



InvestCEC

Circular economy investments- Financial barriers and potential measures to address them

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1. Introduction

One of the most difficult challenges facing modern societies is the scarce availability of resources coupled with the large amount of waste produced and the excessive consumption of energy and water. However, traditional business models favour a linear chain of production, which increases waste generation and resource depletion. On the other hand, one of the key components of the circular economy is the recovery and reuse of by-products or secondary recovery that can help reduce waste accumulation and the extraction of new resources, generating economic and environmental benefits.

In order to transition to Circular Economy models, a paradigm shift is needed to ensure that resources are used more efficiently. Thus, Circular Economy (CE) is at the forefront of international policy and government agendas, particularly in Europe [1], which aims to favour an economy capable of creating jobs, boosting new businesses, fostering security of supply, reducing costs, waste and caring for the environment. [2].

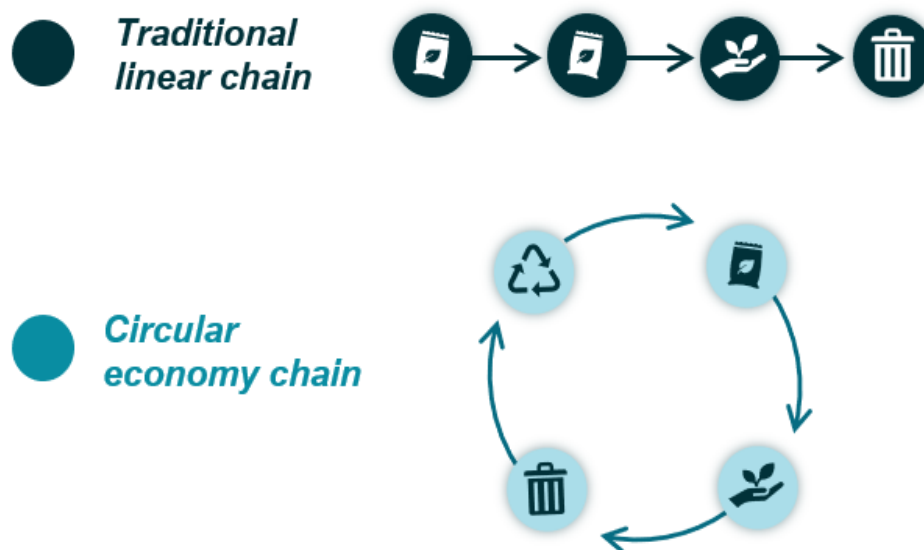


Figure1. Comparison between the traditional linear chain and the circular economy chain

Investment opportunities connected to “Circular economy,” however are often considered riskier than similar investment opportunities connected to more traditional “linear supply/value chains” (Fig. 1). For example, CE often involves innovative and unconventional approaches to production, consumption, and waste management, so investments in untested technologies or novel business models can carry a higher risk of

failure. Additionally, CE practices may require changes in consumer behavior and market acceptance, changes in regulations and may require significant changes to traditional supply chain models. Further, Circular economy projects often involve higher upfront costs and the return on investment might be realized over a more extended period, so investors may be concerned about longer payback periods and delayed profitability. Financial barriers are indeed particularly relevant for the implementation of CE practices. These barriers are not only related to investment risks but also to the interconnection of actors involved in CE models and projects. Figure 2 illustrates an example of a Circular Economy project. In this example, all actors are connected to each other, because the economic activities of one depend on the activities of the other. In other words, behind the different “technical steps” in the circular economy normally stands one or more individual businesses. These businesses are providing different products and or services to the circular economy circle.

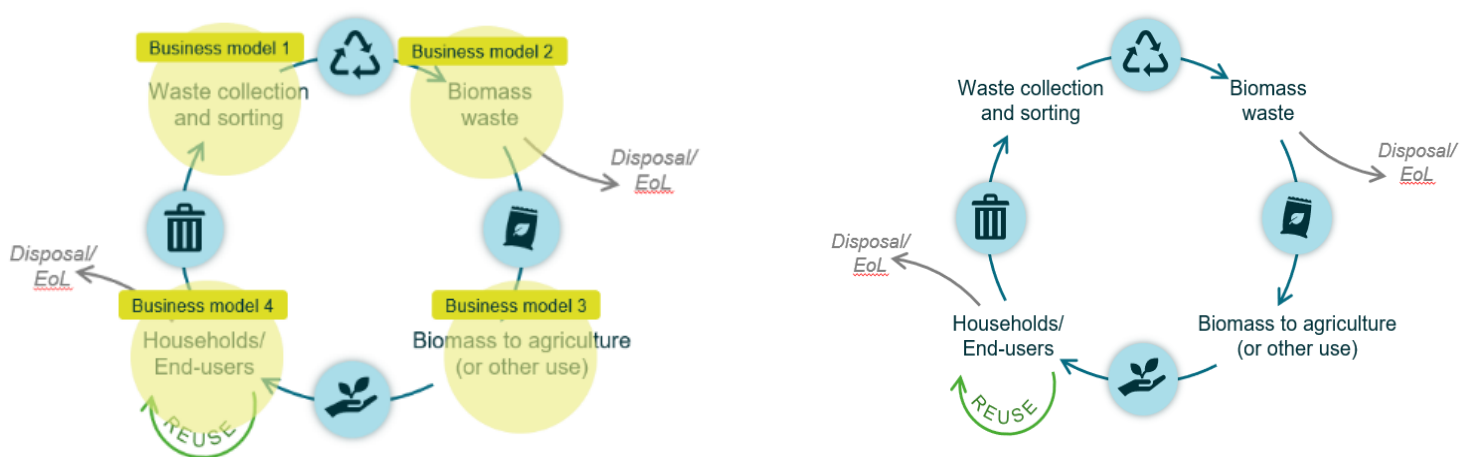


Figure 2. Example of the interconnection of technologies in the circular economy and their business models

It only takes just one element in the circle that is not functioning as foreseen, and the entire “circle” might collapse (Fig. 3)

