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ReTraCE Project

Realising the Transition to the Circular Economy

D4.4

Identification of drivers and barriers for the implementation of regional Circular Economy policies

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie Innovative Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

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EXECUTIVE SUMMARY

The need to address environmental challenges has become an urgent issue, ranking highly on every national and global political agenda. In light of that, the circular economy paradigm has emerged as a response to the current linear system of production and consumption. Regions,[1] as the most important administrative units in the EU policymaking process, have a leading role in the transition towards the circular economy. Compared to the national level, which is often too secluded and disconnected to successfully mobilise local stakeholders, and the municipal level, which is unable to earmark the required critical mass, the regional level is the optimal prefatory level for circular economy implementation. Nevertheless, despite the importance of regions in the transition, studies addressing this concern remain scarce. To foster the transition towards circular economy on the regional scale, it is crucial to understand what can hinder or intensify this shift. One must identify the barriers – which should be efficiently tackled – and the driving forces – on which the envisioned circular economy strategies and directed efforts can then be based. Hence, the aim of this study is to determine both (1) the major driving forces that can foster circular initiatives in the regional context and (2) the key challenges and barriers that can hinder circular action at the regional level. For this purpose, a review of the literature has been conducted, including both academic and grey literature, to collect and identify the confronted and perceived drivers and barriers. Additionally, regional action plans, strategies, and policy documents calling for circular economy action have been scrutinised to uncover new drivers and challenges, enrich the literature, and contribute to a more informed policymaking process.

[1] Level 2 of the EU nomenclature of territorial units for statistics (NUTS 2) is referred to as 'European regions' throughout the abstract.

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LIST OF ABBREVIATIONS/ACRONYMS USED

BRPCE Brussels Regional Program for a Circular Economy
C&D Construction and Demolition
CE Circular Economy
CSR Corporate Social Responsibility
D Deliverable
EEB European Environmental Bureau
EPR Extended Producer Responsibility
ERDF European Regional Development Fund
ESF European Social Fund
EU European Union
SPI Social Progress Index
GDP Gross Domestic Product
GHG Greenhouse gas
ICT Information and Communications Technology
IoT Internet of Things
IS Industrial Symbiosis
MS Member States
NIMBY Not in my backyard
NUTS Nomenclature of Territorial Units for Statistics
OECD Organisation for Economic Cooperation and Development
PESTEL-O Policy, Economic, Social, Technological, Environmental, Legal, Organisational
PLA Polylactic acid
PPS Purchasing Power Standard
QNH Quintuple Helix
R&D Research and Development
R&I Research and Innovation
RCEAF Regional CE-Centric Assessment Framework
SDG Sustainable Development Goal
SMEs Small and Medium-sized Enterprises
UNFCC United Nations Framework Convention on Climate Change
VFG Vegetable, Fruit and Garden
WP Work Package

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1. INTRODUCTION

This report presents the results of a study conducted in the context of the ReTraCE project, within Work Package 4 (WP4). The contribution of WP4 is primarily related to development policies, including the role of international, national, and regional legislation in promoting the transition towards the circular economy (CE), from both the bottom-up (looking at ways to foster entrepreneurial opportunities and innovative business models) and the top-down (looking at required governmental supports and incentives). To that aim, the implementation of the WP4 has been conveyed into six research reports – Deliverables (D), throughout the duration of the project, as presented in **Figure 1**.

The first deliverable of ReTraCE WP4 (D4.1)[2] was the investigation of the role of policies in enabling an ecosystem that fosters CE transition, with an emphasis on the role of policymaking at the regional[3] level. Existing regional EU policies were considered, covering the concept of regional resilience, various levels of innovation systems, the place-based approach, and the 'smart specialisation agenda'.

The second deliverable of the ReTRaCE WP4 (D4.2)[4] made the first efforts to adjust existing models for stakeholder mapping in the regional CE scenario. A new model was proposed – namely, the CE-centric quintuple helix (QNH) model, which promotes the emergence and deployment of trilateral networks, hybrid organisations, and development or cooperation platforms. At the core of this model is the academia-industry-government nexus, which has been extended to include the civil society sphere and the natural environment.

The focus of the D4.3[5] report was on devising and proposing a framework to measure the transition to the CE at a regional level. This conceptual framework – the regional CE-centric assessment framework (RCEAF) – is a multi-criteria and multi-stakeholder framework, encompassing multiple perspectives, conforming with the systemic nature of the CE-paradigm shift.

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[2] 'Circular Economy Implementation at a Regional level: a Preliminary Review' (Available at: http://www.retrace-itn.eu/wp-content/uploads/2020/04/ReTraCE-D4.1.pdf)

[3] The level 2 of the EU nomenclature of territorial units for statistics (NUTS 2) is referred to as 'European regions' throughout the report.

[4] Maps of stakeholders and interactions for designing policies for CE implementation (Available at: http://www.retrace-itn.eu/wp-content/uploads/2020/07/ReTraCE-D4.2.pdf)

[5] 'Measuring the transition towards a Circular Economy at a regional level: a review' (Available at: http://www.retrace-itn.eu/wp-content/uploads/2020/07/ReTraCE-D4.3.pdf)

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The current report, D4.4, provides an overview of the identified drivers and barriers to the implementation of regional policies for the transition towards a CE.

Another two reports have been prepared within WP4: D4.5, which concentrates on the consumer perception of the CE transition, and D4.6, presenting the business perspective by covering the innovative CE business models. The arguments for the NUTS 2 level of the regions as the most suitable for implementing and measuring circular change have been presented in all WP4 reports to date.

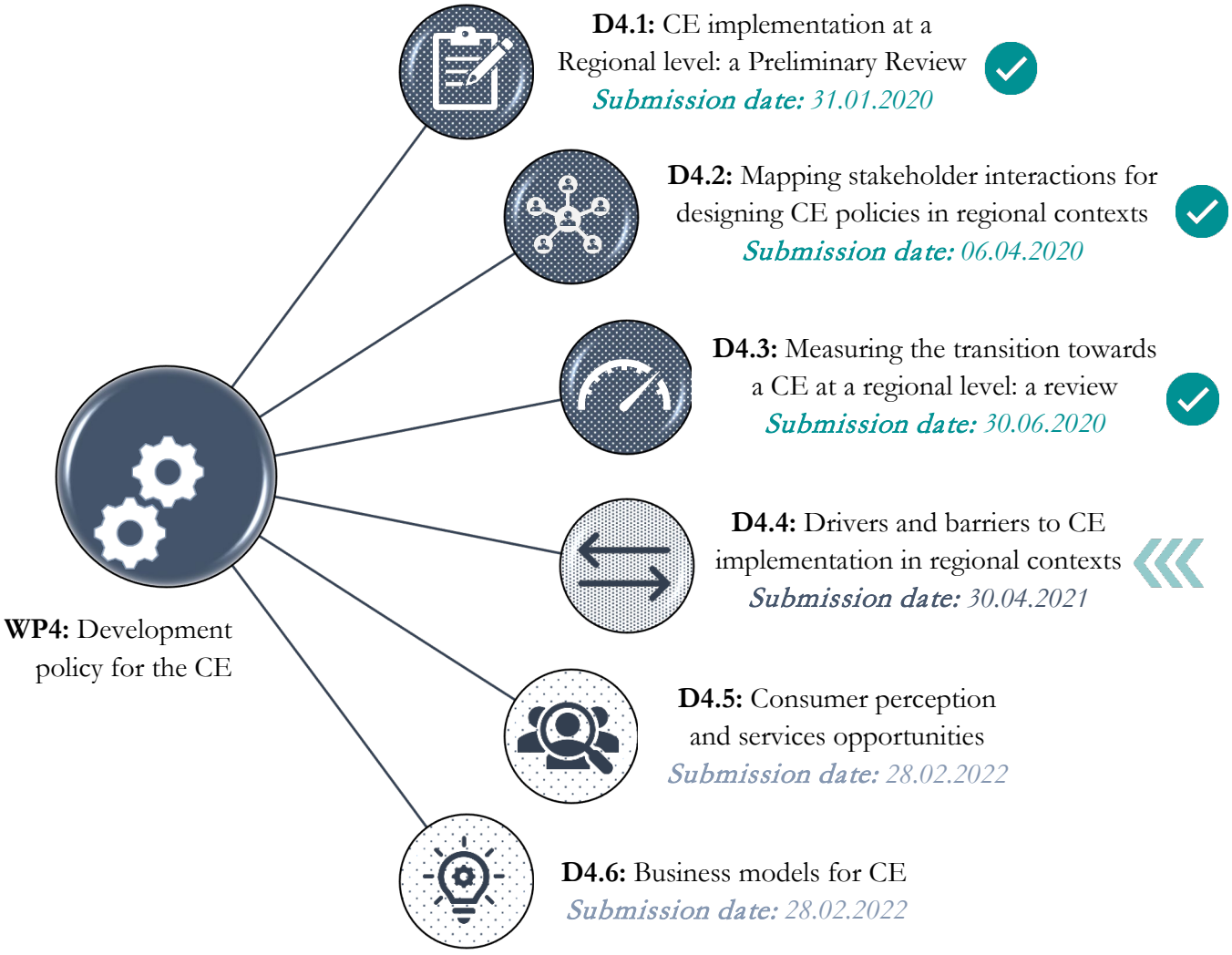

Figure 1: Implementation of WP4 deliverables

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1.1 THE ROLE AND STRUCTURE OF THE REPORT

In addition to (1) exploring policies for enabling a suitable ecosystem in which regional CE practices and actions can thrive, (2) developing a model to capture all relevant regional stakeholders and ensure inclusion, and (3) proposing a multi-criteria and multi-stakeholder framework for measuring the transition to the CE at a regional level, it is also important to understand what can hinder or intensify the CE transition. As stated in the previous section, the first three of these points have been addressed in previous reports, and the last is studied in this one.

It is vital to identify the barriers, which should be efficiently tackled, and the drivers, on which the envisioned CE strategies and directed efforts will be based. Hence, the purpose of this report is to determine both (1) the major driving forces that can foster circular initiatives in the regional context and (2) the key challenges and barriers that can hinder circular action at the regional level. For this purpose, the report is organised in two main parts.

The first part reviews the existing literature concerning the two main objectives, including academic contributions and grey literature (e.g., policy reports, think tank reports, strategies, white papers). The analysis of pertinent publications and literature provided background information and a critical understanding of the research conducted so far, gathering both primary (e.g., surveys, interviews, questionnaires) and secondary data (desk-research on reports, strategies, action plans, policies).

The second part of this work presents several EU NUTS2 regions and their regional action plans and strategies for the transition towards CE, scrutinising their content to uncover new drivers and challenges, enrich the literature, and contribute to a more informed policymaking process.

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2. EN ROUTE TO REGIONAL CIRCULAR ECONOMY: KEY DRIVERS AND BARRIERS FROM THE LITERATURE

This section provides an overview of the incentives for CE and obstacles to implementation at the regional level, as outlined in the existing academic literature and public reports. The collected resources have been selected for their relevance, thus all are discussing or analysing drivers and barriers encountered at regional level. The first section discusses the factors that could potentially foster the adoption of CE practices and thereby contribute to a greater level of circularity in a specific region. The drivers identified in previous studies are not only pertinent to one stakeholder group – on the contrary, the list of drivers concerns multiple groups of actors, including different levels of government, industry, academia, and civil society. The collected driving forces, presented in **Table 1**, are more generic, related to general dynamics that can increase the circular activities in a specific region. Two sources were considered the primary contributors on the categorisation of the drivers, and these were the CIRCTER Policy Guide (2019) and the OECD Synthesis Report (2020). Other relevant studies that provided regional drivers were also taken into account (Avdiuschchenko, 2018; Barbero and Pallaro, 2018; Smol et al., 2018; Andretta et al., 2019; Savini, 2019; Scarpellini et al., 2019). The main groups of drivers emerging from the literature review and the respective subgroups have been analysed and the findings are presented in **section 2.1**.

The transition towards a CE at any level (including the regional) inevitably meets obstacles. Thus, it is crucial to identify the forces that the regions could leverage to potentially accelerate their circularity journeys. However, it is equally important (if not even more so), to identify the key barriers to CE implementation, as well as potential challenges that could arise in the future. Furthermore, it is not sufficient to simply identify them: one must also find a way to effectively address them, using the proper combination of incentives. For this purpose, the challenges faced by multiple regional actors in previous studies were collected and presented in **Table 2**. Similarly, the collected barriers were also from a broader nature. Again, the CIRCTER Policy Guide (2019) and the OECD Synthesis Report (2020) were the primary sources used for developing these categories, along with the study of Obersteg *et al.* (2019) on the main governance challenges for urban regions shifting to CE, which used the PESTEL-O framework. Other relevant studies that examine regional barriers were also taken into consideration (Wu *et al.*, 2014; Avdiuschchenko, 2018; Barbero and Pallaro, 2018; Smol *et al.*, 2018; Scarpellini *et al.*, 2019). Barriers known to slow or reverse the adoption of regional CE practices were identified in the literature review, and the respective subgroups are analysed in **section 2.2**.

In addition to the general studies analysing broader drivers and barriers, numerous studies have been conducted in specific sectors or fields of CE, identifying specific sector-related or field-related driving and/or blocking forces. These include the work of Lombardi (2017), Aranda-Uson *et al.* (2018), Husgafvel *et al.* (2018a), Husgafvel *et al.* (2018b), Vanhamaki *et al.* (2019), Whicher *et al.* (2018), Dabrowski *et al.* (2019), Fleischmann (2019), Paletta *et al.* (2019), Plastinina *et al.* (2019), Virtanen *et al.* (2019), and Volk *et al.* (2019). These academic contributions were also taken into account, and they are listed in **Table 3** and discussed in **section 2.3**.

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2.1 CATALYSTS FOR REGIONAL CIRCULAR PRACTICES

The collected drivers from the desk review were synthesised into eight categories, presented in **Figure 2**. The categorisation of the drivers was primarily based on the grouping proposed in the CIRCTER Policy Guide (2019) and the OECD Synthesis Report (2020). The driver categories and specific subcategories are elaborated in the following sections.

