched within the **Scotland - circular economy strategy "Making Things Last"**. The city of Graz, in Styria, introduced a system with a maximum support of EUR 100 per household per year, whereby repair is made cheaper by reimbursing a certain percentage of the labour costs.

Similarly, the **collaborative economy** could also be supported and promoted at the local levels. Collaborative platforms operating new business models have a higher uptake in more densely populated urban areas. This is the case for different types of car-pooling, platforms for accommodation sharing, platforms for sharing different tools, used items, etc. However, sharing economies should be promoted with caution, trying to avoid rebound effects[15]. Collaborative platforms may also function in rural areas but the bigger distances make many of these business models and environmental costs more difficult to sustain.

Finally, cities need to be enabled to establish a comprehensive approach to assess and implement potentials for local **circular economy strategies**. Particularly successful urban agglomerations with regards to circular economy implementation have already an explicit circular economy strategy in place (e.g. Amsterdam, Brussels, Maribor).

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[15] Some authors have claimed that sharing economies, along their current implementation pathways based on corporate leadership, are unlikely to drive a genuine shift to sustainability (Martin, 2016).

### 8.2.3 Policies for a circular economy: different opportunities for different types of regions

#### The circular economy in rural regions

Rural territories are in the position to explore the opportunities presented by the **bioeconomy**, in all its variations. As emphasised in the **Updated Bioeconomy Strategy** (COM(2018) 673), “the bioeconomy offers important opportunities for new jobs regional economic development and improved territorial cohesion, also in remote or peripheral areas” (EC, 2018a). This approach is already reflected in an increasing number of national bioeconomy strategies in Europe, as well as in many RIS3 strategies from rural and peripheral regions. Still, the focus should shift towards more sophisticated policies aiming at strengthening rural value chains and local productive networks..

As recognised in the Cork Declaration 2.0, the bioeconomy has the potential to provide an important source of income diversification for farmers, foresters and fishermen, and to boost local rural economies. But this requires increased and focused investment in skills, knowledge, innovation and new business models related to the circular, green, and fossil-free economies, as well as cautious evaluation of the alternatives to avoid potential trade-offs with other sectors, in particular taking into account the potential environmental impacts linked to an increasing feedstock demand (EC, 2016).

The development of local strategies can contribute to identifying priority resources for the territories, settle conflict of usage (e.g. competition between food crops and energy/biochemical crops) and promote the development of new economic activities by sustaining the transition towards sustainable agriculture and forestry.

#### The circular economy in industrial regions

While **remanufacturing** is largely business-driven and the manufacturing industry a complex ecosystem of various (regional, national, and international) players, regions and cities can play an important role in increasing awareness. Moreover, regions can help promote remanufacturing to financial institutions as well as create financial incentives for businesses wishing to take up remanufacturing so that firms have facilitated access to capital. While remanufacturing may be more relevant in predominantly urban or intermediate regions (at least for long manufacturing value chains), such measures can just as well be meaningful in rural areas.

Similarly, several economic and regulatory instruments introduced by regional and local authorities can indirectly drive **industrial symbiosis**. For example, favouring higher and penalising lower waste hierarchy options can render very positive results. Examples include relatively higher landfill and incineration taxes, pay-as-you-throw schemes, local landfill bans of various waste streams (e.g. on organic waste), targeted economic incentives. The **Case study on Industrial Symbiosis in Sicily** has identified several successful measures including an online platform to launch industrial symbiosis and to analyse material and waste flow and identify potential matches for waste reuse, as well as guiding documents to implement the matches, and creating a network of local stakeholders and companies. As a result, more than 690 potential matches were found between the participating enterprises.

**Voluntary agreements** between governments and industry actors can be an efficient way to complement the policy legislation in driving progress towards circular economy. A recent example is the adoption of the EU Plastics Strategy (COM(2018) 28 final) that coincides with voluntary commitments from a number of stakeholders from the European plastics industry. **Voluntary agreements can also be applied on local or regional level or along value chains.** The EU voluntary labelling instrument Eco-management and Audit Scheme (EMAS) is particularly suitable for industrial regions although it is not explicitly targeting the circular economy. Nevertheless, it has inherent potential to contribute to circularity objectives as EMAS implementing organisations have committed to monitoring their processes and constantly improving their resource efficiency. The CEAP states that improving the efficiency and uptake of EMAS and the Ecolabel could benefit business and SMEs in moving towards circularity.