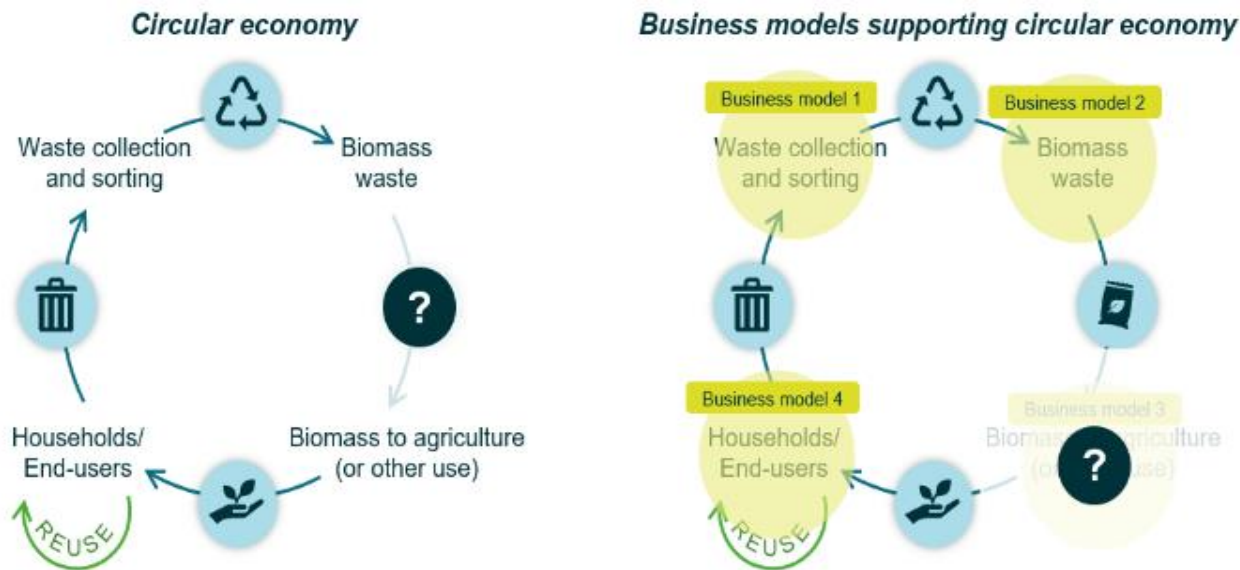


Figure 3. Uncertainty in the emerging circular economy due to investment risks in individual companies.

In this deliverable, our focus is on the financial challenges or barriers, acknowledging that recent studies have expanded their scope to include cultural and technological obstacles [3]. These challenges are interconnected, as factors such as low financial viability and the absence of adequate policies influence investor willingness to support technologies, subsequently limiting the array of circular economy products and hindering the growth of the circular economy market. This, in turn, impacts the adoption of circular economy practices by public authorities, investors, and citizens. The primary objective of this deliverable is to provide a detailed account of the identified financial and investment barriers to the transition to the circular economy in cities and regions, along with a presentation of the selected measures designed to overcome these specific hurdles.

1.2. Types of barriers in circular economy

Numerous studies on the circular economy have attempted to identify and classify the factors that hinder the implementation of cross-border cooperation, resulting in four main categories of barriers that are the most frequently identified in the literature: technological, institutional, social, and economic barriers (market barriers, financial barriers, etc.). [4]

a) Technological barriers. These barriers are attributed to the design, the lack of know-how (especially in SMEs) or new technologies, and the optimal quality of recycled products/materials. These challenges are evident both on the part of the producers, who in many cases still favour raw materials) and among consumers.

b) Institutional (and regulatory) barriers. These barriers are caused by increasing global economic interconnections, different political approaches between different countries and the lack of physical infrastructure for reverse logistics.

c) Social (and cultural) barriers. These barriers are the result of a corporate culture not oriented towards change, low consumer awareness of product circularity and reduced collaboration along the value chain.

d) Market barriers. These barriers are related to market deficiencies (externalities are not internalized) or lack of market, lack of financing for circular business models, high implementation costs and low prices of raw materials [5].

2. Aim of this Deliverable

This document will focus on identifying and providing measures to address the main financial obstacles and challenges that slow down the transition to the circular economy in cities and regions, such as unclear business models, lack of profitable business cases, coordination of public and private funders/investors, risk assessment and management, accounting for non-monetary co-benefits in financial models, and assessment and management of non-monetary risks in financial models.

This deliverable includes a systematic literature review on financial barriers in the circular economy. First, the objective of the review was defined, as well as the keywords and search criteria. Subsequently, these keywords and search criteria were used to search the literature in Google Scholar.

Further, interviews with stakeholders have been conducted by the Stadtwerke Klagenfurt to identify innovative financing instruments and innovative investment instruments in the circular economy sector and financing opportunities in other sectors. In doing so, the application of financing approaches from other sectors to circular economy investment will be assessed, and new strategies and the development of existing measures to mitigate barriers will be offered. Solutions will be generated through the literature review (CARTIF), feedback from consortium expert partners (G2G, VENCAP, MAT), and validated through stakeholder interviews (STW-AG).

3. Financial Barriers in the Circular Economy and Potential Solutions

Financial barriers can significantly impede the successful implementation and scaling of circular economy projects. These barriers manifest in various ways, affecting the adoption of circular practices, limiting investments, and impacting the overall feasibility of circular initiatives. One significant challenge is the high initial investment costs associated with circular economy projects [6]. These endeavors often demand substantial upfront investments in technology, infrastructure, and process redesign. Companies may hesitate to commit to these expenses, particularly when returns are uncertain or when alternative linear models appear less capital-intensive [7]. Access to capital is another major hurdle, particularly for smaller enterprises or start-ups aiming to fund circular economy projects. The lack of available capital can constrain the ability to initiate or scale circular initiatives, hindering the transition to more sustainable business models [5]. The perceived uncertainty regarding financial returns poses a significant barrier, deterring investors and financiers from supporting circular economy projects. Investors often prioritize short-term return expectations, and circular economy benefits may be realized over an extended period, making it challenging to attract funding. The limited availability of financial instruments specifically designed for circular economy projects is an additional challenge because a shortage of financing options restricts businesses from finding suitable funding models aligned with circular principles [5]. Additionally, the complexity of circular transactions, such as take-back programs or reverse logistics, can lead to higher operational and administrative costs, increasing the financial burden on companies and potentially reducing the overall economic viability of circular practices [8].

Other financial challenges are more related to human resources aspects. For example, a lack of understanding among investors about the potential financial benefits and risks associated with circular business models further complicates the issue. This lack of confidence and comprehension can impede the attraction of investment. Regulatory uncertainty, resistance to change within existing financial structures, market challenges, and consumer behavior also contribute to financial barriers for circular economy projects. These challenges collectively hinder the adoption of circular practices and may place companies embracing circular initiatives at a competitive disadvantage. Addressing financial barriers requires a collaborative effort involving businesses, investors, policymakers, and other stakeholders. Strategies may include developing financial

instruments tailored for circular projects, promoting awareness and understanding of circular business models among investors, and advocating for supportive regulatory frameworks that incentivize sustainable practices. Additionally, showcasing successful circular initiatives with clear economic benefits can contribute to building confidence and overcoming financial barriers.

Following, we will describe the main financial barriers to the circular economy that have been identified and discuss potential solutions for each one.

The global economy is based on a linear business model, with excessive use of natural resources, waste generation, and underutilisation of products. Despite information campaigns and the urgency to move from linear to circular economies, current processes are still heavily driven by fossil fuels and linear production models. Following, we will list the main financial barriers to the circular economy that have been identified and in the following points of this deliverable, we will give a more detailed description of these barriers, proposing possible solutions for each one, facilitating the transition to the circular economy.

Other financial barriers may be of an operational or attitudinal nature to the implementation of circular economy practices, such as quality issues in recycled materials, supply chain complexities, inter-firm coordination issues, product design, production, and disassembly [9].

After listing some examples of financial barriers to circular economy implementation with a brief description, we will elaborate on each of them in the following sections of this deliverable, outlining possible solutions for each financial barrier. Although the list of financial barriers could undoubtedly be longer, only the barriers that we have considered to be the most representative have been included in this document.