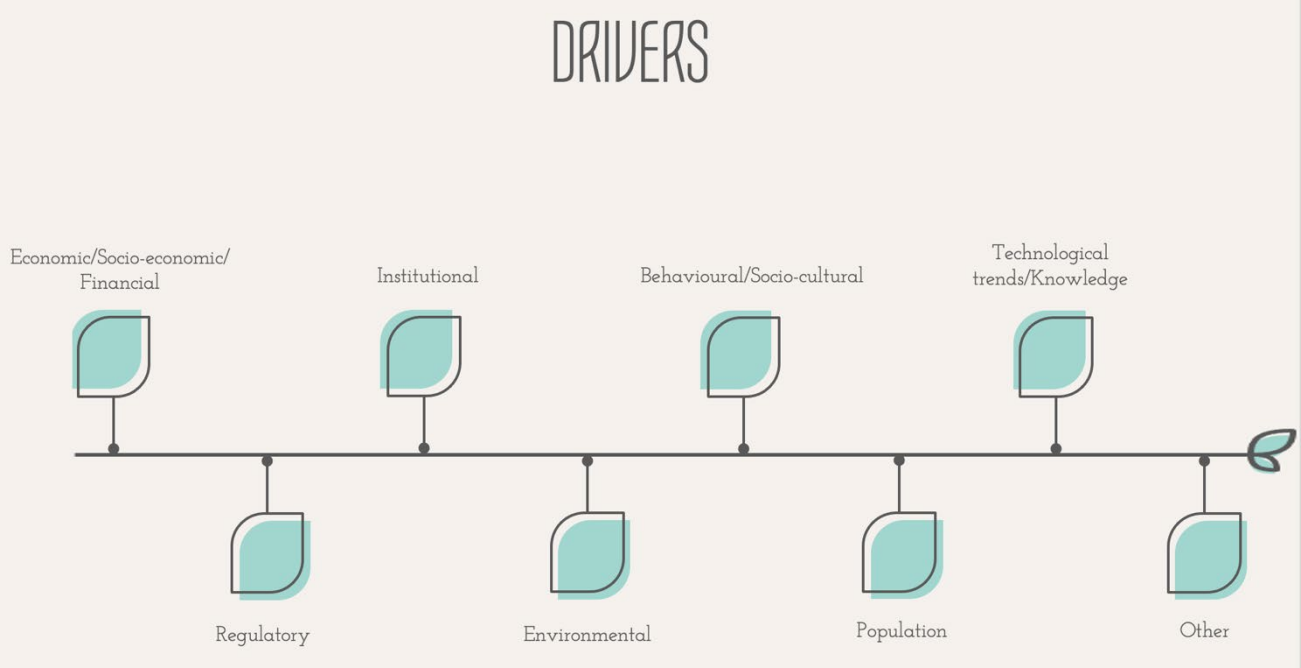

Figure 2: Categories of drivers for regional circular economy implementation

2.1.1 Economic/Socio-economic/Financial

The CIRCTER Policy Guide (2019) suggests a number of economic drivers that can help a region to promote CE activities. These include **economic savings**, **profit increases**, **new market or business opportunities**, **high prices for imported or raw materials**, and **attractive prices for circular products and services** (CIRCTER, 2019).

In Smol *et al.* (2018), most survey respondents (80%) reported long-term prospects for the development of CE in the Malopolska[6] region, if financial support were provided. Hence, **financial support by national and regional governments** is positioned as an incentive for CE action.

The recent OECD Survey (2020) found that more than half (51%) of the surveyed cities and regions considered the **changing economic conditions** to be a major driving force towards the CE. As stated in the report (2020), *'the COVID-19 crisis has put the world on standby, unlike any other economic, social and climate crisis, resulting in a very significant GDP loss for 2020 (4.5%)'*. However, despite

[6] The Polish region of Malopolska is classified as a NUTS2 region.

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this, cities remain the apparatus of economic growth, and forecasts project that a group of 600 cities will generate almost 65% of the global economic growth by 2025 (McKinsey Global Institute, 2012).

In addition, as they grow in size, cities tend to create more income per capita (Bettencourt *et al.,* 2007); and while pursuing economic growth, resource efficiency tends to be improved, as denoted by the concept of 'decoupling' (OECD, 2020). Nevertheless, the question of decoupling, related to the possibility of green growth, is a matter of intense political deliberation between green growth and post-growth supporters. The recent report from the European Environmental Bureau (EEB) presents a review of the empirical and theoretical literature on the validity of the *'decoupling hypothesis',* and the conclusions are revealing:

> *not only is there no empirical evidence supporting the existence of a decoupling of economic growth from environmental pressures on anywhere near the scale needed to deal with environmental breakdown, but also, and perhaps more importantly, such decoupling appears unlikely to happen in the future.*

Taking these decisive findings into consideration, policymakers must accept that tackling environmental issues necessitates a *'direct downscaling of economic production and consumption in the wealthiest countries'*. Therefore, the report proposes complementing *efficiency-oriented policies* with *sufficiency policies*, with a priority shift and accent from the former to the latter, while acknowledging that both policies are instrumental (Parrique *et al.*, 2019).

Recent evidence has shown a positive relationship between city size and income distribution, with income inequality tending to increase with city size. When cities are small, growth in size is desirable because it enables better economic performance. However, excessive growth of already large cities has negative consequences (Castells-Quintana *et al.*, 2020). Excessive city size can result in congestion diseconomies, which ultimately reduces economic performance (Frick and Rodriquez-Pose, 2018), and equally important, it can contribute to increased inequality and the threat of less cohesive societies (Castells-Quintana *et al.,* 2020).

Another important driver emphasised by the surveyed cities and regions is **job creation** (47%) (OECD, 2020). During the period of 2012 to 2018, the number of CE-related jobs in the EU increased by 5% to 4 million (EC, 2020). According to the ECa (2020), circularity is estimated to have a positive net effect on job creation, assuming that staff are trained accordingly and possess the specific skills needed for the green transition. Additional jobs emerge because the CE supports repair, maintenance, upgrading, remanufacturing, reuse, recycling of materials, and product-life extension, which are more labour-intensive than the mining and manufacturing of a linear economy (Wijkman and Skånberg, 2017). However, the transition must also consider the wellbeing of society, life quality, and equity (OECD, 2020).

2.1.2 Regulatory

Regulatory drivers are very closely linked to economic incentives and taxation systems. The CIRCTER Policy Guide (2019) suggests a number of regulatory drivers that can help a region to

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encourage CE activities. These include the existence of **charges, taxes on unsustainable and harmful activities**, **high charges for waste and high landfill taxes**, **tax benefits for green activities**, and **bans of specific products** (e.g., single-use plastic; CIRCTER, 2019).

Similarly, Andretta *et al.* (2019) propose regulatory incentives, such as environmental taxes for promoting the EU CE strategy. The authors argue that the taxation of waste-production or discarding – or of any environmental concerns generally – can be a powerful stimulus for CE objectives, being instrumental in building environmental knowledge and raising awareness. These regulatory incentives include taxes on energy, carbon and transport, urban waste-management and disposal, electrical electronic waste, and air pollutants; charges on packaging (plastic bags and bottles); and taxes on environmental damage or for environmental protection. Waste-management environmental taxes can be at the regional and even local level, with high regulatory dispersion; a heterogeneous condition that can result in market fragmentation and economic inefficiencies. Therefore, tax reform is required to harmonise regional taxes for waste-management – within the country and also within the EU (Andretta *et al.*, 2019).

Scarpellini *et al.* (2019) identified the following regulatory drivers to be considered in regional environmental policy to promote CE among businesses in the region of Aragon[7]: **subsidies and bonuses to promote the CE in business, subsidised training plans for employees**, **certification of products and companies**, and **the creation of regional waste-interchange systems**. The experts interviewed in the study ranked the organisation of a waste-exchange system among the most important incentives for the CE transition in the region, followed by subsidised training. Additionally, subsidies for companies to implement new CE production processes and incentive systems or fiscal bonuses linked to improvements in environmental terms were also perceived as effective. More specifically, tax raises for the most polluting companies were suggested as a regulatory incentive for CE acceptance, as well as increased tax rates contingent on the quantity and type of waste disposed of, with the goal of supporting 'zero landfill' (Scarpellini *et al.*, 2019).

2.1.3 Institutional

More than half (52%) of surveyed cities and regions cited **global agendas** as propelling forces of CE implementation (OECD Survey, 2020). The CE approach contributes to the attainment of the 2030 Agenda for Sustainable Development, directly associated with SDG12 (*Sustainable and responsible consumption and production patterns*), while other SDGs (6, 7, 15) are also deemed important for increasing sustainability in cities (SDG 11). Moreover, the CE supports the Paris Agreement under the UNFCCC, as circular practices not only reduce greenhouse-gas (GHG) emissions but also tackle issues related to natural-resources extraction and exploitation. Finally, the CE contributes to the implementation of the New Urban Agenda (2016), the EU Green Deal, and the G20 initiatives on resource efficiency (OECD, 2020).

[7] The Spanish region of Aragon is classified as a NUTS2 region.

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National and **supranational legal frameworks** provide a significant impetus towards the CE for 40% of the surveyed cities and regions (OECD, 2020). The most vital supranational legal frameworks include 'the European Circular Economy Package' and 'the New Circular Economy Action Plan', while examples of national legal frameworks include 'the Federal Roadmap for a Circular Economy', Belgium (2016); 'the Strategy for Circular Economy', Denmark (2018); 'Leading the Cycle – the Finnish Road Map to a Circular Economy 2016-2025' (2016); 'the Finnish Road Map to a Circular Economy 2.0' (2019); 'Circular Economy and Bioeconomy Strategy', Finland (2017); 'the Circular Economy Roadmap of France: 50 Measures for a 100% Circular Economy' (2018); 'Towards a Model of Circular Economy for Italy: Overview and Strategic Framework' (2017); 'A Circular Economy in the Netherlands by 2050' (2016); 'The Roadmap Towards the Circular Economy in Slovenia' (2018); 'the Spanish Strategy for Circular Economy: España Circular 2030' (2020); and 'Circular Economy – Strategy for change in Sweden' (2020).

Additionally, **civil society circular initiatives** (31%) and **private-sector circular initiatives** (46%) stimulate the transition in the regions (OECD, 2020). Numerous international organisations, umbrella organisations, and foundations encourage cities and regions in their CE journeys, with business and citizen initiatives such as the Ellen MacArthur Foundation, C40, Climate KIC, ICLEI, and the European Investment Bank. Several bottom-up initiatives motivate governmental actions in the surveyed regions. For instance, in the region of Lapland,[8] CE practices commenced as a business-sector initiative in 2012. The industrial sector (bio-forest, forestry, mining, and steel) requested support from the public authorities related to the reuse of by-products and residues to promote the competitiveness of the industry associated to the regions' resilience. Local authorities welcomed the appeal, opening a dialogue about CE, providing technical assistance, and promoting collaborations (OECD, 2020).

The development of **CE policies** has also been mentioned as a stimulus of a region to increase its circularity (Avdiuschchenko, 2018; Barbero and Pallaro, 2018). Avdiuschchenko (2018) alludes to the vital responsibilities that policymakers have to devise carefully considered CE-related policies that balance the numerous benefits of the CE model with the need to reduce transitional costs as much as possible. Like any transition instigating considerable changes in regional development, CE inevitably has both positive and negative impacts for stakeholders in the given region. The sectors that face the largest transitional costs include the industries extracting virgin materials or non-durable consumer goods. Furthermore, the transition not only entails economic costs, but also social costs, due to changes in employment rates in the industries at the forefront of the competition with the CE-based substitutes (Avdiuschchenko, 2018).

2.1.4 Environmental

The OECD report on CE in cities and regions reveals that **climate change** is perceived as a CE driver by 73% of the surveyed cities and regions (OECD Survey, 2020). To achieve the objectives of the Paris Agreement and limit global warming to less than 2 ℃ and 1.5°C by 2030, emissions

[8] The Finish region of Lapland is classified as a NUTS3 region.

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must be 25% and 55% lower than in 2018, respectively (UNEP, 2019). In light of that, the EU Green Deal framework sets the goal of achieving a climate neutral economy by 2050. Moreover, with the 2030 Climate and Energy Framework, the EU aims for 32% usage of renewable energy and 32.5% improvement in energy efficiency for the period of 2021 to 2030 (ECb, 2020). Cities and regions are a large part of the resolution, as most environmental and climate-related spending occurs at the subnational level. The transition towards a CE is growing in importance in connotation with investments outlooks and necessary infrastructure. More than 50% of the urban infrastructure that will exist in 2050 is yet to be constructed, and the manner in which this infrastructure is planned and built will affect how people travel, buildings are constructed, and materials are repurposed, with the ultimate goal of decreasing the use of fossil fuels (OECD, 2020). In the period of 2000 to 2016, subnational governments in 30 OECD countries were accountable for an average of 55% of environmental and climate-related spending (OECD, 2019). Nonetheless, climate-related investment accounted for only 0.4% of their gross domestic product (GDP) within the same period (OECD, 2020).

To achieve low-carbon economies, governments must encourage more efficient use of resources, taking into account **natural-resources availability**, sustainable consumption, and production trends, while supporting CE to retain the highest possible value of goods and products, avert waste generation, and reuse and convert waste into resources (OECDa, 2020).

2.1.5 Behavioural/Socio-cultural

High consumer awareness, a strong **CSR culture**, and strong **entrepreneurial culture** are some of the suggested behavioural and socio-cultural drivers that can help a region to foster its CE transition (CIRCTER, 2019). Scarpellini *et al.* (2019), in their study of the region of Aragon,[9] highlight **awareness-raising campaigns** and the **dissemination of good practices and green procurement** as potential incentives to be considered for regional environmental policy to promote CE among businesses.

Increased awareness among wider society and policymakers regarding the vital function of CE in delivering smart, sustainable, and inclusive growth, as stressed in the Europe 2020 Strategy (COM no. 130, 2014), is a primary driving force of the CE shift. All stakeholders (government, academic, industry, and citizens) partaking in CE activities (Carayannis and Campbell, 2012), plus citizens and their awareness and conduct, all have a vital role in putting CE notions into practice (Smol *et al.*, 2018). According to Elia *et al.* (2017), CE is a novel concept in Europe, therefore it is vital to observe and assess public awareness because a profound ecological culture and societal awareness are essential for creating a responsible CE society (Smol *et al.*, 2018). Specifically, efforts should be directed towards awareness among the youth, as their knowledge, attitudes, and consumption

[9] The Spanish region of Aragon is classified as a NUTS2 region.

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behaviours are instrumental for building a CE-oriented society with long-term benefits (Kanchanapibul *et al.*, 2014).

Today, most research on CE awareness is conducted in China (e.g., Xue *et al.*, 2010; Liu *et al.*, 2009; Liu and Bai, 2014; and Guo *et al.*, 2017), where CE has been a national development strategy since 2009. Zeng *et al.* (2017) report increasing public and business awareness of CE, compared to 2008, when the first study of CE awareness was conducted. In the EU, the EC began to conduct CE-oriented research to explore CE-related industry enticements (Flash Eurobarometer, 2016), but few studies have investigated public awareness of the CE on the EU scale (Lakatos *et al.*, 2016), and no research has been dedicated to youth awareness (Smol *et al.*, 2018).

In light of this, Smol *et al.* (2018) position **public awareness** as a major driver of the transition to CE. The authors conducted an evaluation of public awareness and attitudes to CE in the Malopolska[10] region of southern Poland. A large proportion of the participants were aged 18-30 years (33%). The results of the study show that the region's inhabitants are open to the transition and most believe that a CE strategy could be adopted in the region. However, time is needed to change people's ways of thinking and acting, and funding should be channelled by national and regional governmental bodies for this purpose. To raise awareness of CE among the community, the Ministry of Environment organised targeted educational activities for all stakeholders (children, young people, students, communities, entrepreneurs, and officials), with the goal of informing consumer attitudes and developing optimal behavioural patterns in the marketplace (Smol *et al.*, 2018).