The **industrial areas in transition and deindustrialisation** deserve particular attention. In the spirit of the circular economy, abandoned industrial installations could be dismantled and either sold for reuse or recycled and industrial sites could be re-used. Vacant buildings could also be adapted to new circular industrial uses (waste treatment and separation, composting, etc.) and non-industrial uses (e.g. residential, agricultural), or be transformed into public spaces (art galleries, co-working spaces, community-centres, repair markets, etc.), thereby contributing to regenerative spatial and urban planning. We can also assume that when industries close down industrial unemployment would go up. This is an opportunity for urban and regional authorities to redirect some of the employment to circular economy sectors such as waste management and recycling, collaborative economies, etc. This would be done mainly through labour policies which are outside of the scope of this report.

## 8.3 Enhanced territorial policies for a place-sensitive circular economy

### 8.3.1 The circular economy in the future Cohesion Policy

Cohesion Policy applies a fully territorial approach and investments are targeted to meet the local and regional needs. The Cohesion Policy is not directly related to circularity as there are no specific provision of such actions and investments. Nevertheless, there are still plenty of opportunities to promote circular economy and two of the policy’s thematic objectives are linked to circularity, namely Low-carbon Economy and Environment and Resource efficiency.

The CEAP specifically acknowledges the important role to be played by Cohesion Policy in areas such as waste management. In the past programming period, significant funds have been spent on the development of waste infrastructure, including waste sorting, treatment and storage facilities. The focus of Post-2020 Cohesion Policy should first be on *waste prevention* and subsidiarity on *responsible waste management*. This is totally aligned to the current policy objectives in current Commissions proposals for the 2021-2027 programming period (EC, 2018c). Policy Objective 2 promotes a greener, low-carbon Europe by, inter-alia, supporting the circular economy. This will present an opportunity to regions and cities to speed up the transition to the circular economy. Therefore, during the programming process circular economy should be well-integrated in Partnership Agreements and Operational Programmes.

Cohesion Policy funds directed at SMEs should be increasingly aligned with the circular economy objectives relevant to businesses such as resource efficiency, better waste management and technological development. Similarly, Cohesion Policy funding should keep supporting industrial symbiosis schemes as initiatives might stop functioning if funding dries out (Domenech et al., 2018). For example, the UK's National Industrial Symbiosis Programme which has had huge success in the past has received Cohesion Policy support.

The **European Regional Development Funds (ERDF)** channelled to innovation could increasingly incorporate the circular economy criteria in order to re-formulate the ways our current societies consume and produce. Horizon 2020 has already been granting money for circular economy demonstration and research projects and for projects in the fields of food waste, re-manufacturing, etc. ERDF and European Social Funds (ESF) could also be used for increasing the knowledge and the awareness of the population of the circular economy, circular economy business models, etc. For example, Scotland's Waste & Resources Action Programme (WRAP), which has been quoted as a very good example of an institution supporting the circular economy, has been partly financed through ERDF.

The EC is currently assessing the possibility of launching a platform together with the European Investment Bank and national banks to support the financing of the circular economy. The European Investment Bank already has a funding line focusing on the bioeconomy (EIB, 2017). Against this backdrop, the Cohesion Policy could also be used to trigger additional private and public funds for the circular economy through special financial instruments. Availability of **funding** for the circular economy is a pre-condition for speeding up transition. 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.

One of the major risks of funding innovative growth is linked with the danger of "providing a blanket authorisation or spending on a wide range of often ineffectual and poorly monitored programmes and projects" (Farole et al., 2011). This could be easily related to Circular Economy Business Models some of which still remain vague for a large number of actors. Therefore, we recommend policies for further exploring these models and reducing 'the degree of vagueness' but also by adopting very robust monitoring frameworks for circular economy.

A key challenge of both circular economy and cohesion policies is value retention. In this respect, the future Cohesion Policy should contribute to diversify the rural economies by helping to establish new downstream processing activities. This is particularly relevant for the bioeconomy. From a cohesion perspective, it is fundamental that the updated Bioeconomy Strategy is implemented in such a way that value added is retained in rural areas, e.g. through the adoption of decentralised and small-scale production schemes linked to the cascade use and processing of natural feedstocks. Cohesion Policy can support this by e.g. providing funding to cross-sectoral clustering actions within value chains and also help develop cross-regional synergies (e.g. through Interreg Europe projects[16]).