Generally speaking, removing financial barriers requires a focus on education and outreach to investors, policy makers, and the general public to overcome the "take, make, dump" mentality and short-term profits.

Another solution would be to collaborate along the entire value chain by creating financial instruments to invest in several companies instead of just one, thus helping to reduce the financing risk for circular enterprises [10].

Circular finance solutions could include financing models, such as leasing, sharing, and pay-as-you-go, that incentivise the use of resources for as long as possible. In addition, companies can increase profitability through higher asset utilisation, risk mitigation and long-term relationships that increase margin stability. [11].

In the following sections, possible solutions to the barriers raised in point 3 and its sub-sections will be described.

3.1. Investments in the circular economy

Investors are very diverse. For example, pension funds and other institutional investors, including large family funds, invest for the long term, while other types of investors, such as private equity and investment funds, tend to have a shorter time horizon.

Investing in the circular economy requires targeted investments that focus on resource efficiency, side stream valorization, waste reduction and innovation, considering the opportunities for innovation and investment while promoting resource efficiency by generating cost savings. On the other hand, companies do not want to take certain investment risks because, although the opportunities offered to investors in the circular economy are extensive, the level of development and maturity of companies is not yet sufficient to take on such investments [12].

When identifying circular economy investment opportunities, investors can look for key indicators that can help them assess the potential of a company or project such as indicators based on the performance of production within a company measuring the circularity and environmental impact of a company or project. Other indicators would be economic and business indicators that measure the added value of the circular economy or the existence of technologies and spaces. For example, investors can look for indicators that measure the proportion of hazardous waste, the use of raw materials and other negative impacts of a company or project on the environment and the potential for reducing emissions generated by the extraction and manufacture of waste and raw materials that may be critical raw materials by focusing on a circular business model by keeping resources at their maximum value and reducing waste [13].

The most significant economic and business indicators specifically adapted to the circular economy are added in Annex 1 at the end of this document (Table 3) [14].

Another way to tackle the lack of investments in circular economy projects is to change investor mentality. For example, small private investments would be a solution to take advantage of emerging and niche industries, which offer a prudent form of early-stage investment versus small-cap public companies that tend to be more volatile [15]. Financial management teams can incorporate circular practices at company level to reduce operating costs, improve production resilience, reduce environmental risks, and anticipate evolving consumer preferences and potential regulatory changes. Quality management teams can use circular economy approaches to manage business risks, especially contingent environmental risks and social concerns [16].

3.2. Lack of pricing for externalities

Externalities can have a significant impact on the circular economy, both positive and negative. In the case of the negative impact, they can cause market inefficiencies, where the decisions of individuals affect the welfare of another individual outside the market.

The lack of pricing for outsourced work, (i.e. the practice of contracting out specific tasks, processes, or services to external third-party entities rather than handling them internally within an organization), disguises their true cost of products and practices, and environmental impact, particularly in terms of GHG emissions. Quantifying the negative impacts (such as the GHG emissions generated) of outsourced work can help to level the playing field and scale up the circular economy. Other negative aspects include pollution, resource depletion and waste which can have a significant impact on the environment and biodiversity. In recent years, work has been done on models for setting these costs, with carbon pricing being the most studied and implemented. However, the latest research still largely analyses externality pricing at a theoretical level, and the implementation of externality pricing models can bring its own challenges, such as the lack of accurate and readily available data. An example of this is the barriers to investment in nature-based solutions (Fig. 4).

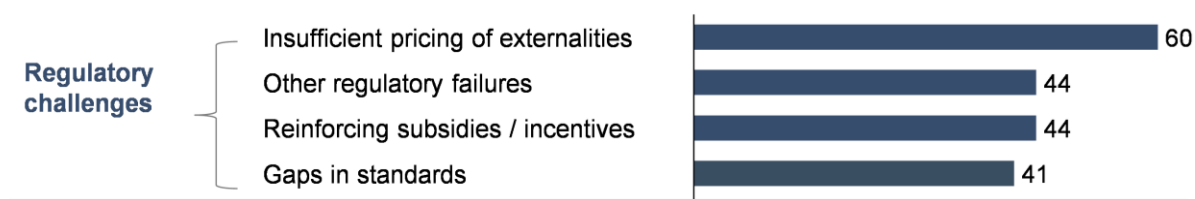


Figure 4. Barriers to investment in nature-based solutions and biodiversity business opportunities

In this example, environmental externalities are the negative consequences of human activity on nature and biodiversity. In fact, many forms of natural capital are available for free, artificially reducing the cost of nature-negative business models. The cost of these externalities can be extremely high: the global value of environmental externalities in 2013 was estimated to be \$4.7 trillion (4.39 billion of €) between water use, GHG emissions, waste, air pollution, soil and water pollution, and land use alone, or 7% of global GDP that year. All externalities accounted for \$7.3 trillion (6.8 billion of €), or more than 10% of global GDP.

These externalities remain unpriced in our current economic system that prioritises economic cost efficiency, favouring "quick wins" that solve short-term problems, but limiting long-term consideration of public welfare [17].

Environmental economics builds on conventional economics but recognises its shortcomings in relation to environmental problems by taking externalities into account. An externality is a market failure that causes

inefficiency. It is a situation in which the decisions of one agent affect the welfare of another agent in a different way than the market does. Nevertheless, the circular economy can generate positive externalities, which occur when the benefits of a particular activity or transaction extend beyond the direct parties involved, leading to positive effects on third parties or society as a whole [18]. By internalising the environmental costs associated with the production and consumption of goods and services, the pricing of externalities can create economic incentives for more sustainable and circular practices.

A possible solution to the lack of pricing of externalities in the public sector would be the use of specific subsidies and tax benefits to incentivize circular economy practices. For example, reducing taxes such as the value-added tax on reuse, repair and remanufacturing activities can incentivize circular designs and business models and support the circulation of valuable goods, materials and nutrients. Overall, pricing externalities is a crucial step towards a sustainable circular economy, but it is not the only solution. Policymakers and businesses must also address other market failures, such as transaction costs, divided incentives, imperfect information, insufficient public goods or infrastructure, and insufficient competition [19].

3.3. Valuation in the circular economy

Current valuation practices used by financiers are an important factor affecting the financing of companies participating in the circular economy. According to the data related to this study, the most significant factor affecting the financing of CE companies is that current financial tools, such as financial risk assessment and valuation and pricing tools, are limited to linear companies and are not suitable for VC companies.

The circular economy redefines the approach to value creation, and the financial sector can be a catalyst to unlock opportunities while helping companies to reorient their business strategies. Companies that shift towards a circular model can increase their competitiveness in the medium to long term, becoming more attractive to financial institutions in terms of financing and financial support, while creating a positive impact on local communities [20]. There is a link between circularity and valuation, and this link can be incorporated into current valuation procedures, using non-traditional methods to conceptualise circular economy performance. Regarding non-market-based environmental asset valuation methods, there are two approaches to estimating the value of environmental resources: market-based and non-market-based valuation techniques. These two approaches can support and integrate both intangible and tangible assessments of environmental benefits. Market valuation techniques include physical linkages, while non-market valuation techniques tend to include behavioural linkages, like the Contingent Valuation Method (CVM), which CVM involves directly asking individuals about their preferences and willingness to pay for a particular environmental good or service through surveys [21].