2.1.6 Population

A growing population and higher living standards increase waste-production levels and the consumption of natural resources. It is forecasted that the global population will reach 9 million by 2050, and more than half (55%) will be living in cities (OECD/EC, 2020). This projected **demographic change** and **urbanisation** will entail a substantial enlargement of existing cities, as well as the construction of new ones (UNEP, 2018). The consequences will include increased use of biomass, metals, non-metallic materials, and fossil fuels to meet the food, housing, energy, and infrastructure needs (OECD, 2020). Crucial areas of the CE – such as waste-management, energy, and material consumption – are conditional on population density, since more densely populated countries consume fewer materials.

Regarding local and regional arrangements, carbon emissions are closely linked to urban density and structure, as more compact cities and regions can contribute to reducing GHG emissions by reducing the need for construction of new roads, sewers, water lines, and other infrastructure (Ellen MacArthur Foundation, 2019; UNEP, 2018). In this context, Morikawa (2012) established a positive relationship between energy-consumption efficiency and population density. Urban density, moreover, has an important role in the waste sector, because low population density can

[10] The Polish region of Malopolska is classified as a NUTS2 region.

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be a restraining factor on recycling rates, due to the higher costs of waste-collection and transportation in less populated areas (OECD, 2020). Nevertheless, high population density can be a 'double-edged sword', since it requires a more efficient waste-management system due to sanitation problems and the scarcity and cost of land (Montevecchi and Reisinger, 2014; Matsunaga and Themelis, 2002).

2.1.7 Technological trends/Knowledge/Capacity

Qualified staff and research and innovation (R&I) capabilities, along with **availability of and access to innovation and testing facilities** are among the technology-related drivers that can aid a region's transition toward CE (CIRCTER, 2019). Additionally, the OECD survey revealed that **new business models** (43%), **technical developments** (43%), and research and development (**R&D**; 41%) are regarded as driving forces by more than 40% of the surveyed cities and regions (OECD, 2020). New business models – ranging from reverse logistics, reuse, leasing, and sharing – are thriving, alongside an increase in practices related to green infrastructure and decoupling alternatives, such as electric vehicles, solar panels, smart grids, retrofitting of buildings, and recycling facilities. Furthermore, cities and regions are increasingly hosting industrial symbiosis processes and clusters, on the understanding that the waste of one is input for another (OECD, 2020).

2.1.8 Other

Some drivers were difficult to classify into the set categories, hence a final category of 'Other' was created. Savini (2019) explains the importance of the **logistics sector**, describing it as both a target and driver for CE policymaking. Barbero and Pallaro (2018) argue that **systemic design** promotes the concept of a CE in which cross-sectoral flows of materials and energy create a network that imitates nature, presenting the Piedmont[11] region as a case study. Finally, in the conceptual paper of Avdiuschchenko (2018), which proposes NUTS2 regions as the optimal level for CE implementation, it is concluded that **circular cities** are the main drivers of CE-model adoption in their surrounding regions.

Table 1: Drivers of circular economy (CE) implementation at the regional level

[11] The Italian region of Piedmont is classified as a NUTS2 region.

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Drivers	Studies	CIRCTER (2019)	OECD (2020)	Scarpellini *et al.* (2019)	Savini (2019)	Andretta *et al.* (2019)	Barbero and Pallaro (2018)	Smol *et al.* (2018)	Avdiuschchenko (2018)
Economic savings	Economic/socio-economic/financial	■							
Profit increase		■							
New market/business opportunities		■							
High prices for imported or raw materials		■							
Attractive prices for circular products/services		■							
Economic change			■						
Job creation			■						
Financial support by national/regional governments								■	
Subsidies/bonuses to promote CE in business	Regulatory			■					
Subsidised training plans for employees				■					
Charges/taxes on unsustainable/harmful activities		■				■			
High charges for waste/high landfill taxes		■				■			
Tax benefits for green activities		■							
Ban on specific products (e.g., single-use plastic)		■				■			
Certification of products/companies				■					
Creation of a regional waste-interchange systems				■					
Global agendas	Institutional		■						
National legal frameworks			■						
Supranational legal frameworks			■						
Civil society initiatives			■						
Private-sector initiatives			■						
CE policies							■		■
Climate change	Environmental		■						
Natural-resources availability change			■						
High public awareness	Behavioural/socio-cultural	■		■				■	
Corporate social responsibility culture in companies		■							
Strong entrepreneurship culture		■							
Dissemination of good practices/green procurement				■					
Demographic change	Population		■						
Urbanisation			■						
Qualified staff & research and innovation capabilities	Technological trends/knowledge	■							
Availability/access to innovation & testing facilities		■							
New business models			■						
Technological developments			■						
Research and development			■						
Logistics sector	Other				■				
System design							■		
Circular cities (to adopt CE in surrounding regions)									■

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2.2 INHIBITORS OF REGIONAL CIRCULAR PRACTICES

The barriers collected from the desk review were synthesised into eight categories, presented in **Figure 3**. The categorisation of the drivers was largely taken from the grouping proposed in the two reports, the CIRCTER Policy Guide (2019) and the OECD Synthesis Report (2020). The barrier categories and specific subcategories are elaborated in the following subsections.

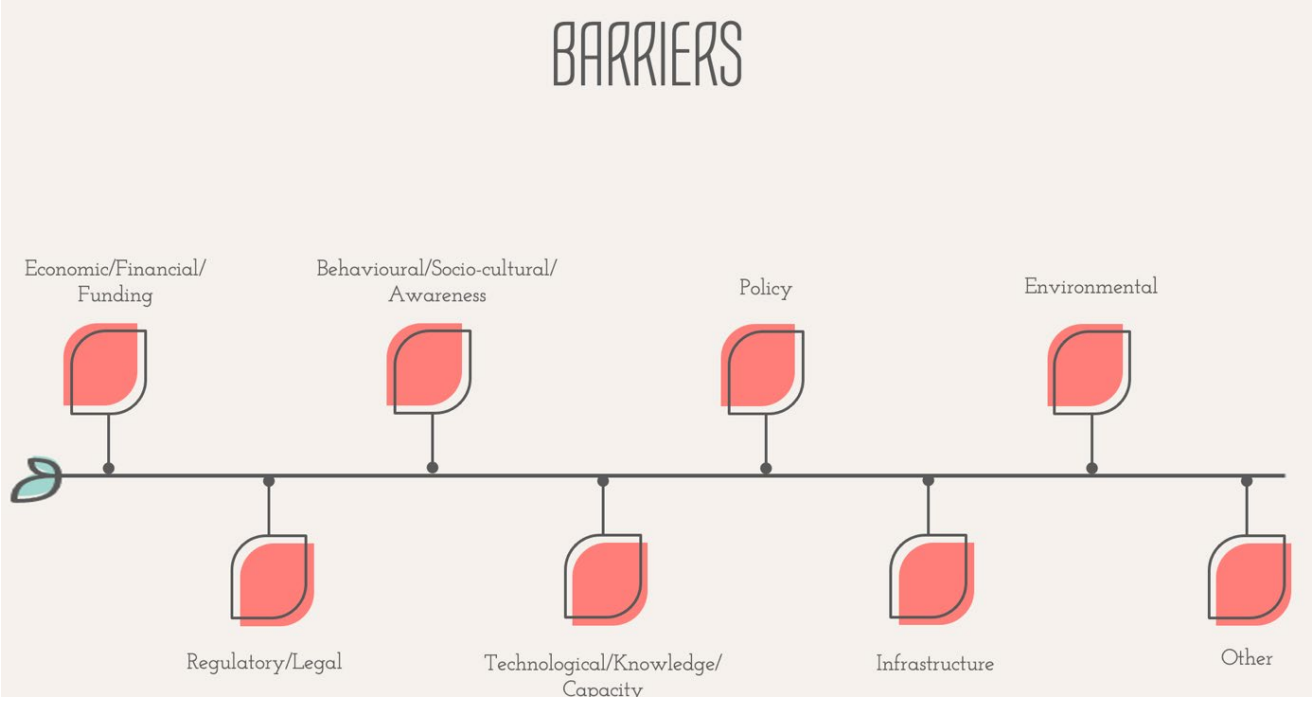

Figure 3: Categories of barriers for regional circular economy implementation

2.2.1 Economic/Financial/Funding

The economic/financial/funding category of barriers is the widest and more frequently mentioned. CIRCTER (2019) provides examples of economic challenges that regions can face, such as **limited or the absence of returns from investment**, **limited markets for recycled products**, and a **lack of funding and investment sources** for CE businesses and initiatives. This lack of funding and investment is also observed by Scarpellini *et al.* (2019) and Wu *et al.* (2014).

In light of this, the OECD (2020) claims that the CE shift necessitates investment and appropriate incentives to support the economic and financial case for the CE. The surveyed cities and regions responded that they face constraints as a result of the funding gaps, including **insufficient financial resources** (73%), **financial risk** (69%), **lack of critical scale for business and investment** (59%), and **lack of private-sector engagement** (43%). Moving towards an economy that is more circular will entail a substantial amount of investment, but investment gaps are reported and typically bridged by public funds, such as taxes and subsidies (OECD, 2020). Circular initiatives and pilot projects are recorded, but scaling them up is usually complex because of the restricted

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access to additional financial resources. Additionally, the shift towards a CE creates financial risks for the economic actors, partly due to the scale of the activities taking place in cities of different sizes, due to market size, population, material flow, and so on (OECD, 2020). Moreover, the inclusion of well-known, big industry players as accelerating agents for the transition is needed. The NUTS1 region of Flanders, for instance, emphasises the need for funding projects that cover the entire product or value chain (OECD, 2020).

Scarpellini *et al.* (2019) argue that **price increases are often not appreciated by consumers** and it is **difficult to meet the volume and standards requirements for recycling materials**. On the other hand, Barbero and Pallaro (2018) include **unaccounted externalities** and **market failure** as potential economic barriers, while Avdiuschchenko (2018) notes the **transactional costs** (economic and social) that some industries face.

Finally, Obersteg *et al.* (2019) list a number of economic and financial barriers that emerged from their study of several urban European regions. Some of these hindrances include **banks being reluctant to finance CE ventures**, **higher waste taxes in the region than nationally**, **financing or up-scaling CE initiatives in the linear economy**, **dual-waste systems (households/industrial) hinder waste-management optimisation**, **local service fees not used to refinance new sectoral investments**, **the development of the circular business model**, **recently centralised secondary raw-material market being inaccessible to local service-providers**, **slow market development for eco-innovative solutions**, **complex application process for additional funding for developing innovative solutions**, and **unclear or insubstantial incentives for waste separation**.

Current researchers question the core of the CE, asking whether closing material and product loops actually prevents primary production. Zink and Geyer (2017) claim that the economic element of the CE has been overlooked, and CE activities ultimately increase overall production, which can partly or entirely counterbalance their benefits. *Circular economy rebound* then occurs, when CE activities either fail to compete effectively with primary production or reduce prices, hence increasing shifting consumption patterns (Zink and Geyer, 2017). Following this, managerial efforts should not be directed to simply closing material and product loops, but rather to causing the *displacement* of primary production. Likewise, a priority shift is required to maximise the 'utility' of the product or material to maximise the *displacement potential* of end-of-life goods (Zink *et al.*, 2014). In conclusion, the environmental outcome of the CE is vague, since closing the material loops is not sufficient to ensure environmental improvement.

2.2.2 Regulatory/Legal

A substantial number of the collected barriers belong in the regulatory or legal category, affirming the vital role of regulation in the transition. CIRCTER (2019) lists, as regulatory barriers faced by some regions, the **subsidies for traditional polluting or inefficient activities** (e.g., coal, water, and energy costs) and **rigid 'end-of-waste' criteria** to prevent repurposing of waste streams for recycling, reuse, remanufacturing; while Barbero and Pallaro (2018) give **regulations hindering exchange of waste** as an example of a regulatory barrier.

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Scarpellini *et al.* (2019), as well as measuring the degree of penetration of CE activities in the region, analysed the main barriers to and incentives for the CE at a reginal level. They point to the general **administrative and regulatory barriers**, the **lack of standards for action**, and the **lack of a stable regulatory framework favouring the long-term investments required by the CE**. Another barrier mentioned by the experts during the interviews is the current **'end-of-pipe'** environmental management model for the treatment of waste at the end of the process. These principles are not fully considered during the design of the product (Scarpellini *et al.*, 2019).

In the regulatory category of challenges faced by regions and cities, the OECD (2020) notes the **inadequate regulatory framework** (73%) and **incoherent regulation across levels of government** (55%). The surveyed cities and regions argue that the regulatory framework needs to be established and adapted to unlock the full potential of the region for the circularity journey. Uncertainty regarding waste-stream classification was reported by numerous stakeholders, along with the need to clarify how materials can be reintegrated into the manufacture process when they are still reusable but qualified by law as waste. In that respect, they claim that one of the largest hindrances to the implementation of the CE is the current definition of 'waste' in national legislation. The existing EU directive for eco-design concentrates on areas linked to energy and partially disregards the materials and typology of products in a wider outlook (OECD, 2020).

The final major source of regulatory and legal barriers in the literature is the study of Obersteg *et al.* (2019), which records the following challenges in the surveyed regions: **unclear legislation on waste ownership**, **legal control by the EU on regional waste-management**, **poor measures for implementing CE processes**, **redundancy of authorisation for implementing waste plants**, **lack of space to manoeuvre for local (government) stakeholders**, **privatised collection**, and **conflict between waste-management and other uses of public spaces**.

2.2.3 Behavioural/Socio-cultural/Awareness

The concept of CE is becoming more widely recognised across Europe and globally, owing to the promotional activities taking place in the EU, China, Japan, and other developed countries, with the involvement of international organisations (Smol *et al.*, 2018). The emphasis of exploration on CE-related public awareness differs, depending on the implemented approach in the given territorial area. For instance, comparative evaluation of CE policy in China (Geng *et al.*, 2012; Jiao and Boons, 2017) and Europe (Ghisellini *et al.*, 2016) has revealed contrasting focuses formulated by diverse barriers. McDowall *et al.* (2017) state that China's focal point tends to be general environmental issues and pollution, while Europe is directing its efforts towards materials, resource efficiency, waste, new business models, new jobs, eco-innovations, social innovations, information and communications technology (ICT), in addition to wider implementation (Smol *et al.*, 2018).

In this context, **lack of awareness** is one of the most frequently encountered barriers to the regional advance in the circular direction, as shown by the analysed contributions in this report. More than half of respondents (63%) of the OECD survey cited lack of awareness as a challenge they are facing (OECD, 2020). Additionally, the CIRCTER (2019), Obersteg *et al.* (2019),

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Avdiuschchenko (2018), Smol *et al.* (2018), and Wu *et al.* (2014) all note the same barrier. The CIRCTER (2019) points to an **old-fashioned mindset in companies and among leadership** and a **lack of entrepreneurial spirit**, describing these as additional challenges for transitioning regions.