In addition to the above considerations, we would like to pick up some of the recommendations made by Fabrizio Barca after the analysis of the ESIF draft legislation (Barca, 2018). It is not particularly targeted at the circular economy but insights are relevant to the topic as well:

- The divide between rural and urban areas has been exacerbating at the expense of rural areas. Additional divides include the ones between declining cities and thriving cities and between urban centres and urban peripheries. A note of caution with regards to the circular economy originates from this finding namely that thriving urban centres with vision and knowledge risk to attract the majority of funding for circular economy and fall prey to the so-called '*metrofilia'*. Therefore, special efforts should be made to explore circular economy opportunities in rural and declining regions as well as regions with losing industrial importance. In this way, the goal of the Territorial Cohesion to 'capitalise on the strengths of each territory' would be achieved. These opportunities should in no way take the form of 'compassionate compensations'. Additionally, efforts should be made for spreading innovation/growth by facilitating spatial spillovers and linkages to highly developed places.
- According to Barca, Cohesion Policy is not perceived as a 'distinctive European touch' (Barca, 2018). Therefore, funding of new, innovative business models, and particularly circular economy business models, can partly fill in this gap of a lack of clear niche.

### 8.3.2 The Circular Economy and Territorial Agenda post-2020: some ideas for a potential link

The EU Territorial Agenda of 2011 (TA 2020) does not include any direct links to the circular economy, nor to material consumption or waste management. The TA 2020 merely stresses

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[16] The draft regulation on European Territorial Cooperation proposes to address inter-regional cooperation through cooperation between adjacent regions of MS but also between one MS and one external region; cooperation between outermost regions; scaling up of inter-regional innovation projects, etc. (EC, 2018d)

the sustainable utilisation of territorial capital in form of natural values and ecological services but there is only a limited reference to circularity-relevant issues in the form of efficient and environment friendly production. Therefore, the principles of **the EU Strategy on circular economy should be integrated with the post-2020 Territorial Agenda** especially with the role of regions and cities and the necessary broader commitment from all levels of government for moving towards a circular economy. 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 milieu factors. The roles of the regions as well as the impact and potentials of various territorial specificities (including in Territories with Geographical Specificities) in developing circular economy could be given even more attention.

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. It states that “most policies at each territorial level can be made significantly more efficient and can achieve synergies with other policies if they take the territorial dimension and territorial impacts into account”. This is highly relevant also for the circular economy. Territorial cohesion could also be understood as the need to ensure spillovers from highly developed urban regions leading in the circular economy to lagging cities, rural regions and urban peripheries in this way achieving more balanced territorial development. Tendencies towards the geographical agglomeration of certain circular economy activities are likely to occur (Farole et al., 2011). Hence, territorial policies should articulate measures to prevent circular innovations from increasing territorial disparities.

More thorough information on the European policy framework for a circular economy and specific recommendations aimed at various territorial levels are provided in Annex 8 to this report. Detailed policy fiches are also included in Annex 9. The CIRCTER Policy Guide in Annex 11 provides step-wise guidance for policy design and implementation at regional and local levels.

# 9 Suggestions for further research

This section promotes several topics that could not be covered in the CIRCTER project and might attract attention in future research initiatives on the circular economy and its territorial manifestations. Potential topics for future research have been grouped in three themes.

## 9.1 Better metrics for a circular economy

As stressed by the EU Urban Agenda Partnership on Circular Economy, territories still experience the need of indicators for monitoring and to report on their progress towards a circular economy. The lack of monitoring indicators can actually be a bottleneck for implementing circular economy strategies (The Circular Economy Partnership, 2018). This is because the available metrics and monitoring systems have been designed for the characterization of traditional (i.e. linear) economic systems. Albeit some progress towards the development of new metrics has been made by the Monitoring Framework for a Circular Economy (EC, 2018e), the indicators available so far provide limited information at a very coarse spatial resolution.