Non-traditional valuation methods can be used to conceptualise the performance of the circular economy [21][22] such as cost elimination, measuring the willingness to try to avoid environmental damage to avoid associated penalties or analysing the price of environmentally related goods, or analysing environmental goods according to people's choice or conducting surveys to find out how much they are willing to pay. These non-traditional valuation methods can be used to estimate the value of environmental goods and services in the circular economy. Environmental goods and services are products and benefits that are derived from the environment and contribute to human well-being. These may include tangible goods (renewable energy plant, waste recycling) or intangible goods (tourism, cultural values), as well as ecosystem services. By using these methods, businesses can better understand the economic benefits of circular practices and make informed decisions about their investments in circular economy initiatives.

Value creation in a circular economy requires companies to rethink their value creation and stakeholder relationships. While value creation in a circular economy is different from traditional linear models, it can create new opportunities for companies and stakeholders. Here are several ways in which a circular economy creates new opportunities:

- Designing products for longevity and durability creates an opportunity for companies to build a positive reputation for quality and reliability. Customers are more likely to choose products that last longer, reducing the need for frequent replacements and contributing to customer loyalty.
- Companies can explore the business of remanufacturing and refurbishing products at the end of their life cycle. Remanufactured products often have lower production costs and can be sold at competitive prices, creating additional revenue streams, and reducing the environmental impact associated with manufacturing new goods. This promotes resource efficiency and waste reduction, and businesses can save on raw material costs, energy consumption, and waste disposal, contributing to improved operational efficiency and cost savings.
- Demonstrating a commitment to sustainability through circular practices provides an opportunity for companies to differentiate their brand. Consumers increasingly value environmentally conscious brands, leading to increased customer trust, loyalty, and a positive brand image.
- Circular economy principles drive innovation in product design and manufacturing processes. Companies that invest in innovative, sustainable designs can stay competitive, appeal to environmentally conscious consumers, and potentially patent and license their innovations.
- By designing products for easy disassembly and component reuse, companies can tap into secondary markets for spare parts. This opens up revenue opportunities in the aftermarket, creating a sustainable revenue stream.
- Embracing circular practices positions companies to comply with evolving environmental regulations and mitigate risks associated with resource scarcity. Proactive compliance reduces the risk of regulatory penalties and contributes to long-term business sustainability.

Table 1. Comparison of company-centric and stakeholder relationship perspectives on value creation in a CE

Dimension	Company-centric perspective on value creation	Stakeholder relationship perspective on value creation
Focus of value creation	Value creation, transfer and capture within the business model, the supply chain, and the value network	Value creation with and for stakeholders within all stakeholder relationships
Stakeholders	Suppliers, customers, and partners	All stakeholders related to a company's CE business
Stakeholder view	Stakeholders as entities	Value-creating stakeholder relationships
Managerial activity	Stakeholder management to create value	Stakeholder collaboration and joint activities to create value
Defined value proposition	Customer value proposition	Stakeholder value propositions
Value	Business and sustainability value	Business, sustainability and/or stakeholder value and multidimensional value

Overall, valuation practices in the circular economy require new methods and approaches that take into account the unique characteristics of circular models. The financial sector can play a key role in unlocking opportunities and supporting the transition to a more sustainable economic model.

3.4. Financial structures in the circular economy

Financial structures within companies can be a barrier to the transition to a circular economy. According to studies carried out when different forms of financing have been evaluated, individual companies, supply, production chains and joint projects, sometimes the sources of financing - being public and private - apply various criteria that are negative for the implementation towards a circular economy.

Financial structures in the circular economy, on the other hand, are designed to support and facilitate the transition from a linear, take-make-dispose model to a more sustainable, circular model that prioritizes resource efficiency, waste reduction, and the longevity of products. These financial structures play a crucial role in encouraging businesses and investors to adopt circular practices. Some examples of financial structures that can be applied to Circular Economy are explained next:

- **Circular Business Models:** Circular business models involve designing products for durability, repairability, and recyclability. These models often include strategies such as product-as-a-service, sharing platforms, and take-back programs. In this case, revenue is generated not just from selling products but also from services, subscriptions, and the recovery of materials through recycling and remanufacturing.
- **Extended Producer Responsibility (EPR):** EPR is a regulatory approach that makes producers responsible for the entire life cycle of their products, including collection, recycling, and disposal. Companies are thus financially incentivized to design products with easier recyclability and invest in collection and recycling infrastructure.
- **Green Bonds and Sustainable Financing:** Green bonds are financial instruments specifically earmarked for environmentally sustainable projects, including those in the circular economy. Companies can raise funds for circular initiatives, such as sustainable manufacturing practices, resource efficiency projects, and circular supply chain development.
- **Circular Economy Funds:** Some financial institutions and investment funds focus specifically on supporting businesses that adopt circular economy principles. In this model, investors contribute capital to these funds, which is then allocated to companies and projects that demonstrate a commitment to circular practices.
- **Pay-for-Performance Financing:** This financing model involves paying for a service or product based on its performance or impact, rather than a traditional upfront purchase. Companies providing circular services, such as waste reduction or product leasing, receive payments based on the effectiveness of their solutions.
- **Subsidies and Grants:** Governments and organizations may provide financial support in the form of subsidies and grants to encourage the adoption of circular practices. These funds can help offset the costs associated with transitioning to circular business models, implementing sustainable technologies, or developing circular supply chains.
- **Risk-Sharing Partnerships:** Businesses may enter into partnerships where risks and rewards associated with circular initiatives are shared among collaborators. This collaborative approach allows stakeholders to pool resources, share investment costs, and jointly benefit from the success of circular projects.
- **Reverse Logistics Financing:** Reverse logistics involves managing the return of products and materials for recycling or remanufacturing. Financing structures may support the development of efficient reverse logistics systems. Investments in reverse logistics can optimize the recovery of materials, reduce waste, and create opportunities for revenue generation through secondary markets.

- **Incentive-Based Programs:** Governments and organizations may implement incentive programs to encourage circular practices, such as tax incentives, subsidies for sustainable products, or discounts for environmentally friendly services. Companies participating in these programs can benefit from financial incentives that make circular initiatives economically viable.
- **Circular Supply Chain Financing:** Financing structures that support the development and optimization of circular supply chains, including partnerships between suppliers, manufacturers, and distributors. Investments in circular supply chain initiatives can improve resource efficiency, reduce waste, and enhance the overall sustainability of the supply chain.

3.5. Risks Of Circular Economy Investments

Some of the strategies that can be pursued to reduce risk in circular economy investments will be to decouple economic growth from resource consumption. This can help reduce the risks associated with resource scarcity and price volatility. Economic growth has also made resources scarcer and more expensive. While countries have established public policies focused on resource and energy efficiency, there is a growing need for a coordinated industrial strategy capable of creating sustainable wealth through holistic natural resource management, capable of "decoupling" economic growth from resource extraction and social development for the majority of stakeholders in these regions. [23]

Circular economy strategies can reduce investment risk by decoupling economic growth from resource consumption, diversifying business models, and enabling companies to better anticipate stricter regulation and changing customer preferences by prioritizing circular economy strategies. low risk and high potential

Another solution to reduce investment risk is to diversify business models by offering circular products and services or anticipating stricter regulation and changes in customer preferences can also reduce risks by implementing strategies and exploring the integration of the circular economy into risk models.