Other awareness gaps indicated by the OECD Survey (2020) include **cultural barriers** (67%) and **inadequate information** (55%); and this inhibits the ability of policymakers to make decisions, businesses to innovate, and citizens to embrace sustainable consumption practices. Some CE-related behaviours – such as reuse – are rarely regarded as valuable alternatives for reducing consumption and waste generation. The persisting acceptance issue is partly due to a lack of awareness, as well as a lack of trust in the quality of the reused products. To that end, many cities and regions have developed systems of quality certification, such as the 'Revolve Re-use' programme from Zero Waste Scotland that establishes reuse quality standards for reuse shops, awarding a specific logo distinguishable by consumers (OECD, 2020).

Informational barriers are also highlighted by Avdiuschchenko (2018) as a potential obstacle. Moreover, Scarpellini *et al.* (2019) list the **resistance to change** and **lack of interest from shareholders and stakeholders** as other barriers. Similarly, Barbero and Pallaro (2018) argue that **lack of experience in identifying opportunities** could be a hindrance for the transition.

Finally, the study of Obersteg *et al.* (2019) is a source of numerous other behavioural barriers, including the following: **consumer readiness to pay premiums for circular products**, **reliance on business leaders to make the CE transition**, **citizens' distrust of institutions**, **suspicions about the quality of organic and C&D waste products**, and the **topic of waste not being adequately covered in the school curricula**.

2.2.4 Technological/Knowledge/Capacity

Several barriers related to technology and knowledge are also acknowledged in the CIRCTER Policy Guide (2019), such as a **lack of experts in areas related to regional CE**, **limited R&I capabilities in companies and universities**, and **poor-quality or lack of research, testing, and piloting infrastructure**. Scarpellini *et al.* (2019) also cite **the lack of trained specialised personnel** as a key barrier. Two capacity gaps were identified by the OECD (2020), with the **lack of human resources** and of **technical solutions** posing a challenge for 61% and 39%, respectively, of the surveyed cities and regions. There are certain capacities that are essential for a region that wishes to progress towards a more CE (OECD, 2020).

2.2.5 Policy

The systemic nature of the CE is due to the variety of stakeholders, sectors, and goals involved in the process. This entails a wide policy focus through policy integration of silo strategies (OECD, 2020). As stated by the OECD (2020), *'when interactions and complementarities are overlooked, the lack of a systemic approach might lead to the implementation of fragmented projects in the short to medium run, rather than sustainable policies in the long run'*.

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In many instances, the CE debate is concerned with enabling niche, tecno-economic experimentation, while discussions around more socio-economic agendas are less frequent (Genovese and Pansera, 2020). These fragmented efforts and silo policy approaches can be somewhat avoided by adopting a more holistic view. However, one barrier highlighted by the surveyed regions and cities is a **lack of holistic vision** (cited by 67% of the respondents), which in turn could be the result of poor leadership and coordination (OECD, 2020). The responsibility for devising CE strategies and putting them into practice amongst the city administration is sometimes unclear, which leads to fragmented initiatives and weak accountability. On many occasions, the specific mandate for setting and executing long-term CE visions has been assigned to waste-management or environmental departments, another time circumventing the multi-dimensional aspect of the CE. Numerous sections partake in CE-related undertakings, hence stronger coordination is required. Other policy gap identified was around the **lack of political will** (39%; OECD, 2020).

Wu *et al.* (2014) claim that insufficient funding and rigorous environmental restraints have left local governments facing difficulties in **balancing and coordinating economic development and environmental regulation**.

In addition, a number of policy challenges are listed by Obersteg *et al.* (2019), including **a lack of consistency in municipal sustainability policies, a lack of regional CE policy formulation and coordination**, **a silo-mentality within governments and businesses regarding CE**, **competition among municipalities for leadership of waste management**, **a lack of policies on problems going beyond administrative boundaries**, **regional policies not being calibrated to local contexts**, **long-term and solid cooperation being difficult to build**, **the integration of CE in urban-planning policies**, **the balance of general regulations with tailor-made solutions**, **a lack of real participation by stakeholders**, **a lack of decentralisation of decision-making**, **insufficient horizontal municipal cooperation**, and **challenges to cooperation between local authorities and the private sector**.

2.2.6 Infrastructure

Many barriers identified by the surveyed stakeholders from urban regions in the study of Obersteg *et al.* (2019) were related to inadequate infrastructure. These include **a lack of recycling points in the peri-urban area**, **improve valorisation of food surpluses from the distribution chain**, **insufficient solutions for special-waste collection and treatment**, **the limited number of companies with innovation potential**, **the limited capacity for bulky-waste storage and waste containers in public spaces**, **the persistence of existing waste-technology preventing innovation**, and **the long distances between waste generation and treatment**.

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2.2.7 Environmental

Obersteg *et al.* (2019) present the results of a governance analysis of six urban regions in Europe. The scholars applied the PESTEL-O framework to identify governance challenges for urban regions moving towards CE. Numerous barriers of an environmental nature were identified by the interviewed stakeholders and said to be undermining the circular practices in the regions. These include **points for separated waste-collection frequently becoming wasted areas**, **the need to enhance the efficiency of waste-collection-system management to reduce mixed waste**, **the location of new waste-treatment plants**, **suburbanization significantly increasing waste-management costs**, **peri-urban assemblages of wastelands**, and **abandonment and illegal deposit of waste along peri-urban streets**.

2.2.8 Other

Some barriers were difficult to classify into the set categories; hence, a category of 'Other' was created. Scarpellini *et al.* (2019), in addition to measuring the degree of penetration of CE activities in the region, also analysed the main barriers to and incentives for the CE at a reginal level. One barrier identified was **difficulties with supplying recycled products**. Avdiuschchenko (2018) argues that the **absence of CE-monitoring instruments** for EU regions poses a challenge to the successful adoption of the policies, potentially hindering the realisation of the processes and strategies.

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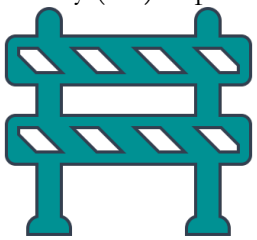
Table 2: Barriers to circular economy (CE) implementation at the regional level



Barriers	Studies	CIRCTER (2019)	OECD (2020)	Scarpellini et al. (2019)	Barbero and Pallaro (2018)	Smol et al. (2018)	Avdiuschchenko (2018)	Wu et al. (2014)	Obersteg et al. (2019)
Limited or lack of returns from investment	Economic/financial/funding	■							
Limited market for recycled products		■							
Lack of funding/investment sources		■	■	■				■	
Price increase not appreciated by consumers				■					
Difficulties in meeting volume & standard requirements for recycled materials				■					
Market failure					■				
Unaccounted externalities					■				
Transactional costs (economic & social)							■		
Financial risks			■						
Lack of critical scale for business & investment			■						
Lack of private-sector engagement			■						
Banks reluctant in financing CE ventures									■
Limited awareness of successful CE business models in resource management and planning projects									■
European waste management sanctions to be paid									■
Tendering not respondent to CE processes									■
Highest waste tax in the region compared to national									■
Financing/up-scaling CE initiatives in linear economy									■
Developing circular business model									■
Dual-waste system (household/industrial) hinders waste-management optimisation									■
Local service fees not purposed for refinancing new sectoral investments									■
Recently centralised secondary raw material market inaccessible to local service-providers									■

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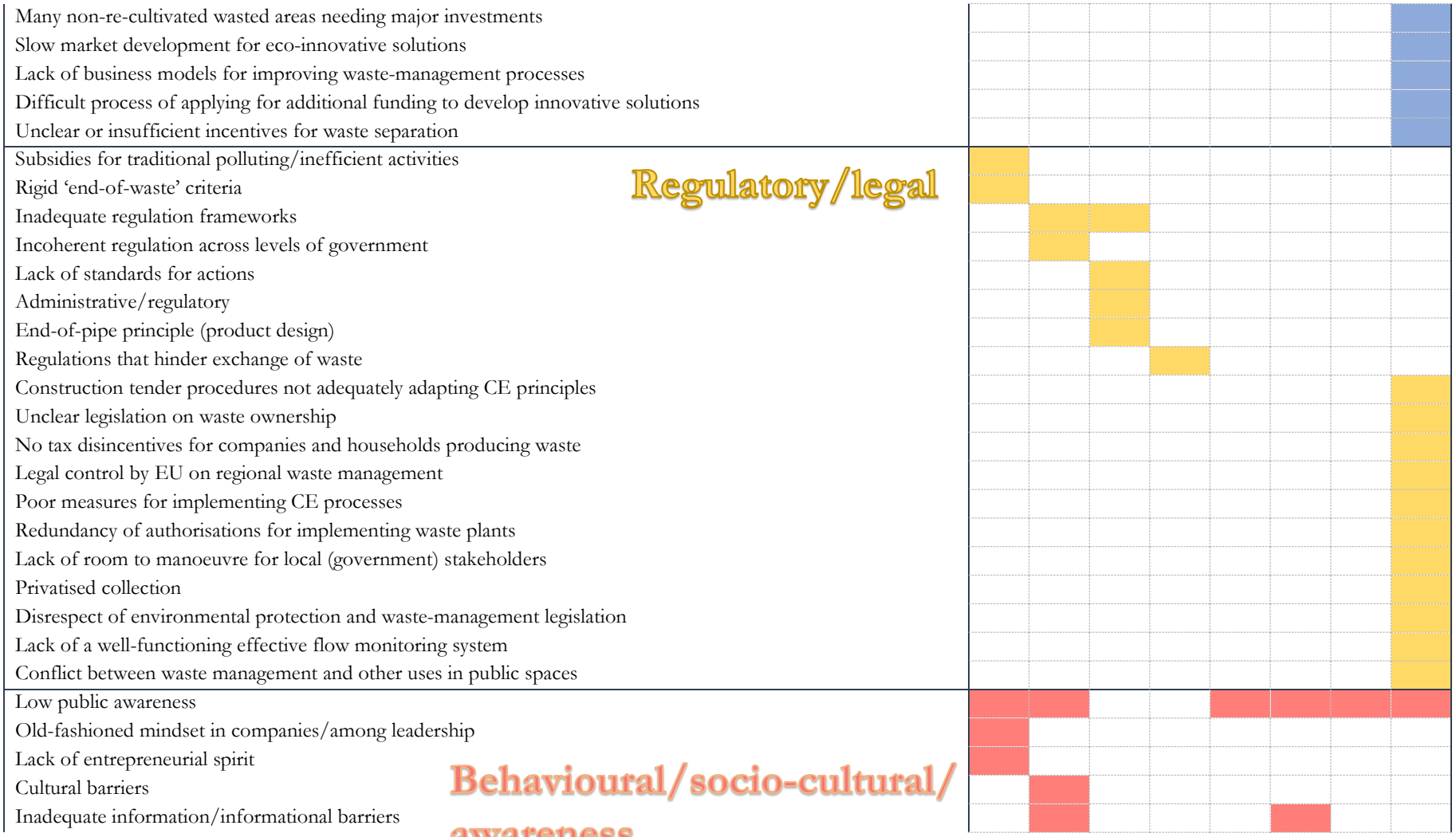

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Lack of interest	
Resistance to change	
Lack of experience in identifying opportunities	
Consumer readiness to pay premiums for circular products	
Reliance on business leaders to make the CE transition	
Citizens' distrust of institutions	
Suspicion of the quality of organic and construction and demolition (C&D) waste products	
'NIMBY' syndrome in local communities	
Engaging households in fighting food waste	
Participation (quantity and quality) in separate collection vegetable, fruit, and garden (VFG) waste	
Excessive (mainly landfilled, food, plastic) waste	
Residual/garden waste burning practice of households	
Waste topic not included sufficiently in school curricula	
Little interest in waste from either landlords or tenants	
Lack of experts/human resources in a region	Technological/knowledge/ capacity
Lack of research & innovation capabilities in companies/universities	
Poor-quality or absence of research, testing, piloting infrastructure	
Lack of technical solutions	
Lack of holistic vision and political will	Policy
Balance and coordinate economic development and environmental regulation	
Lack of consistency in municipal sustainability policies	
Lack of regional CE policy formulation and coordination	
Silo-mentality within governments and businesses regarding CE	
Competition among municipalities for leadership on waste management	
Lack of policies for facing problems beyond administrative boundaries	
Regional policies not calibrated to local contexts	
Long-term and solid cooperation are difficult to build	
Integrate CE in urban-planning policies	
Balancing general regulations with tailor-made solutions	

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Lack of real participation of stakeholders								
Lack of decentralisation of decision-making								
Not enough horizontal municipal cooperation								
Difficult cooperation between local authorities and private sector								
High percentage of organic-waste displacement								
Disposal of eco bales								
Lack of recycling points in the peri-urban area	Infrastructure							
Improve valorisation of food surpluses from distribution chain								
Nuisance related to storage and collection of VFG-waste								
Path dependency of waste-management system and planning practice								
Low density of waste-collection points								
Insufficient solutions for special waste-collection and treatment and waste separation infrastructure								
Small number of companies with innovative potential								
Limited capacity for bulky-waste storage and waste containers in public spaces								
Persistence of existing waste-technology preventing innovation								
Long distances between waste generation and treatment								
Presence of polluted or noise-restricted peri-urban wastescapes in port and airport areas								
Abandonment and illegal deposit of waste along peri-urban streets	Environmental							
Deposit of eco bales in peri-urban areas								
Peri-urban assemblages of wastelands								
Environmental impact of waste transport								
Points for separated waste-collection frequently becoming wasted areas								
No solutions for polylactic acid (PLA) collection and treatment and low level of distribution								
Efficiency of waste-collection-system management for reducing mixed waste								
Locations of new waste-treatment plants								
Suburbanisation significantly increasing waste-management costs								
Biowaste potential not fully used for bio-gas production								
Difficulties supplying recycled products								
Lack of CE-monitoring instruments for regions	Other							

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2.3 SECTOR-SPECIFIC CATALYSTS AND INHIBITORS

While some studies identify generic drivers of and barriers to CE introduction, development, and implementation, others focus on specific sectors (e.g., forest, waste, design, plastics). A summary of these, including the granular and sector-specific incentives and challenges, is presented in **Table 3** and **Table 4**. These academic contributions highlight sector-specific drivers and barriers identified in different regional contexts.

Aranda-Uson *et al.* (2018) provide an overview of the favourable conditions that can accelerate the transition towards circular models, as well as noting some of the challenges faced in Chinese settings that hinder the introduction of CE. Paletta *et al.* (2019) investigated a sample of 364 plastics-converting companies in the Emilia Romagna region of Italy and identified four categories of barriers in the plastic valorisation sector: technical-technological, legislative, economic, and socio-cultural. The pioneering work of Dabrowski *et al.* (2019) sought to investigate the barriers to knowledge transfer in the field of CE. For this purpose, the paper focused on novel empirical material: namely, the knowledge-transfer process for spatial solutions encouraging CE between two EU metropolitan regions (the Amsterdam metropolitan area and the Naples metropolitan areas), focusing on eco-innovative solutions for circular resource management. Design is a vital instrument for the movement to more CE-friendly policies and regulations; and, in their study conducted in Scotland, Whicher *et al.* (2018) identified the presence or absence of supportive policies and regulation to be a key driver of or hindrance, respectively.