A new generation of circular economy metrics is hence needed. Such 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). The newly developed indicators should quantify the final material impacts of regional and local economies. This could only be achieved by adopting a *footprint* approach on circularity metrics. The new metrics should also allow to quantify the materials that are effectively recovered from waste flows (i.e. effectively recovered and not just sorted/separated for recycling). Similarly, material and waste flows between different regions should be elicited, enabling for example the development of network analyses depicting the interconnections between territories and the frequency of their interactions. This could guide the development of cross-regional policies.

However, a full characterization of local closed-looped systems cannot be done by only looking at aggregated material and waste flows. In order to address all the relevant aspects surrounding circular economy transitions, particularly those affecting territorial development, further information needs to be collected e.g. on the penetration of circular business models at all levels, from macro-area to project level, as well as on the adoption of measures aiming at waste prevention.

## 9.2 Understanding the deep impacts and long-term effects of circular transformations

The CIRCTER project has made significant progress in the identification of the potential territorial implications of a circular economy. The project has successfully identified a series of territorial factors affecting the distribution and manifestations of circular economies at sub-national levels and has also addressed the likely territorial consequences stemming from circular economy transitions. However, our work has mostly focused on the direct, proximate and local consequences of circular reconfigurations. Further quantitative and qualitative investigations into the socio-economic effects of the structural changes intrinsic to the circular economy might help to evaluate the more distal and sometimes distant impacts of transitions. Among all the possible aspects deserving attention, we highlight the following two issues:

**Reconfigurations of global value chains**: A salient research topic is the evaluation of circular economy value chains. Further investigation is needed to fully understand: (1) what value chains are disrupted and newly created by the circular economy; (2) 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 and attain a global leadership position – where are the trade-offs; (3) where are innovation hotspots of circular economy technologies and where the global competition – which are the key enabling technologies for a circular economy, which areas are likely to gain momentum based on their innovation capacity on this field, which ones are likely to lose economic relevance, (4) which would be the likely impacts of closed-loop systems on remote geographies, often characterised by having high concentrations of extractive industries, and how these impacts may condition European territorial development; (5) what cross-regional dynamics emerge from the new territorial logics – what synergies from the creation of interconnected circular economy clusters based on the local strengths of each region.

**The potential contribution of a sustainable bioeconomy to territorial cohesion**: The bioeconomy clearly represents an opportunity for Europe. This holds in particular for the most ruralised regions, including remote and peripheral areas. If entire product systems based on fossil fuels are to be transformed into biobased alternatives (e.g. traditional plastics are replaced by bioplastics), a substantial number of new jobs should be expected in those areas. This will certainly have a positive impact on territorial cohesion.

Still, positive impacts are far from being granted, nor materialised in the same way across all regions. Understanding how territorial factors can impact the bioeconomy is essential to capitalise on its potential positive impacts. For instance, issues such as land use, land availability and productivity, accessibility to markets, as well as international commodity prices, among other factors, will contribute to define which feedstock supply alternatives become economically feasible and attractive in different areas. Similarly, access to technology, innovation capacity of regions, skills and a range of existing and new policies will determine how local bioeconomies are materialised and which division of roles between regions is finally established.

Perhaps more importantly, the very extent to which bioeconomy transformations can occur within the ecological boundaries of natural systems is a matter of heated scientific debates (OECD, 2018). To our current knowledge, no study has systematically analysed the pre-conditions, potentials and limitations for sustainable regional bioeconomies in Europe, nor assessed their expected impacts on land use, ecosystem services and biodiversity conservation. All these aspects deserve further evaluation.

## 9.3 Quantitative evaluation on policy effectiveness

The CIRCTER project has reviewed and characterized the key policies supporting circular economies and closed-loop systems at various territorial levels (see Annexes 8 and 9). The project has also provided policy advice for the definition of fit-to-purpose circular economy strategies at local and regional levels (see Annex 11: CIRCTER Policy Guide). However, our policy analysis has been mostly conducted on a qualitative level. This work could be complemented by numerical models quantifying the impacts of specific policy interventions in selected locations. Similarly, validating the extent to which policy coherence between regions contributes to generate synergies, and comparing the role of endogenous versus exogenous circular economy drivers are issues that could be addressed though more focused quantitative evaluations.

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**ESPON 2020 – More information**

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