3.6. Lack of financial support in the circular economy

The absence of external financial support can have various adverse effects on circular economy projects, limiting their development and hindering their potential impact. For example, circular economy projects often involve innovative approaches to resource management, recycling, and sustainable design. Without external financial support, there may be insufficient funds available for research and development, limiting the ability to explore and implement cutting-edge solutions.

Financing circular economy enterprises can be complicated by several factors. For example, some cities and regions do not have sufficient financial resources, which is a major obstacle to help entities move away from a linear economy. [24]. However, difficult financing of circular economy is not only due to a general lack of financing. The needs of regions are often not covered by existing business models/CE companies or only insufficiently so that the willingness to make investments is low.

3.7. High initial investment costs

The upfront costs associated with circular economy initiatives are significant factors that can influence the adoption and success of circular practices. The upfront costs for acquiring and implementing new technologies or for the construction or adaptation of facilities can be a barrier for businesses, especially for smaller enterprises. The financial sector is increasingly recognizing the circular economy as a framework for addressing global problems, and circular business models can increase the competitiveness between companies in the same sector in the medium and long term, becoming more attractive to financial institutions in terms of financing and financial support. There are several strategies and approaches that can help address and mitigate these costs, making circular economy initiatives more financially feasible:

- **Public-Private Partnerships (PPPs):** Collaborative arrangements between public and private entities to jointly finance and implement circular economy projects. Sharing investment costs and risks between the public and private sectors can make projects more financially viable.
- **Government Incentives and Subsidies:** Governments can provide financial incentives, grants, or subsidies to businesses implementing circular economy projects. These incentives can help offset initial costs, making circular practices more attractive to businesses.
- **Circular Economy Funds and Financing Programs:** Specialized funds or financing programs that specifically target circular economy initiatives. Companies can access funds dedicated to circular projects, reducing the financial burden of upfront investments.
- **Green Bonds and Sustainable Financing:** Raising funds through green bonds or other sustainable financing instruments to support circular economy projects. Investors interested in sustainable projects may provide funding at favourable terms, and the proceeds can be used to finance circular initiatives.
- **Collaborative Funding Models:** Collaborative funding mechanisms involving multiple stakeholders, such as industry consortia or joint ventures. Sharing investment costs among several organizations can make projects more financially viable for individual participants.
- **Phased Implementation and Pilots:** Implementing circular initiatives in phases or starting with smaller-scale pilot projects. This approach allows businesses to test and demonstrate the feasibility of circular practices with lower initial investments before scaling up.

- **Supplier Financing and Collaboration:** Collaborating with suppliers to share the costs and benefits of circular practices throughout the supply chain. Joint investments with suppliers can create a more circular and resilient supply chain while distributing costs.
- **Technology Partnerships and Licensing:** Partnering with technology providers or licensing innovative solutions instead of developing technologies in-house. This can reduce the costs of technology development and deployment, particularly for specialized technologies needed in circular projects.

By combining these strategies and tailoring them to the specific context of a circular economy project, businesses can overcome the hurdle of high initial investment costs and create a more sustainable and economically viable circular system.

3.7. Uncertain return on investment in the circular economy

Investing in circular economy solutions and business models is still considered high risk for financiers, and uncertain returns are one of the main risks associated with circular economy initiatives [7]. Uncertain returns may erode investor confidence in circular economy projects. Investors, especially those seeking predictable financial outcomes, may be hesitant to commit funds to projects with unclear or variable returns. As a result, financiers may demand higher risk premiums to compensate for uncertainties in returns and companies may be discouraged from investing in innovative circular technologies or business models. Uncertain returns may also lead to longer payback periods for circular economy projects and raise questions about the overall viability of circular economy projects, particularly when compared to more traditional, linear models.

To address these challenges, it becomes crucial for companies involved in circular economy projects to actively manage and communicate uncertainties. This may involve developing robust risk management strategies, providing clear and transparent reporting, and actively engaging with stakeholders to build trust. Demonstrating the positive environmental and social impacts of circular initiatives alongside potential financial gains can also enhance the overall value proposition and mitigate concerns about uncertain returns. Additionally, collaboration within the circular economy ecosystem and efforts to standardize impact measurement can contribute to reducing uncertainties and attracting investment.

As mentioned, one way to combat the uncertainty of circular economy investments is to reduce potential risks. Table 2 describes financial instruments for de-risking the circular [7].

Table 2. Financial risking instruments to finance circular economy solutions.

Instrument	Description	Application for circular economy finance
Loan guarantee schemes (LGS)	LGS backed by governments can facilitate and encourage commercial banks to provide loan finance to small firms that, because of the high risk involved or lack of collateral, are unable to obtain conventional loans.	This instrument can be used for SMEs operating in the value chain of key sectors of the economy in developing countries to invest in circular solutions. In the context of the COVID-19 pandemic, it can also help SMEs in key sectors to deal with the liquidity challenges that have been created.
Political risk insurance (PRI)	PRI is a tool for businesses to mitigate risks arising from the adverse actions of governments, situations of armed conflict, civil strife and unrest, and terrorism. PRI helps companies to provide a more stable environment for investments into developing countries, and to unlock better access to finance. Most public providers of PRI are national export credit agencies. ¹⁴²	PRI has been used to facilitate financing for infrastructure projects and investments in natural resources sectors of developing countries. PRI could be used to finance infrastructure necessary for the circular economy, such as fixed-line broadband, waste management and recycling infrastructure, or equipment-leasing models.
Public equity co-investments	This instrument is a minority investment, made directly into an operating company by partners of investment funds. In conjunction with a financial sponsor or other private equity investor, co-investments allow a manager to make larger investments while avoiding risk exposure issues.	Equity co-investment is being used to fund forestry plantation projects. The instruments could be expanded to finance regenerative agroforestry or non-timber forestry projects.



<p>Blended finance</p>	<p>Public–private blended finance aims to use the investment from the public sector to catalyze commercial finance for the public good. Blended finance has a catalytic effect and helps overcome major barriers by attracting much-needed private capital. It also enables investment managers to take a higher-risk approach when dealing with their portfolio target companies.</p>	<p>As a structuring approach, blended finance has been applied to create investment opportunities in developing countries to help achieve the SDGs, crowding in additional private sector funds in higher volumes. Examples include financing of water and sanitation, and clean energy projects</p>
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3.8. Inadequate incentives and subsidies

Inadequate incentives and subsidies can hinder the transition towards a circular economy. Circular economy initiatives are often small in scale and inadequate to address the entirety of sectoral investment [7]. Companies may be hesitant to invest in circular practices without financial incentives and inadequate support may discourage businesses from adopting sustainable technologies, redesigning products for recyclability, or implementing circular business models. Further, without subsidies or incentives, businesses that choose to adopt circular practices may face higher costs compared to those adhering to traditional, linear models. This competitive disadvantage can hinder the broader adoption of circular economy principles within industries.