Husgafvel *et al.* (2018a) conducted two studies: a regional study of sustainability and competitive advantage in the forestry sector companies in the Kymenlaakso region (Finland), and a second case study concerning the potential for cascading recovered solid wood in wood products. An attempt was made in a second paper to detect the CE challenges in the seafaring sector in the Kainuu region of Finland (Husgafvel *et al.*, 2018b). Several studies have analysed the incentives and challenges found in the waste sector (Fleischmann, 2019; Vanhamaki *et al.*, 2019), including construction and demolition (C&D) waste management (Volk *et al.*, 2019), regional solid municipal waste management (Plastinina *et al.*, 2019), and obstacles to closing the loop of regional material flows (Virtanen *et al.*, 2019).

Industrial symbiosis (IS) is increasingly employed as a strategic instrument to help deliver the CE at all levels in Europe – local, regional, national, and European (Lombardi, 2017). With this in mind, Lombardi (2017) conducted 65 surveys of companies in the resource-intensive-process industry sectors (cement, ceramics, chemicals, engineering, minerals, non-ferrous metals, steel, and water). The results revealed various non-technical barriers to the adoption of IS, with regulation, organisational and governance challenges, and a lack of information being the most vital (Lombardi, 2017).

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Table 3: Drivers identified in specific sectors and fields

	Drivers
Aranda-Uson *et al.* (2018)	*Favourable conditions that can accelerate the transition towards circular models*
	- Regulation and public support - Geographic proximity - Local and regional authorities, policymakers - Introduction of industry-driven and/or collaborative models (self-regulation) - Establishment of voluntary standards - Promotion of eco-design and manufacturing standards that stimulate closing of materials loops
Fleischmann (2019)	*Waste sector*
	- Better governmental waste-management and incentives - Design-led innovation
Volk *et al.* (2019)	*Construction and demolition (C&D) waste management*
	- Financial incentives - Education - Interlocking policy system
Plastinina *et al.* (2019)	*Regional solid municipal waste management*
	Economic efficiency of economic activity as main incentive for CE implementation: - Development of sorting facilities - Provision of incentives for separate municipal solid-waste collection - Introduction of proper tariff system - Favourable conditions for business development
Vanhamaki *et al.* (2019)	*Waste*
	Waste (biowaste) management
Husgafvel *et al.* (2018a)	*Forest sector*
	- Technological innovation - Supportive regulatory environment - Extended producer responsibility (EPR) schemes could be one option for promoting the recovery and use of wood in new products and helping to direct more attention to design processes that would ease the dismantling of products.
Whicher *et al.* (2018)	*Design*
	- Policy and regulation
Lombardi (2017)	*Industrial symbiosis*
	Benefits of industrial symbiosis implementation from the survey results: - Improved environmental performance of the company - Reduced costs of waste disposal - Improved environmental performance of the community - Revenue generation and reduced cost of input - Adherence to regulatory requirements and satisfaction of CSR requirements - Opportunity to implement similar process in other areas of business - Improved links with other businesses and quality of inputs

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Table 4: Barriers identified in specific sectors and fields

	Barriers
Aranda-Uson *et al.* (2018)	*Challenges to improving the introduction of the circular economy (CE) in China*
	- Lack of reliable information - Shortage of advanced technology - Poorly enforced legislation - Weak economic incentives - Poor leadership and management - Lack of public awareness
Paletta *et al.* (2019)	*Plastic valorisation*
	- Technical-technological - Legislative - Economic - Socio-cultural
Fleischmann (2019)	*Waste sector*
	- Lack of incentives - Lack of funding
Dabrowski *et al.* (2019)	*Knowledge-transfer process for spatial solutions to promote CE, focusing on eco-innovative solutions for circular resource management*
	- Language - Disciplinary background - Geography (of metabolic flows) - Socio-cultural - Socio-economic differences - Other socio-political phenomena - Legal aspects - Governance and decision-making - Technological aspects
Virtanen *et al.* (2019)	*Challenges of closing the loop of regional material flows*
	- Small and medium-sized enterprises lack resources - Incomplete value chain
Volk *et al.* (2019)	*Construction and demolition waste management*
	- Regulatory and incentive environment - Lack of waste-processing facilities - Poor communication among involved parties - Lack of awareness and poor behaviour among project stakeholders - Lack of awareness of environmental implications of waste disposal - Cultural resistance and poor project processes
Plastinina *et al.* (2019)	*Regional solid municipal waste management*
	State management failures: - Legal requirements for waste recovery (Russian targets for waste recovery are far below EU targets) - Legally underdeveloped financial state support to waste-processing enterprises (and lack of details in subordinate legislation for specific regulations)

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	- Lack of internalisation of externalities, such as reduced waste volume, reduced environmental damage, and virgin resource consumption having social value in the form of environmental taxes or fees - Environmental fees and pollution payments are a formality - Irregular waste fraction recycling
Husgafvel *et al.* (2018a)	*Forest sector – 1. Barriers in the woodworking industry field, potential for cascading recovered solid wood; 2. Barriers to the use of recovered wood*
	1. Scale and profitability (processes optimised for logs, strength grading in load bearing structures, possible humidity requirement, quality requirements, moisture content, origin of the recovered wood, cleanliness, humidity requirements in bendings, availability of recovered hardwoods, sorting, energy use) 2. Price/cost effectiveness (industrial scale, quality, cleanliness, logistics, availability, requirement for moisture, origin, authorisation, strength grading, separation of wood species, length, appearance)
Husgafvel *et al.* (2018b)	*Challenges to the CE in the seafaring sector*
	- Clever products and services - Development of cooperation and logistics - Energy and material efficiency - Evaluating the developing of supply/value chain - Creating value added - Increase of sectoral cooperation and interaction - Increase of recycling and reuse and minimisation of waste - Intelligent production and processes - Local or regional resource banks - New symbiosis products and utilisation of by-products and side flows - Developing of international guidelines and best practices - Development of harbour operations and management - Development of operational environment of EU - International vocational education
Whicher *et al.* (2018)	*Design*
	- Policy and regulation
Lombardi (2017)	*Industrial symbiosis – 1. Selected group of non-technical barriers to the CE through industrial symbiosis; 2. Challenges to implementing industrial symbiosis, highlighted in the survey results*
	1. Informational (regulatory and policy, commercial, organisational/governance) 2. Process barriers (regulatory barriers, financial barriers, transport barriers, lack of information regarding alternative feedstock/inputs, lack of time to implement solutions, long timeframe for implementation of solutions, coordination barriers, concerns about confidentiality, gaining approval from relevant authorities, contractual barriers, logistical barriers)

3. EN ROUTE TO THE REGIONAL CIRCULAR ECONOMY: KEY DRIVERS OF AND BARRIERS TO THE REGIONAL STRATEGIES

Chapter 2 provided an overview of the drivers and barriers associated with implementation of CE at the regional level, as presented in the academic literature and relevant grey literature. To verify and complement these findings, a preliminary secondary data analysis was conducted for selected

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EU regional strategies and action plans for CE transition. The analytical results are presented in this chapter.

3.1 SELECTION STRATEGY AND PROCESS

To define the term 'region' as used throughout WP4, the NUTS classification was presented in the first deliverable (D4.1) of this WP. All EU member states (MSs) – along with their NUTS 1, NUTS 2, and NUTS 3 regions – are compiled in a comprehensive set of tables presented in Appendix A ('NUTS classification'), provided as supplementary material for this technical report. As the NUTS2 regions have been proposed as the optimal level for CE implementation, the 281 NUTS 2 EU regions were the starting point for selection of the regional strategies analysed in the following sections. The flow chart presented in **Figure 4** illustrates the selection strategy and process of the regions and their CE strategies.

As explained in **Box 1**, the NUTS 2 regions belong to three development categories. The first selection criterion was to include regions from all categories to ensure representativeness and minimise the possibility of presenting biased and distorted representations of the status of the CE efforts across the EU regions. Additionally, an attempt was made to delve into an intercountry case and select regions with CE strategies from the three development categories and compare them. For that purpose, three Spanish regions were included in the analysis, having been chosen on the basis of the online availability of data and the authors' knowledge of the Spanish language.

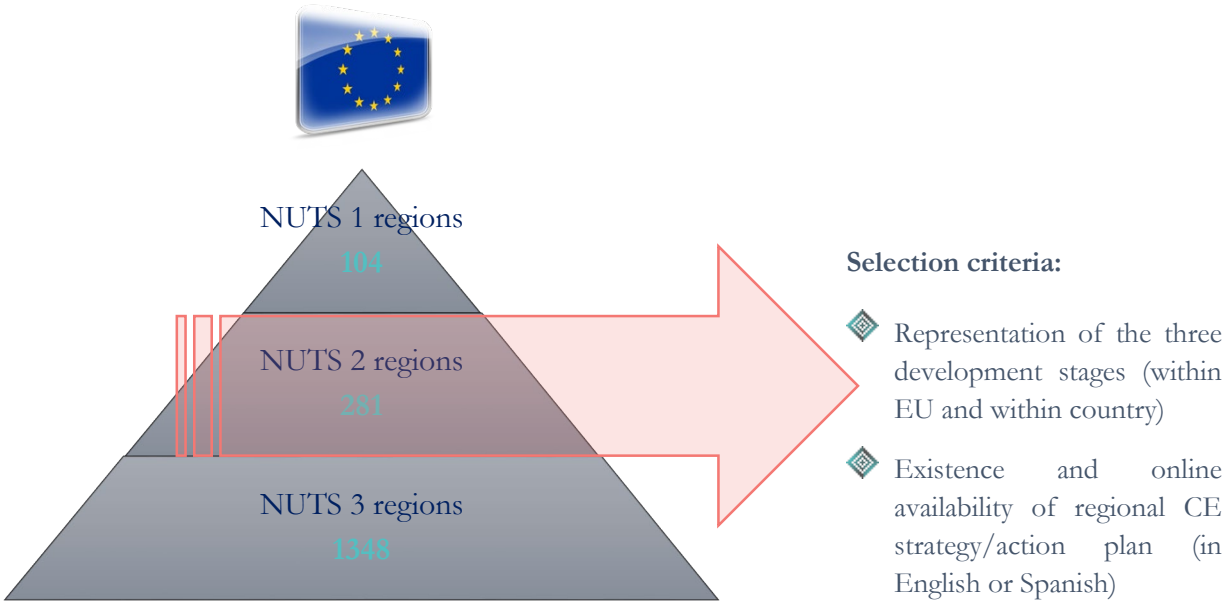

Figure 4: Selection strategy and process (regions according to NUTS 2016 classification)

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Box 1: The NUTS 2 regions

The NUTS classification provides the basis for regional boundaries and geographic eligibility, as statistics from regional accounts are used for the allocation of EU funds. During the period of 2014-2020, eligibility for the European Regional Development Fund (ERDF) and the European Social Fund (ESF) was calculated on the basis of regional GDP per inhabitant in purchasing power standard (PPS), as averaged for the period of 2007-2009. NUTS level 2 regions were ranked and split into three groups:

- **less-developed regions**, where GDP per inhabitant was **less than 75%** of the EU-27 average;
- **transition regions**, where GDP per inhabitant was **75%-90%** of the EU-27 average; and
- **more developed regions**, where GDP per inhabitant was **more than 90%** of the EU-27 average.

Eligibility for the cohesion fund – which was established to strengthen the economic, social, and territorial unity of the EU in the interests of promoting sustainable development – is assessed on the basis of the NUTS 2 level regions. Hence, a large proportion of the cohesion policy budget has been allocated to regions whose development lags behind the EU average; more specifically, more than 50% of the total budget was distributed to less-developed regions, primarily located in the south or the east of the EU, the Baltic Member States, and several of the outermost regions (Eurostat Regional Yearbook, 2019).

The next step of the selection process was to identify regions that had CE strategies in place that are available online and written in English or Spanish. Regions in the more developed regions category had the greatest representation, as a large proportion had strategies and action plans in place. Difficulties arose, however, when trying to identify less developed and transitioning regions that had a strategy for CE implementation available online. These regions tended to lack a national policy framework or action plan for the CE, as was the case for Bulgaria,[12] Cyprus,[13] Estonia,[14] and Hungary.[15] On the other hand, Nordic countries ranked highly for their pro-environmental initiatives and seem to be focusing their efforts on achieving circularity in their smaller territories, more particularly their NUTS 3 regions. As reported in the OECD Synthesis report (2020), the regions of North Karelia, South Karelia, and Southwest Finland have developed actions plans for the NUTS 3 level regions, but they were excluded from the analysis in this report. The regional strategies analysed in the following chapter – on the NUTS 2 level only – are shown in **Table 5**.

Table 5: Selected NUTS 2 regions with regional initiatives for analysis

[12] https://www.interregeurope.eu/reduces/news/news-article/10186/bulgaria-on-its-journey-to-circular-economy/

[13] https://switchmed.eu/wp-content/uploads/2021/02/Country-Profile-Cyprus_final.pdf

[14] https://ringmajandus.envir.ee/index.php/en/creating-strategy-and-action-plan-circular-economy-estonia

[15] https://www.oecd-ilibrary.org/sites/9789264298613-11-en/index.html?itemId=/content/component/9789264298613-11-en

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Country	Region	PPS per capita[16]	Strategy/Action Plan
More developed regions			
	Luxembourg	253%	The Data-Driven Innovation Strategy for the Development of a Trusted and Sustainable Economy in Luxembourg (2019)
	Brussels Capital Region	196%	Brussels Regional Program for a Circular Economy 2016 – 2020 (BRPCE)
	Catalonia	110%	Estratègia d'Impuls a l'economía verda i a l'economía circular (2015)
Transition regions			
	Friesland	88%	Circulair Fryslân: De Economie Van De Toekomst (2015)
	Galicia	82%	Estratègia Gallega de Economía Circular 2019-2030
Less-developed regions			
	Extremadura	64%	EXTREMADURA 2030 Estratègia de economía verde y circular (2017)
	Central Macedonia	53%	Action Plan: Towards Bio-Based Circular Economy (2019)

[16] PPS per capita 2017 data available here: https://ec.europa.eu/eurostat/documents/2995521/9618249/1-26022019-AP-EN.pdf/f765d183-c3d2-4e2f-9256-cc6665909c80

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3.2 REGIONAL BLUEPRINTS

This section presents the so-called blueprint of the selected regions, showing the profile of the region and its respective CE policy documents. The name of the region and its NUTS code is given first, followed by its population and stage of development; all the information has been extracted from the European Social Progress Index 2020 (2020 EU-SPI) Scorecards.[17] In **Table 5**, the PPS per capita economic measure is introduced; and based on this, the regions are categorised as more developed, transitional, or less developed. As such, no other economic indicator is presented in this section. An effort was made to identify NUTS 2 regional indicators and measures to represent a broader perspective of the regions' status, giving an overview of the social and environmental dimensions. For that purpose, two sources were included in the **Regions' Blueprints.**

First, the **European Social Progress Index 2020** (2020 EU-SPI) is incorporated as a measure of societal development and quality of life at the regional level, going beyond GDP. The index measures social progress in European regions, at the NUTS-2 level, using 12 components described by a total number of 55 comparable social and environmental indicators, excluding economic aspects. The components are further aggregated into three broader dimensions of basic human needs (necessary enablers of societal development), foundations of wellbeing (intermediate factors of social and environmental progress), and opportunities (the most advanced component of a cohesive and tolerant society). The higher the score of the region, the better its rank within the 240 EU NUTS-2 regions.