Further, some subsidies can go against the Circular Economy principles. For example, subsidies that are harmful to the environment should be phased out [25]. Emissions trading schemes, for example, could have the unintended consequence of concentrating pollution in economically disadvantaged areas (pollution hotspots) [26]. Another example of environmentally harmful subsidies in the circular economy are the tax rebates on liquefied petroleum gas (LPG) used for water heating that favour higher energy consumption by reducing the price of energy and distorting competition with solar thermal energy [27]. In Spain, there are currently partial fuel tax reductions and refunds for agriculture. This tax reduction was introduced in 1995 to help farmers reduce production costs and increase profitability, e.g., the reduced tax for diesel used in tractors and agricultural machinery is more than three times lower than the normal rate. In addition to reductions on fuels, reduced rates of tax (VAT) are also applied to agricultural inputs such as fertilisers and pesticides. These types of subsidies also exist in other EU countries, such as Austria, Belgium, Bulgaria, Croatia, Cyprus, France, Ireland, Italy, Poland, Portugal, Romania, and Slovenia. Austria has a flat-rate taxation of company cars for private use by supporting the use of company cars as a non-monetary or in-kind benefit. The main beneficiaries are employees of companies whose company car policy allows the use of the car for private purposes. Similar support exists in Denmark, Germany, Italy, Luxembourg, the Netherlands and Slovakia. In 2020, two thirds of all new cars in Austria were registered in the name of companies or other legal persons. Most of them were petrol or diesel cars, which shows the scale of the problem. [28]. As part of the Eighth Environment Action Programme (EAP), EU member states agreed to identify environmentally harmful subsidies and promote the phase out of these types of counterproductive incentives.

The support of public institutions and regulations could indeed help address this challenge. For example, targeted fiscal support can play a vital role in stimulating innovation and incentivising circular economy

practices. Reducing taxes, such as value-added taxes, on reuse, repair, and remanufacturing activities can incentivise circular designs and business models and support the circulation of valuable goods, materials, and nutrients. Policymakers can also use subsidies, especially in times of crisis, to promote future areas of growth and employment, and incentivise producers to minimise their dependence on resources by exploring circular economy practices.

3.9. Market demand and limited prices

The dynamics of consumer preferences, pricing structures, and market conditions can either facilitate or hinder the adoption of circular practices. The success of circular products often depends on whether consumers are willing to pay a premium for sustainable and recycled goods. If market demands indicate a low willingness to pay more for circular products, businesses may face challenges in pricing their sustainable offerings competitively. Then, if price constraints make circular practices more expensive than linear alternatives, businesses may be reluctant to adopt sustainable models, hampering the growth of circular initiatives. Further, price constraints can limit the availability and affordability of these materials and if circular practices incur higher production costs, companies may be hesitant to adopt them due to concerns about maintaining competitiveness.

Very often, price constraints are related to the inability of circular markets to solve an existing problem because a market does not yet exist or the market is so limited that the pricing process does not result in the right prices [29]. The market system incentivises competition over cooperation, demands cost reduction and price-determined value, which creates incentives that are the complete opposite of a functional circular economy. Today, the burgeoning market for high-priced reused products tends to be reduced to luxury, collectible, and limited-availability items. [30]

To overcome these challenges, policymakers and businesses must work together to create an enabling environment for the circular economy. This includes developing policies that incentivise circular practices, investing in research and development, and creating new business models that prioritise circularity over linear growth. In addition, educating consumers about the benefits of circular products and services can help increase demand and boost the circular economy. Companies can also provide information to consumers about the benefits of circular products and services, which can help increase market demand and increase consumer's trust in their product. Creating incentives for sustainable purchasing can encourage consumers and, on the other hand, taking advantage of new technologies such as mobile apps, websites and social media can also be beneficial for consumption [31]. An effective circular business model should be needs-based and focused on affordability to make sustainable products accessible to all [32]. Finally, the factors influencing consumer choices can be addressed to increase consumer awareness and demand for circular economy products [33].

3.10. Complex financial models in circular economy

Circular economy initiatives often involve unique challenges, such as extended product life cycles, reverse logistics, and new revenue streams. Complex financial models, while essential for capturing these intricacies, can have several effects on circular economy projects. Even if the financial model itself might not necessarily be complex, the underlying asset structure certainly is. For example, Circular Economy financial models may require significant resources, including skilled personnel, advanced software, and time for development and maintenance. Complexity in financial models may make it challenging for decision-makers to understand and interpret the data accurately and they may be difficult to communicate effectively to various stakeholders, including investors, employees, and partners. This complexity can also introduce challenges in identifying, quantifying, and managing risks associated with circular economy projects, which could lead to increased exposure to risks and unexpected financial setbacks. Another added complexity is the investment needs of circular economy businesses where they have to finance product ownership for longer than in a linear model, as revenues from customers are linked to usage or performance and are filtered through the lifetime of the product. Secondly, existing companies moving from a linear to a circular business model require investments to change existing systems, such as creating a different revenue model. In summary, complex financial models in the circular economy involve strategies to create a sustainable circular business model, taking into account changing financial flows, increased dependency, and more complex risks [34] [35] [36].

Financial asset complexity can be addressed by implementing strategies that invest in training and expertise, enhance communication, make use of user-friendly tools, and simplify the models when possible. For example, ensuring that personnel involved in financial modelling have the necessary skills and expertise to understand, develop, and maintain complex models, and involving key stakeholders, including financiers, in the development and review of financial models can enhance understanding and build trust. (Fig 5).

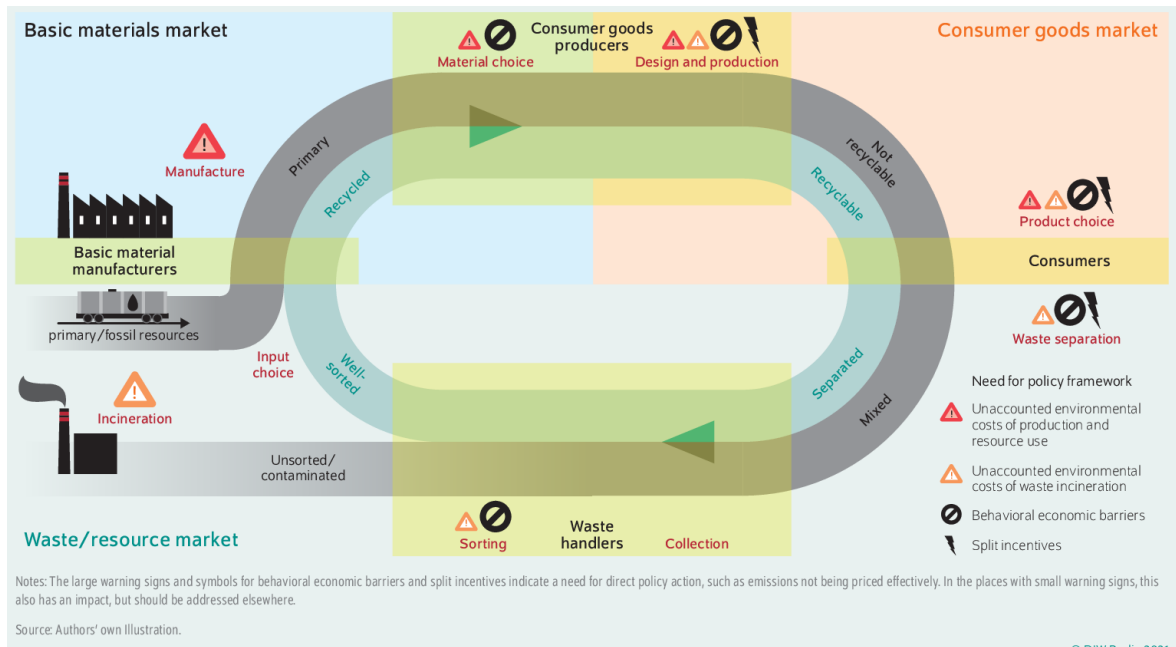


Figure 4. Examples of policy measures to guarantee the functioning of the main markets in a circular economy.

4. The case of Klagenfurt: a real case scenario of financial barriers in Circular Economy projects

The following section summarises the work carried out by STW-AG in which reference is made to numerous individual discussions or contract negotiations with various representatives of banks, insurance companies and pension funds over the last two years.

4. 1. Initial situation and financial barriers

During the phase of low interest rates, insurance companies and pension funds, in particular, were on the lookout for sustainable investments in infrastructure companies like “Stadtwerke “. Initially and primarily related to the regulated electricity- and gas-grid sector, but in recent months increasingly also for green projects, such as the construction of photovoltaic or circular economy systems.

There were also contacts with international and local banks, which for their part are aligned with the strategic objectives such as sustainability and long-term instead of short-term returns. As part of the discussions, however, it quickly became clear, that banks were using complex legal hedging methods to counter the existing risks. An extremely complex legal contract design was the result of considerable expenses.

The associated risk premiums – especially for outsourced companies – also made it more difficult to conclude long-term financing agreements at favourable interest conditions. Due to extensive initial and more risky investments due to the current market situation, the impact of the long-term yield curve including risk premiums is high.

There were also isolated contacts with major industrialists, who were also committed to long-term sustainable goals. Future social and economic advantages play therefore a key role in connection with the implementation of the EU Commission’s directives CSRD and EU Taxonomy.

A reasonable ratio of equity to borrowed capital had also to be ensured in the corporate balance sheet. In addition to high needs for financial resources the long-term pay-back period of such green projects had to be taken into account.

The uncertain development of energy prices, rising inflation, and uncertain market development due to increasing international trouble spots are making financing costs more expensive. The legal and administrative burden is also increasing.

No or less political will to make structural changes prevents financial resources from being channelled into sustainable projects via financial equalisation between public bodies (in Austria called “the Financial Equalisations Act”).

Financial equalisation in Austria refers to the distribution of financial resources between the various federal states. This equalisation is intended to ensure that all regions have a sufficient financial basis to provide public services. It is based on a complex system of allocations and levies between the federal government, regions, cities, and municipalities.

As part of the financial negotiations, the cities and municipalities are represented only by interest groups (Association of Cities or Municipalities), which have the right to make proposals, in practice these proposals are often only taken into account to a rudimentary extent. The introduction of the principle „whoever buys also pays“ instead of „one buys the other pays“ would help a lot in the future.

The distribution keys used in the Financial Equalisation Act are also outdated and partly date back to the time after the Second World War, when the entire infrastructure was destroyed and had to be completely rebuilt. However, this was based on the technologies of the time.

And the distribution of public funding still follows the same pattern today. As part of the national implementation of the RRF (Resilience and Recovery Fund), also at the beginning, the funding agencies did not pay sufficient attention to promoting sustainable infrastructure. For example, those cities and their companies are currently penalised, when they pursue the implementation of green projects in the context of sustainable infrastructure systems.

As a result, although the cities have adopted strategic goals with regard to decarbonisation and climate change, the funding for implementation is completely lacking.

In the meantime, however, there are working discussions to change this situation. But the will for sustainable changes is only making slow progress, both among the authorities and in customer behaviour. Increasing

financial deficits in the financial budgets of cities and municipalities are making this change process more difficult.

Due to the lack of funding, it is also not possible, to get the required political resolutions for the implementation of sustainable projects. It is therefore particularly important, that financial aspects are also taken into account at the very beginning of the projects in addition to technical aspects. This was not always the case in the past.

Due to the high level of investments required for a sustainable energy transition and the associated high future investment and financing volume, it quickly became clear to the “City of Klagenfurt “, and specifically to the “Stadtwerke AG“ as the greatest outsourced company of the city, that in addition to existing financial partners new strategic financing partners and new financial solutions for approaches were needed. In conclusion, with regard to potentially risky green projects, public sector financing instruments are currently structurally unable to cover the considerable financing needs of cities and municipalities on their own.

4. 2. Potential measures to address financial barriers in Klagenfurt

It is essential to find a financing mix of measures between the public sector and the private sector that consider both the objectives of the EU Commission’s directives CSRD and EU Taxonomy. For example, existing equity-enhancing financial instruments like „profit participation capital“ enable municipal utilities like “Stadtwerke“ as infrastructure service providers to enter into partnerships with public and private financial partners. Based on the opinion of the Expert Committee for Corporate Law and Auditing of the Chamber of Public

Accountants and Tax Advisors on accounting for profit participation rights and hybrid capital (KFS/RL 13), it is possible in Austria to do this via direct participation in joint ventures or in the form of agreements under civil law. In addition to strengthening equity, the provision of venture capital via private funds plays an important role in the future.

5. Conclusions

In conclusion, our review of financial barriers in the context of circular economy projects highlights several challenges, such as high upfront investment costs that deter businesses from adopting sustainable practices, access to capital, especially for smaller businesses and start-ups, perceived uncertainty around financial returns and short-term expectations prevailing among investors. Other important financial barriers would be the absence of financial instruments specifically adapted to circular projects limiting financing options and the complexity of circular transactions.

On the other hand, addressing financial barriers in the circular economy provides many benefits to companies, improving resource efficiency by optimising resources, saving costs and minimising waste, as well as enhancing their brand image and attracting environmentally conscious consumers. Creating new markets with innovative products is another important benefit, as well as diversifying the number of suppliers with supply chains that are less vulnerable to disruption.

Ultimately, addressing these financial barriers requires the collaboration of businesses, investors, policy makers and other stakeholders to work together towards a more sustainable and circular economy.

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7. Annex 1

Table 3. Economy and business-related indicators. Adapted from ANDER, E. (2021).