The **OECD Regional Wellbeing**[18] measure is then presented. Each OECD region is measured on 11 scales important for wellbeing – including the environment. The values of the indicators are expressed as a score between 0 and 10. A high score indicates better performance relative to the other regions.

To further complement the picture of the institutional and fiscal decentralisation of EU countries, the **Division of Powers**[19] was added to the **Regions' Blueprints**, showing the legal bases for the various governance structures in the respective countries, the responsibilities and powers of the regions, and their respective regional authorities.

Finally, the national and regional frameworks are presented, along with the specific CE action plans or strategies for the regions. Relevant information has been extracted from the policy documents, focusing primarily on the cited or implied drivers, incentives, and challenges and barriers faced by the region in its journey towards the CE.

[17] https://ec.europa.eu/regional_policy/en/information/maps/social_progress2020/#3

[18] https://www.oecdregionalwellbeing.org/

[19] https://portal.cor.europa.eu/divisionpowers/Pages/default.aspx

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LUXEMBOURG (LU00)

Population	Stage of development (1=Lowest; 5=Highest)
602 000	5

2020 EU-Social Progress Index (SPI)

Score (0-100)	74.6
Rank	42/240
EU score (0-100)	66.7

OECD Regional Wellbeing (0-10)

Education	7.3
Jobs	7.0
Income	6.8
Safety	9.4
Health	8.5
Environment	6.0
Civic engagement	10.0
Accessibility	9.9
Housing	6.1
Community	6.2
Life satisfaction	6.7

Division of powers – Luxembourg

Member state without legislative powers at the sub-national level – unitary state.

Representing NUTS 1, NUTS 2, and NUTS 3 regions.

Central level (state responsibilities): Exclusive legislative and administrative powers in all fields related to national interest.

Regional level: District commissioners ensured compliance with laws and general and municipal regulation.

Policy area: Environment & the fight against climate change is governed centrally by the **Ministry of Environment, Climate, and Sustainable Development** and the **Sustainable Development Higher Council.**

Regional CE Strategy: 'The Data-Driven Innovation Strategy for the Development of a Trusted and Sustainable Economy in Luxembourg' (2019) – a national and regional strategy, as the state of Luxembourg is equivalent to NUTS 1, 2, and 3 regions.

Responsible institution: The Government of the Grand Duchy of Luxembourg – Ministry of Economy, integrated the CE in its data-driven innovation strategy as a key-sector for innovation. The data-driven innovation strategy has seven priority sectors, including 'eco-technologies', which is comprised of CE and smart mobility focus areas, coordinated by the **Ministry of Energy and Spatial Planning** and the **Ministry of Mobility and Public Works**.

Aim (within the CE focus area): To become an honest broker for Europe's CE and develop data-driven performance-based services.

Drivers: Including CE principles in the masterplans of large urban development projects; integrating the CE into the municipalities' climate pacts, encouraging circular procurement; developing material passports in the construction sector, including all relevant information on how to turn buildings into material banks; creating a data hub for CE to provide data, knowledge, and services to circular stakeholders and complete integrated value chains; adapting the financial, regulatory, fiscal, and accounting systems to the CE; creating attractive ecosystems and developing a new specific sector by addressing issues and developing new services related to accounting, financing, insurance, liability, tax, contracting, testing, regulation, standards, value propositions, and qualified intermediaries such as consultants and entrepreneurs.

Challenges: A need for an ecosystem that supports company efforts to performance-based business models; the development of further domestic test markets; lack of data available on products and components, as well as a lack of precision on materials grouped in generic categories (e.g., plastics); financing of the transition costs for circular business models; and internal change management (for companies).

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BRUSSELS CAPITAL REGION (BE10)

Population	Stage of development (1=Lowest; 5=Highest)
1 207 000	5

2020 EU-Social Progress Index (SPI)

Score (0-100)	68.5
Rank	123/240
EU score (0-100)	66.7

OECD Regional Wellbeing (0-10)

Education	7.1
Jobs	2,9
Income	3,8
Safety	7,8
Health	6,9
Environment	5,1
Civic engagement	10,0
Accessibility	7,8
Housing	6,7
Community	7,3
Life satisfaction	6,3

Division of powers – Belgium

Member state with legislative powers at the sub-national level – complex federal state.

Regional level: Has legislative and executive organs known as the **regional parliament** and the **regional government**. Regions have legislative powers in fields connected to their territory and, therefore, may issue regional decrees that have the force of law.

No hierarchical relationship between the regions and the federal authority, and their powers have shared responsibilities in some areas (i.e., environment, taxation, energy, etc.).

Responsible ministries/bodies in the policy area of environment & the fight against climate change include the following: **The Health, Food Chain Safety and Environment FPS/FOD, the Flemish Department for Living Environment, Nature and Energy, Environment Wallonie, Brussels Environment.**

Regional CE strategy: Brussels Regional Program for a CE (BRPCE) 2016-2020 (2016).
General objectives: (i) To transform environmental objectives into economic opportunities; (ii) to relocate the economy to Brussels to produce locally whenever possible, reduce travel, optimise land use, and create added value for Brussels inhabitants; and (iii) to help create employment.
Steering of the BRPCE: Three Ministers (**Minister for Housing, Quality of Life, the Environment and Energy; Minister for the Economy, Employment and Vocational Training; Secretary of State Responsible for Public Cleanliness, the Collection and Treatment of Waste, and Scientific Research**), four regional administrative bodies (**Impulse – the Brussels Enterprise Agency, Brussels Environment – the Brussels administration for the Environment and Energy, *Bruxelles-Propreté* Agency – the Brussels Agency for Urban Cleaning, and the Collection and Treatment of Household Waste, Innoviris – the Brussels administration for the promotion and support of innovation**) and other stakeholders.
Drivers: Combining bottom-up and top-down approaches – involving multiple public and private stakeholders in the origination, operation, and reporting of the measures; cross-functional measures (favourable regulatory framework); sector-based measures (target construction, resources and waste logistics, trade and food sectors); territorial measures (integrating the CE at the local level); governance measures (strengthening coordination between authorities); BRPCE, designed as a 'living strategy' and being revised every 18 months;
Challenges: Incorporation of bottom-up and top-down approaches creates the greatest challenges; working efficiently in a multi-administration and co-creative manner, with production facilities located outside the region.

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CATALONIA (ES51)

Population	Stage of development (1=Lowest; 5=Highest)
7 499 000	4

2020 EU-Social Progress Index (SPI)

Score (0-100)	67.1
Rank	135/240
EU score (0-100)	66.7

OECD Regional Wellbeing (0-10)

Education	4.7
Jobs	5.2
Income	4.0
Safety	9.6
Health	9.7
Environment	5.5
Civic engagement	4.4
Accessibility	7.6
Housing	5.6
Community	7.9
Life satisfaction	4.8

Division of powers – Spain

Member state with legislative powers at the sub-national level – unitary state organised on a decentralised basis.

Regional level: Autonomous communities enjoy important autonomy and have legislative powers, with the right to self-govern.

Policy area: Environment & the fight against climate change is governed centrally by the **Ministry for the Ecological Transition and the Demographic Challenge.**

International frameworks: UN's Global Green New Deal (as supported by UNEP's Green Economy Report, 2011); the OECD's Green Growth Strategy; the UN's Rio+20, 'The Future We Want' (2012).

EU frameworks: European Green Deal (2019), preceded by Europe 2020 strategy (2010).

Regional frameworks: RIS3CAT – 'Strategy for research and innovation for smart specialisation of Catalonia', integrating the green economy into leading sectors, emerging activities, facilitating technologies, and context that facilitates innovation.

Regional CE strategy: Strategy for the promotion of the green economy and the circular economy (Approved by governmental agreement GOV/73/2015 on 26 May 2015).

Responsible institution: The Regional Government of Catalonia (Territorial and sustainability department).

Main objective(s): (1) To align, in competitiveness matters, to the standards of smart, sustainable, and inclusive growth of the EU and leading surrounding countries; (2) to provide coherence and visibility to the different plans towards green/CE of the different governmental departments; (3) to establish priorities for future governmental action; and (4) to boost corporate leadership and the capacity to transition to circular/green economy, also for society as a whole.

Drivers: Interreg Europe CircE Project ('European Regions Toward Circular Economy') involves eight partners and representatives of different European social and economic scenarios. It seeks to enhance the ability of the involved regions' policy instruments to drive the transition towards more circular economies through the exchange of knowledge and experience, as well as broad stakeholder involvement. In the specific case of Catalonia, the 'Action plan to promote circular economy in the textile and beverage sectors 2019-2021' is in place as part of the project. '*Catalunya Circular*' (Circular Catalonia) is an innovation hub and meeting point for companies and institutions that offer solutions for a more circular Catalonia.

Challenges: It envisages the key areas of action in terms of generating demand and creating market structures, improving access to funding, promoting R&D, and boosting internationalisation.

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FRIESLAND (NL12)

Population	Stage of development (1=Lowest; 5=Highest)
647 000	3

2020 EU-Social Progress Index (SPI)

Score (0-100)	78.2
Rank	26/240
EU score (0-100)	66.7

OECD Regional Wellbeing (0-10)

Education	6.6
Jobs	8.7
Income	3.8
Safety	9.9
Health	6.9
Environment	5.7
Civic engagement	8.4
Accessibility	9.9
Housing	6.7
Community	8.3
Life satisfaction	9.3

Division of powers – The Netherlands

Member state without legislative powers at the sub-national level – unitary state organised on a decentralised basis.

Central level (state responsibilities): National issues; legislative and administrative power, but provinces and municipalities may issue provincial and municipal regulations, as long as they are in compliance with national law.

Regional level: The representative governing body at the provincial level is the **Provincial Council** (*Provinciale Staten*), while the executive body is the **Board (College) of the King's Commissioner** (*Commissaris van de Koning*) and the **Provincial Aldermen** (*Gedeputeerde Staten*).

Responsible Ministry in the policy area environment & the fight against climate change is **the Ministry of Infrastructure and Water Management**, with the **Regional Authorities** for the provincial levels.

National framework: *Grondstoffenakkoord* – national agreement outlining the country's commitment to a CE by 2050.
Regional CE strategy: *Circulair Fryslân: De Economie Van De Toekomst* (2015).
Responsible institutions: Province of Friesland, Municipality of Leeuwarden, Circular Friesland Association, Metabolic, Urgenda.
Drivers: General joint activities outlined for each sector (setting up a platform, organising roundtable discussions); inspiring flagship projects and overarching activities; stimulating cooperation between different sectors, incubators, and accelerators; a platform to collect knowledge and attract companies that will supply the new circular products in the construction sector; the establishment of the Frisian Salt Institute to gather knowledge via projects in various test locations and related research; circular experts – catalysers and theme specialists; the promotion of industrial symbiosis; a focus on cultural diversity and extension of added value to CE; system thinking approach where the circular consumer is at the centre; changes in behaviour and mentality; circular business models and entrepreneurship; circular procurement; integral approach to education, including CE and sustainable development in education programmes, from primary-school to university level; circular construction; circular design.
Challenges: An initial need for opportunity analysis and correct stakeholder involvement.

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GALICIA (ES11)

Population	Stage of development (1=Lowest; 5=Highest)
2 705 000	3

2020 EU-Social Progress Index (SPI)

Score (0-100)	68.7
Rank	120/240
EU score (0-100)	66.7

OECD Regional Wellbeing (0-10)

Education	4.2
Jobs	3.5
Income	3.1
Safety	10.0
Health	9.0
Environment	8.0
Civic engagement	3.5
Accessibility	6.8
Housing	7.2
Community	8.2
Life satisfaction	4.4

Division of powers – Spain

Member state with legislative powers at the sub-national level – unitary state organised on a decentralised basis.

Regional level: Autonomous communities enjoy substantial autonomy and have legislative powers, with the right to self-govern.

Policy area: Environment & the fight against climate change is governed centrally by the **Ministry for the Ecological Transition and the Demographic Challenge.**

International frameworks: UN's Sustainable Development Goals (2016).
EU frameworks: Closing the loop – An EU action plan for the Circular Economy (2015).
National frameworks: Spanish Circular Economy Strategy: España 2030 (still in draft stage).
Regional CE strategy: Galician circular economy strategy.
Responsible institution: The Regional Government of Galicia.

Main objective(s): (1) To promote a knowledge-based economy; (2) to drive a life cycle and eco-design philosophy in the corporate/market culture; (3) to promote a CE information platform; (4) to drive new business models based on use/utility (rather than product ownership); (5) to employ CE as a demographic engine, highlighting the riches of local resources (human or natural); (6) to implement eco-efficient urbanism; (7) to implement eco-efficient water-cycle management; and (8) to prioritise circularity in waste management, including a hierarchy of waste-recovery strategies (favouring regeneration of primary materials).

Drivers: The main drivers are envisaged in terms of the general application of systematic eco-design practices, creation of new activities and business model innovation, clear promotion of R&D for the generation of scientific and technical knowledge, together with increased resource efficiency and extended management of materials along their life cycle, as well as increased education and information exposure for all relevant stakeholders. In this sense, Galicia has a clear advantage with respect to its already built (knowledge) capacity in the agricultural and fishing sectors. Economic advantages are viewed as facilitating the implementation of circular strategies.

Challenges: Stakeholder collaboration, led by the government, is necessary and challenging. Incorporation of systematic strategies (as drivers) and the alignment of the Spanish government with these are necessary. In particular, the Spanish government should build coherence between the actions of different regions in Spain to ensure their success (most importantly, in terms of the changes to market incentives and structure necessary for a real transition).

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie Innovative Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

EXTRAMADURA (ES43)

Population	Stage of development (1=Lowest; 5=Highest)
1 071 000	2

2020 EU-Social Progress Index (SPI)

Score (0-100)	64.3
Rank	151/240
EU score (0-100)	66.7

OECD Regional Wellbeing (0-10)

Education	1.7
Jobs	0.5
Income	2.4
Safety	9.8
Health	8.5
Environment	7.4
Civic engagement	5.5
Accessibility	6.8
Housing	6.7
Community	9.3
Life satisfaction	5.9

Division of powers – Spain

Member state with legislative powers at the sub-national level – unitary state organised on a decentralised basis.

Regional level: Autonomous communities enjoy substantial autonomy and have legislative powers, with the right to self-govern.

Policy area: Environment & the fight against climate change is governed centrally by the **Ministry for the Ecological Transition and the Demographic Challenge.**

International frameworks: UN's Sustainable Development Goals (2016); UNEP's Green Economy Report (2011).
EU frameworks: Europe 2020 strategy (2010); Closing the loop – An EU action plan for the Circular Economy (2015); Europe 2030 project (2010); Europe 2020 strategy; Horizon 2020 programme.
National frameworks: Spanish Circular Economy Strategy: España 2030 (draft); National Plan for Management of Residues (2016-2022); Spanish Bioeconomy Strategy Horizon 2030; Climate Change and Energy Transition Law.
Regional frameworks: RIS3Extremadura – Strategy for Research and Innovation for Smart Specialisation of Extremadura (2014-2020).
Regional CE strategy: Green and circular economy strategy EXTREMADURA 2030.
Responsible institution: The Regional Government of Extremadura.
Policy instruments addressed: Social concentration commission; directive committee *Extremadura* 2030; regional strategy coordination commission; territorial commission; technical office *Extremadura* 2030; thematic commission; *Extremadura* 2030 Forum.
Main objective(s): (1) To build a sustainable development model based on green and circular economies; (2) to design a stakeholder involvement process in the governance model; (3) to enable a social transformation based on mass capacity building of citizens; (4) to make *Extremadura* into an internationally recognised laboratory for green and circular economy matters (in terms of R&I); and (5) to identify and valorise stakeholder interactions with respect to the green and circular economies.
Drivers: Stakeholder involvement and knowledge-sharing as a new form of governance are seen as the key enabler of the transition. Monitoring framework inspired by the UN's SDGs is proposed to aid the transition.**Challenges:** Achieving compromise between decision-makers to enable the governance process; understanding the thematic and territorial context, the structures, and governance frameworks for a proper application of the governance model; ensuring a proper resource allocation to boost trust and stakeholder participation; as well as enabling proper comprehension of the multi-level governance model.

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CENTRAL MACEDONIA (EL52)

Population	Stage of development (1=Lowest; 5=Highest)
1 877 000	2

2020 EU-Social Progress Index (SPI)

Score (0-100)	55,8
Rank	211/240
EU score (0-100)	66.7

OECD Regional Wellbeing (0-10)

Education	6.6
Jobs	0.6
Income	2.3
Safety	10.0
Health	7.2
Environment	4.7
Civic engagement	5.1
Accessibility	4.2
Housing	3.3
Community	4.1
Life satisfaction	0.4

Division of powers – Greece

Member state without legislative powers at the sub-national level – unitary state organised on a decentralised basis.

Central level (state responsibilities): general powers for designing and implementing national policies.

Regions are responsible for the administration of affairs of their district. They shape, plan, and implement regional-level policies, under the principles of sustainable development and the social cohesion of the country, taking into account both national and European policies.

Responsible actors in the policy area of environment & the fight against climate change are the **Ministry of Environment and Energy, the special standing committee of the Hellenic Parliament for the protection of the environment** on the state level and **regional authorities** on the regional level.

National frameworks: Revised National Plan for Waste Management, National Strategy for Circular Economy.
Regional frameworks: Regional Waste Management Plan.
Regional CE strategy: Action Plan Towards Bio-Based Circular Economy (2019).
Responsible institution: Regional Development Fund of Central Macedonia – on behalf of the Region of Central Macedonia.
Policy instrument addressed: Regional Operational Programme of Central Macedonia 2014-2020.
Main objective: To strengthen cooperation in the energy utilisation of biowaste.
Drivers: 17 bio-gas plants active in the region – significant potential; knowledge transfer from the participation in the BIOREGIO (INTERREG) project; advisory and support for innovation and knowledge transfer from research results to industrial partners; facilitation and creation of communication channels for information exchange and coordination among administration, scientific community, and economic and societal actors; innovation vouchers for SMEs for funding actions based on waste management and waste as an energy form.
Challenges: The need to utilise additional biowaste streams, the need to cooperate with research organisations for further R&D in the production of biomass energy, information exchange, the need to strengthen the value chain on biowaste and create contacts and synergies among bio-gas plant operators and producers of other forms of biowaste and bring together bio-gas plant operators to exchange information and pursue common goals for anaerobic digestion technologies.

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3.3 DISCUSSION OF RESULTS

From the **Regions' Blueprints** presented in the previous section, seven visions and action plans for regional efforts to transition towards a CE can be identified. The differences between these visions reflect the unique characteristics of the respective regions' cultures, histories, economic and industrial structures, political reality, and institutional arrangements. Some regions base their CE strategies on their predominant sectors and place-based capabilities. For instance, Central Macedonia is focusing on biowaste from its agricultural and food sector; Luxembourg's incorporation of the CE is a strategic priority of the region's data-driven strategy, due to its well-developed 'internet of things' (IoT) capacities and facilities; and the region of Friesland is anchoring its strategy on five emerging sectors that are crucial for the CE and for the region: namely, agriculture, plastic, construction, organic-waste streams, and saline agriculture. In the case of the Brussels Capital region – a large consumption node with limited production activities, capacities, and resources – the focus should be on sustainable consumption, as the urban policies have a partial impact on the production located outside its boundaries (Christis *et al.*, 2019). Accordingly, one of the main aims of the BRPCE is to relocate the economy to Brussels to produce locally whenever possible and create added value for Brussels inhabitants. In the three Spanish cases, the standalone CE strategies have a broader focus.

Taking into account the division of power within the country, some regions have legislative powers that provide more diverse and powerful instruments and mechanisms for implementing the transition towards the CE. The Spanish and Belgian regions, for example, have more complex institutional arrangements. In the case of Luxembourg, which is a unitary state with a smaller population, the country simultaneously represents all three NUTS levels, thus reducing the complexity of multi-level governance.

The analysis of the regional strategic documents to extract the drivers and barriers was a challenging task, as these elements were not explicitly mentioned. However, the actions and initiatives presented in the strategies were established on the basis of the challenges the regions are facing, as well as the driving forces of the transitions. Therefore, the underlying drivers and barriers could be identified for each region, and these are presented in the respective **Region's Blueprint**.

Luxembourg is adapting its financial, regulatory, fiscal, and accounting systems to foster the transition to the CE, as well as developing a new specific sector by addressing issues and developing new services related to accounting, financing, insurance, liability, tax, contracting, testing, regulation, standards, value propositions, and qualified intermediaries, such as consultants and entrepreneurs. For instance, they are investigating how local SMEs can provide performance and products as a service-based model for hotel interiors. This supportive ecosystem is being built by integrated public and private stakeholders, through the continuous development of pilot projects that invite dedicated working groups to learn and to co-create a circular ecosystem. Additionally, the Ministry of Economy is positioning the region as a CE data hub that offers data, knowledge, and services to CE stakeholders and completes integrated value chains in the years to come, though

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the issue of product- and component-data availability – as well as the lack of precision for certain material groups – is underlined.

The 2016 BRPCE was developed as a broader and more holistic programme, as the region had gained valuable experience from its employment-environment alliance, which had mobilised diverse actors to develop environment-related industries. This corroborated, once again, the constructiveness of uniting the public, private, and non-profit sectors under the umbrella of a shared objective. As clearly stated in one of their reports, this balanced approach was a major success factor, with the top-down approach by the government decision-makers having a clear trajectory and the bottom-up initiatives coming from local and sectoral stakeholders who know what is needed and how to put this into practice on the ground. This multi-level, cross-sectoral collaboration was also identified as the largest challenge for the implementation of the strategy. The BRPCE programme is designed as a 'living strategy', being revised every 18 months as an incorporated mechanism to challenge results, revise measures, and involve more sectors and stakeholders.

The region of Catalonia was one of the first to design a CE strategy. This appeared in 2015 and the new strategy will be published mid-2021. With its participation in an Interreg project, the region is aspiring to enhance the policy instruments at their disposal to foster the transition. Another interesting driver is the focus on the innovation hub, which brings together stakeholders to exchange knowledge and experiences and provide circular solutions.

A wide range of stakeholders in the region of Friesland have been well aware of the CE concept and its practical benefits since 2015, and they have been able to identify opportunities for broad cooperation to create new jobs and ensure environmentally sustainable economic growth. Initially, a regional metabolism analysis for Friesland was conducted by Metabolic, and the regional context was mapped, along with the commodity flows and needs of local stakeholders. The presentation of this report marked the birth of the Circular Friesland Association, founded by 25 companies and organisations in a major step towards a circular Friesland. The system thinking approach was adopted for the CE transition in the region, emphasising different segments of society whose needs must be considered throughout the transition – from circular procurement, circular design, integral education on CE, focus on the consumer and changes in behaviour and mentality, to specific measures in specific industrial sectors and circular experts acting as a driving force of the CE.

The focus of the CE strategy in the region of Galicia is primarily R&D solutions for generating scientific and technical knowledge, building capacity, and increasing education and information exposure for all relevant stakeholders. The latter of these is also identified as one of the main challenges, requiring collaboration between different stakeholders and coherence between regional actions in different Spanish regions.

The region of Extremadura, except the main objectives of the CE strategy, provided main governance objectives by stakeholders. For the public sector, the following were identified: initial leadership co-leadership boosting, process development and coordination, resource provision, consensual decision guarantee, governance management, and evaluation coordination. For civil

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society and individual citizens, the contribution to needs and problems identification contribution to solution development, knowledge from experience, closeness and proximity boosting, propositions for betterment, and participatory evaluation were cited. The governance objectives for academia were as follows: diagnosis of needs and problems, innovation in solutions, knowledge transfer, and participatory evaluation. Finally, for corporations, the following governance objectives were acknowledged: contribution to the identification of needs and problems, investment in productive activities, project development, experience sharing, propositions for improvement, and participatory evaluation. The primary driving forces of the CE transition were reported as stakeholder involvement and knowledge-sharing, along with the establishment of a monitoring framework to monitor the process. At the same time, the multi-level governance model and broad stakeholder participation were observed as the largest challenges.

The region of Central Macedonia developed its CE strategy as part of the BIOREGIO *Interreg* project, advocating for a shift from the focus on circular bioeconomy in the Regional Operational Programme of Central Macedonia 2014-2020. This was an attempt to encourage and streamline interventions that promote the transition to a business model built around CE principles. Except the integration of the CE activities in the 2014-2020 programming period, the integration in the next programming period 2021-2027 will be reflected at the regions' financial priority axes. The final pillar of the strategy is the establishment of the targeted strategic actions of RIS3 in the Central Macedonia region to enforce the CE. The key policy changes in this respect concern the introduction of waste management as a priority, as well as the reuse of waste as an energy form. The need for cooperation with all relevant stakeholders – including research organisations for R&D purposes – was highlighted as a challenge, alongside issues regarding information and knowledge exchange, highlighting the need for a platform or hub to act as a meeting point for various stakeholders.

The overall picture is rich and diverse, even with only seven regions included in the analysis; and this mirrors the multifaceted nature of the CE transition, which is influencing many aspects of our society.

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4. CONCLUSIONS AND RECOMMENDATIONS

This report has given an account of the drivers of and barriers to CE implementation encountered at the regional level. A literature review was conducted, including both academic and grey literature, to identify the confronted and perceived drivers and barriers. In addition, regional strategies and action plans were analysed to uncover new drivers and barriers, enrich the literature, and contribute to a more informed policymaking process.

The findings suggest several courses of action for regions that are leading the transition towards a CE, as well as regions that have just begun their journeys. The first implication is that a **place-based approach** is needed, and regions should identify strategic sectors of existing or potential competitive advantage in which they can innovate, specialise, and create capabilities, thereby distinguishing themselves from other regions. Economic, social, environmental, political, and geographical factors should be considered, alongside the institutional settings and industrial profile of the region. Differences in territorial contexts create different sets of needs and opportunities, which the CE strategies must acknowledge.

A **balanced approach to implementation** is required. On one hand, top-down efforts are needed to set the general vision and direction, establish the framework conditions, and direct the flow of funds and regulatory mechanisms. On the other hand, bottom-up initiatives that emerge from society itself are equally essential, as these include grassroots movements, the engine of entrepreneurship, green entrepreneurship, and circular business models.

These efforts in both directions must coordinated, and the silo-mentality must be avoided. For that purpose, a **functional and effective multi-level governance mechanism** should be put in place, enabling effective channels of communication, implementation, and reporting – both vertically (e.g., from local governments, through regional, national, and international governments, and vice versa) and horizontally (e.g., regional governments within a country).

The creation of so-called '**circular hubs**' or **multi-stakeholder platforms** for communication and knowledge transfer would contribute to the acceleration of the transition, bringing together actors from the government, industry, academia, and society. These initiatives can be established nationally or internationally, and they can have different forms (virtual versus physical), with different responsibilities and power given by the state according to the needs of the project.

Participation in **cross-disciplinary international projects** (such as the *Interreg* projects) also contributes to sharing of best practices, solutions, and policy learning, with the ultimate goal of helping regional and local governments to develop and deliver better policy.

Finally, the creation of the regional CE strategies as 'living strategies', with a reasonable **revision mechanism** to account for the latest developments and adjust the policy and its instruments of implementation accordingly is also recommended. This, in turn, will require a **monitoring mechanism** in place to track the progress towards a more circular economy, having AN integrated and sustainable impact on people and places.

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BIBLIOGRAPHY

2020 European Social Progress Index (2020 EU-SPI). Available at: https://ec.europa.eu/regional_policy/en/information/maps/social_progress2020/#3

Action Plan: Towards Bio-Based Circular Economy (2019). Available at: https://www.interregeurope.eu/fileadmin/user_upload/tx_tevprojects/library/file_1572349960.pdf

Andretta, A., D'addato, F., Serrano-Bernardo, F., Zamorano, M., & Bonoli, A. (2018), Environmental taxes to promote the eu circular economy's strategy: Spain vs. Italy. *Environmental Engineering and Management Journal*, *17*(10), 2307–2311. https://doi.org/10.30638/eemj.2018.229

Aranda-Usón, A., M. Moneva, J., Portillo-Tarragona, P., & Llena-Macarulla, F. (2019), Measurement of the circular economy in businesses: Impact and implications for regional policies. *Economics and Policy of Energy and the Environment*, (2), 187–205. https://doi.org/10.3280/efe2018-002010

Avdiushchenko, A. (2018), Toward a Circular Economy Regional Monitoring Framework for European Regions: Conceptual Approach. *Sustainability*, *10*(12), 4398. https://doi.org/10.3390/su10124398

Barbero, S., & Pallaro, A. (2018), Systemic design and policy making. *FormAkademisk – Forskningstidsskrift for Design Og Designdidaktikk*, *11*(4), 1–13. https://doi.org/10.7577/formakademisk.2219

Bettencourt, L. et al. (2007), 'Growth, Innovation, Scaling, and the Pace of Life in Cities', http://dx.doi.org/10.1073/pnas.0610172104.