Subcategory	Sector	Indicator	Unit	Year	Name of the Study
Added value	No sector specific	Net added value of the circular economy	EUR	2016	Circular Amsterdam A Vision and Action Agenda for the City and Metropolitan Area
Added value	No sector specific	Economic value generated	NA	2018	Circular Bilbao and Bizkaia
Added value	No sector specific	Value creation (€) thanks to the growth of circular economy models	EUR	2017	Paris Circular Economy Plan: 2017-2020
Added value	No sector specific	Added value of the circular economy	billion EUR (2010 price level)	2018	Circular economy: what we want to know and can measure
Added value	No sector specific	Gross value added generated	EUR	2017	Leading the transition [Action plan for circular economy in Portugal: 2017-2020]
Added value	No sector specific	Value added at factor cost	percentage of gross domestic product (GDP) at current prices	2019	Monitoring framework for the circular economy
Added value	Resources, materials, waste	Economic value of the resources used and the value at the time they are reintroduced into the system	NA	2017	Towards a Model of Circular Economy for Italy - Overview and Strategic Framework

Subcategory	Sector	Indicator	Unit	Year	Name of the Study
Business	Built environment	Turnover of construction companies with Eco-labelling that prioritises the use of sustainable local raw materials adapted to the requirements of the Circular Economy.	% of total sector	2019	Galician Strategy of Circular Economy 2019-2030
Business	Built environment	Number of companies with certification based on life cycle or eco-design	Number	2019	Galician Strategy of Circular Economy 2019-2030
Business	Industry	Companies implementing product-as-a-service business models	Number	2019	Galician Strategy of Circular Economy 2019-2030
Business	Industry	Improvement of the competitive positioning of the entire business fabric in the green and circular economy	NA	2018	Extremadura 2030. Green and Circular Economy Strategy
Business	Industry	Increase in the number of enterprises and productivity, by productive subsectors of the green and circular economy	Number	2018	Extremadura 2030. Green and Circular Economy Strategy
Business	Industry	Number of companies or products with tax benefits to incentivise the circular economy	Number	2017	Leading the transition [Action plan for circular economy in Portugal: 2017-2020]
Business	Industry	Circular business	% of total	2018	Measuring the Circular Economy Developing an indicator set for Opportunity Peterborough
Business	Industry	Circular companies by total number of companies	Number	NA	NA

Business	Industry	Economic operators supported in circular economies	Number	2016	Regional Programme for the Circular Economy 2016 – 2020 (PREC)
Business	Industry	Economic operators aware of the circular economy	Number	2016	Regional Programme for the Circular Economy 2016 – 2020 (PREC)
Business	Industry	Circular start-ups	Number	2018	Circular economy: what we want to know and can measure
Business	Industry	Percentage of companies innovating for circular reasons	%	2019	Agenda for the Development of the Circular Economy in Navarra 2019-2030
Business	No sector specific	Improvement of the strategic positioning of the territory and its green economy in the global market	NA	2018	Extremadura 2030. Green and Circular Economy Strategy
Business	No sector specific	Increase in the number of green and circular projects contributing to economic diversification	Number	2018	Extremadura 2030. Green and Circular Economy Strategy
Business	No sector specific	New revenue models related to the circular economy	Number	2018	Circular economy: what we want to know and can measure
business	Reuse, repair, share	Business activities involved in repair	Number	2019	Galician Strategy of Circular Economy 2019-2030
Business	Textile	Opening of repair workshops on several easy-to-access sites	YES/NO	2017	1st Roadmap Paris Circular Economy Plan
Business	Tourism	Increase in the number of tourism enterprises and in the productivity of the sustainable tourism sector	Number	2018	Extremadura 2030. Green and Circular Economy Strategy
Business	Waste	Number of businesses that have adopted locally standardized containers	Number	2018	2nd Roadmap Paris Circular Economy Plan

Business	Waste	Number of waste streams or subcategories of regulated electronic appliances under the responsibility extended to the producer.	Number	2019	National Strategy for the Circular Economy
Economic efficiency	Energy	Energy intensity (final)	toe/Million EUR	2018	Extremadura 2030. Green and Circular Economy Strategy
Economic efficiency	Energy	Energy intensity (primary)	toe/Million EUR	2018	Extremadura 2030. Green and Circular Economy Strategy
Economic efficiency	No sector specific	Material intensity	Kg/EUR	2018	Circular Bilbao and Bizkaia
Economic efficiency	Resources, materials, waste	Domestic Material Consumption per capita	EUR/kg	2017	10 Key Indicators for Monitoring the Circular Economy
Economic efficiency	Resources, materials, waste	Generation of waste excluding major mineral wastes per GDP unit	Kg/Thousand EUR	2019	Monitoring framework for the circular economy
Economic efficiency	Resources, materials, waste	Total amount of waste generated, excluding the main mining waste, per unit of GDP in thousands of euros	Kg/Thousand EUR	2019	Basque Country Circular Economy Strategy 2030
Economic efficiency	No sector specific	Economic growth of the circular economy	% GDP	2018	Circular economy: what we want to know and can measure
Economic structure	No sector specific	GDP per Total Greenhouse Gas Emissions	PPP/kg CO2 equivalent	2018	Roadmap towards the circular economy in Slovenia
Economic structure	No sector specific	Weight of the green economy in GDP	NA	2015	Promoting the Green and Circular Economy in Catalonia
Gains and revenues	Food	Sales of organic products and local food products	NA	2019	Agenda for the Development of the Circular Economy in Navarra 2019-2030

Gains and revenues	Industry	Industry turnover in more circular products	Thousand million EUR	2019	Basque Country Circular Economy Strategy 2030
Gains and revenues	Public administration	Economic gains of the reduction of the digital impact in the local administration	NA	2018	2nd Roadmap Paris Circular Economy Plan
Gains and revenues	Reuse, repair, share	Euros recovered through the donation and reselling scheme to the city	EUR	2018	2nd Roadmap Paris Circular Economy Plan
Investments	Reuse, repair, share	Household spending on product repair and maintenance	EUR/capita/year	2017	10 Key Indicators for Monitoring the Circular Economy
Investments	Public administration	Public expenditure on R&D related to EC	NA	2019	Agenda for the Development of the Circular Economy in Navarra 2019-2030
Investments	Education	Investment in research for increasing circular knowledge and expertise	EUR	2018	Circular economy: what we want to know and can measure
Investments	Food	Impact on the primary sector of investments in the processing and marketing of local agricultural products for healthy eating and responsible consumption	NA	2018	Extremadura 2030. Green and Circular Economy Strategy
Investments	No sector specific	Amount invested in circular economy projects	NA	2017	Leading the transition [Action plan for circular economy in Portugal: 2017-2020]
Investments	No sector specific	Gross investment in tangible goods	percentage of gross domestic product (GDP) at current prices	2019	Monitoring framework for the circular economy
Investments	No sector specific	Private investment	Thousand EUR	2018	Extremadura 2030. Green and Circular Economy Strategy
Investments	No sector specific	Investment in R&D over the GDP	%	2019	Galician Strategy of Circular Economy 2019-2030

Investments	Public administration	Public investment	Thousand EUR	2018	Extremadura 2030. Green and Circular Economy Strategy
Investments	Water	Funding to enhance the implementation of projects for the reuse of regenerated water from wastewater	EUR	2019	Galician Strategy of Circular Economy 2019-2030