Brussels Regional Program for a Circular Economy 2016 – 2020 (BRPCE). Available at: https://www.circulareconomy.brussels/a-propos/le-prec/?lang=en

Carayannis, E.G., Campbell, D.F., (2012), Mode 3 knowledge production in quadruple helix innovation systems. In: Mode 3 Knowledge Production in Quadruple Helix Innovation Systems. *Springer New York*, pp. 1e63. https://doi.org/10.1007/978- 1-4614-2062-0_1.

Castells-Quintana, David & Royuela, Vicente & Veneri, Paolo. (2020). Inequality and city size: An analysis for OECD functional urban areas. Papers in Regional Science. 99. 10.1111/pirs.12520.

Christis, M., Athanassiadis, A., & Vercalsteren, A. (2019). Implementation at a city level of circular economy strategies and climate change mitigation – the case of Brussels. *Journal of Cleaner Production*, *218*, 511–520. https://doi.org/10.1016/j.jclepro.2019.01.180

CIRCTER (2019) *Circular Economy and Territorial Consequences – Policy Guide.* Available at: https://www.espon.eu/policy-guide-circular-economy [Accessed 10th January 2021]

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie Innovative Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Circulair Fryslân: De Economie Van De Toekomst (2015). Available at: https://www.metabolic.nl/projects/circular-friesland/

Circular Friesland. Available at: https://circulairfriesland.frl/en/circular-economy/

Cities in Action – BRPCE (2017) Regional programme defines and drives action for change. Available at: https://use.metropolis.org/system/images/2088/original/cooperation_Brussels.pdf

Commission of European Communities (2014), Communication No. 130, 2014. Taking stock of the Europe 2020 strategy for smart, sustainable and inclusive growth (COM no. 130, 2014).

Dąbrowski, M., Varjú, V., & Amenta, L. (2019), Transferring circular economy solutions across differentiated territories: Understanding and overcoming the barriers for knowledge transfer. *Urban Planning*, *4*(3), 52–62. https://doi.org/10.17645/up.v4i3.2162

Division of Powers. Available at: https://portal.cor.europa.eu/divisionpowers/Pages/default.aspx

EC (2020), *A New Circular Economy Action Plan for a Cleaner and More Competitive Europe*, European Commission.

ECa (2020), *Impact of Shift to Circular Economy*, European Commission

ECb (2020), *2030 Climate & Energy Framework*, European Commission, Available at: https://ec.europa.eu/clima/policies/strategies/2030_en

Elia, V., Gnoni, M.G., Tornese, F., (2017), Measuring circular economy strategies through index methods: a critical analysis. *J. Clean. Prod.* 142, 2741e2751.

Ellen MacArthur Foundation (2019), *Completing the Picture: How the Circular Economy Tackles Climate Change*.

Estratègia d'Impuls a l'economia verda i a l'economia circular (2015). Available at: http://mediambient.gencat.cat/ca/05_ambits_dactuacio/empresa_i_produccio_sostenible/economia_verda/impuls_economia_verda/

Estrategia Gallega de Economía Circular 2019-2030. Available at: https://ficheiros-web.xunta.gal/transparencia/informacion-publica/EGEC_cas.pdf

Eurostat (2019) *Regional Yearbook*. Luxembourg: Publications Office of the European Union, 2019.

EXTREMADURA 2030 Estrategia de economía verde y circular (2017). Available at: http://extremadura2030.com/wp-content/uploads/2018/05/estrategia2030.pdf

Flash Eurobarometer 441-TNS Political & Social, (2016) ec.europa.eu/environment/green-growth/.../fl_441_sum_en.pdf (Flash Eurobarometer, 2016).

Fleischmann, K. (2019), Design-led innovation and Circular Economy practices in regional Queensland. *Local Economy*, *34*(4), 382–402. https://doi.org/10.1177/0269094219854679

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie Innovative Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Frick, S., & Rodríguez-Pose, A. (2018). Big or small cities? On city size and economic growth. Growth and Change, 49 (1), 4–32.

Geng, Y., Fu, J., Sarkis, J., Xue, B., (2012), Towards a national circular economy indicator system in China: an evaluation and critical analysis. *J. Clean. Prod.* 23 (1), 216e224.

Andrea Genovese & Mario Pansera (2020) The Circular Economy at a Crossroads: Technocratic Eco-Modernism or Convivial Technology for Social Revolution?, Capitalism Nature Socialism, DOI: 10.1080/10455752.2020.1763414

Ghisellini, P., Cialani, C., Ulgiati, S., (2016), A review on circular economy: the expected transition to a balanced interplay of environmental and economic systems. *J. Clean. Prod.* 114, 11e32.

Guo, B., Geng, Y., Sterr, T., Zhu, Q., Liu, Y., (2017), Investigating public awareness on circular economy in western China: a case of Urumqi Midong. *J. Clean. Prod.* 142, 2177e2186.

Husgafvel, R., Linkosalmi, L., & Dahl, O. (2018b), Company perspectives on the development of the CE in the seafaring sector and the Kainuu region in Finland. *Journal of Cleaner Production*, *186*, 673–681. https://doi.org/10.1016/j.jclepro.2018.03.138

Husgafvel, R., Linkosalmi, L., Hughes, M., Kanerva, J., & Dahl, O. (2018a), Forest sector circular economy development in Finland: A regional study on sustainability driven competitive advantage and an assessment of the potential for cascading recovered solid wood. *Journal of Cleaner Production*, *181*, 483–497. https://doi.org/10.1016/j.jclepro.2017.12.176

Jiao, W., Boons, F., (2017), Policy durability of Circular Economy in China: a process analysis of policy translation. *Resour. Conserv. Recycl.* 117, 12e24

Kanchanapibul, M., Lacka, E., Wang, X., Chan, H.K., (2014), An empirical investigation of green purchase behaviour among the young generation. *J. Clean. Prod.* 66, 528e536.

Lakatos, E.S., Dan, V., Cioca, L.I., Bacali, L., Ciobanu, A.M., (2016), How supportive are Romanian consumers of the circular economy concept: a survey. *Sustainability* 8 (8), 789.

Liu, Q., Li, H.-m., Zuo, X.-l., Zhang, F.-f., Wang, L., (2009), A survey and analysis on public awareness and performance for promoting circular economy in China: a case study from Tianjin. *J. Clean. Prod.* 17, 265e270.

Liu, Y., Bai, Yi, (2014), An exploration of firms' awareness and behavior of developing circular economy: an empirical research in China. *Resources. Conserv. Recycl.* 87, 145e152.

Lombardi, R. (2017), Non-technical barriers to (And drivers for) the circular economy through industrial symbiosis: A practical input. *Economics and Policy of Energy and the Environment*, *2017*(1), 171–189. https://doi.org/10.3280/EFE2017-001009

Matsunaga, K. and N. Themelis (2002), Effects of affluence and population density on waste generation and disposal of municipal solid wastes. Available at:

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie Innovative Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

https://www.researchgate.net/publication/228908198_Effects_of_affluence_and_population_density_on_waste_generation_and_disposal_of_municipal_solid_wastes

McDowall, W., Geng, Y., Huang, B., Bartekova, E., Bleischwitz, R., Turkeli, S., Kemp, R., Domenech, T., (2017), Circular economy policies in China and Europe. *J. Ind. Ecol.* 21 (3), 651e661.

McKinsey Global Institute (2012), 'Urban world: Cities and the rise of the consuming class', Available at: http://www.mckinsey.com/mgi.

Montevecchi, F. and H. Reisinger (2014), 'File note on circular economy package for the Territorial Impact Assessment workshop', http://dx.doi.org/10.2863/11040.

Morikawa, M. (2012), 'Population density and efficiency in energy consumption: An empirical analysis of service establishments', *Energy Economics*, Vol. 34/5, pp. 1617-1622, http://dx.doi.org/10.1016/j.eneco.2012.01.004.

Obersteg, A., Arlati, A., Acke, A., Berruti, G., Czapiewski, K., Dąbrowski, M., … Knieling, J. (2019), Urban Regions Shifting to Circular Economy: Understanding Challenges for New Ways of Governance. *Urban Planning*, *4*(3), 19. https://doi.org/10.17645/up.v4i3.2158

OECD (2019), 'Financing climate objectives in cities and regions to deliver sustainable and inclusive growth', *OECD Environment Policy Papers*, No. 17, OECD Publishing, Paris, https://doi.org/10.1787/ee3ce00b-en

OECD (2020), *The Circular Economy in Cities and Regions: Synthesis Report*, OECD Urban Studies, OECD Publishing, Paris, https://doi.org/10.1787/10ac6ae4-en

OECD Regional Well-Being. Available at: https://www.oecdregionalwellbeing.org/

OECD Survey (2020), *OECD Survey on Circular Economy in Cities and Regions*, OECD, Paris

OECD/EC (2020), *Cities in the World: A New Perspective on Urbanisation*, OECD Urban Studies, OECD Publishing, Paris, https://dx.doi.org/10.1787/d0efcbda-en.

OECDa (2020), *OECD Economic Outlook, Volume 2020 Issue 1*, OECD Publishing, Paris, https://dx.doi.org/10.1787/0d1d1e2e-en.

Paletta, A., Leal Filho, W., Balogun, A.-L., Foschi, E., & Bonoli, A. (2019), Barriers and challenges to plastics valorisation in the context of a circular economy: Case studies from Italy. *Journal of Cleaner Production*, *241*, 118149. https://doi.org/10.1016/j.jclepro.2019.118149

Parrique T., Barth J., Briens F., C. Kerschner, Kraus-Polk A., Kuokkanen A., Spangenberg J.H., (2019), Decoupling debunked: Evidence and arguments against green growth as a sole strategy for sustainability. European Environmental Bureau. Available at: https://mk0eeborgicuypctuf7e.kinstacdn.com/wp-content/uploads/2019/07/Decoupling-Debunked.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie Innovative Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Plastinina, I., Teslyuk, L., Dukmasova, N., & Pikalova, E. (2019), Implementation of circular economy principles in regional solid municipal waste management: The case of Sverdlovskaya Oblast (Russian Federation). *Resources*, *8*(2). https://doi.org/10.3390/resources8020090

ReTraCE D4.1 (2020), Circular Economy Implementation at a Regional Level: a Preliminary Review. Available at: http://www.retrace-itn.eu/wp-content/uploads/2020/04/ReTraCE-D4.1.pdf

ReTraCE D4.2 (2020), Maps of stakeholders and interactions for designing policies for CE implementation. Available at: http://www.retrace-itn.eu/wp-content/uploads/2020/07/ReTraCE-D4.2.pdf

ReTraCE D4.3 (2020,) Measuring the transition towards a Circular Economy at a regional level: a review. Available at: http://www.retrace-itn.eu/wp-content/uploads/2020/07/ReTraCE-D4.3.pdf

Savini, F. (2019), The economy that runs on waste: accumulation in the circular city. *Journal of Environmental Policy and Planning*, *21*(6), 675–691. https://doi.org/10.1080/1523908X.2019.1670048

Scarpellini, S., Portillo-Tarragona, P., Aranda-Usón, A., & Llena-Macarulla, F. (2019), Definition and measurement of the circular economy's regional impact. *Journal of Environmental Planning and Management*, *62*(13), 2211–2237. https://doi.org/10.1080/09640568.2018.1537974

Smol, M., Avdiushchenko, A., Kulczycka, J., & Nowaczek, A. (2018), Public awareness of circular economy in southern Poland: Case of the Malopolska region. *Journal of Cleaner Production*, *197*, 1035–1045. https://doi.org/10.1016/j.jclepro.2018.06.100

The Data-Driven Innovation Strategy for the Development of a Trusted and Sustainable Economy in Luxembourg (2019). Available at: https://gouvernement.lu/en/publications/rapport-etude-analyse/minist-economie/intelligence-artificielle/data-driven-innovation.html

UNEP (2018), *The Weight of Cities*, International Resource Panel, United Nations Environment Programme.

UNEP (2019), *Emissions Gap Report 2019*, United Nations Environment Programme, Available at: http://www.un.org/Depts/Cartographic/english/htmain.htm

Vanhamaki, S., Medkova, K., Malamakis, A., Kontogianni, S., Marisova, E., Dellago, D. H., & Moussiopoulos, N. (2019), Bio-based circular economy in European national and regional strategies. *International Journal of Sustainable Development and Planning*, *14*(1), 31–43. https://doi.org/10.2495/SDP-V14-N1-31-43

Virtanen, M., Manskinen, K., Uusitalo, V., Syvänne, J., & Cura, K. (2019), Regional material flow tools to promote circular economy. *Journal of Cleaner Production*, *235*, 1020–1025. https://doi.org/10.1016/j.jclepro.2019.06.326

This project has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie Innovative Training Networks (H2020-MSCA-ITN-2018) scheme, grant agreement number 814247 (ReTraCE).

Volk, R., Müller, R., Reinhardt, J., & Schultmann, F. (2019), An Integrated Material Flows, Stakeholders and Policies Approach to Identify and Exploit Regional Resource Potentials. *Ecological Economics*, *161*(April), 292–320. https://doi.org/10.1016/j.ecolecon.2019.03.020

Whicher, A., Harris, C., Beverley, K., & Swiatek, P. (2018), Design for circular economy: Developing an action plan for Scotland. *Journal of Cleaner Production*, *172*(December 2015), 3237–3248. https://doi.org/10.1016/j.jclepro.2017.11.009

Wijkman, A. and K. Skånberg (2017), *The Circular Economy and Benefits for Society: Jobs and Climate Clear Winners in an Economy Based on Renewable Energy and Resource Efficiency*, The Club of Rome.

Wu, H. Q., Shi, Y., Xia, Q., & Zhu, W. D. (2014), Effectiveness of the policy of circular economy in China: A DEA-based analysis for the period of 11th five-year-plan. *Resources, Conservation and Recycling*, *83*, 163–175. https://doi.org/10.1016/j.resconrec.2013.10.003

Xue, B., Chen, X-p., Geng, Y., Guo, X-j., Lu, Ch-p., Zhang, Z-l., Luc, Ch-y, (2010), Survey of officials' awareness on circular economy development in China: based on municipal and county level. *Resour. Conserv. Recycl.* 54, 1296e1302.

Zeng, H., Chen, X., Xiao, X., Zhou, Z., (2017), Institutional pressures, sustainable supply chain management, and circular economy capability: empirical evidence from Chinese eco-industrial park firms. *J. Clean. Prod.* 155, 54e65.

Zink, T., F. Maker, R. Geyer, R. Amirtharajah, and V. Akella (2014), Comparative life cycle assessment of smartphone reuse: Repur- posing vs. refurbishment. *The International Journal of Life Cycle Assessment* 19(5): 1099–1109.

Zink, Trevor and Geyer, Roland (2017), Circular Economy Rebound. *Journal of Industrial Ecology*. 21. 10.1111/jiec.12545.

ANNEX A: NUTS Classification

This Annex is provided as an individual file, due to its size and format (Excel file).

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