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CE Circular Economy

CC Climate Change

CCM Climate Change Mitigation

EDR Energy Demand Reduction

GHG Greenhouse Gas

SB Sustainable Business

SBM Sustainable Business Model

SBS Sustainable Business Strategy

1. Executive summary

This report explores the value of Circular Economy (CE) and Sustainable Business Models (SBM) in the Mediterranean region in terms of climate change mitigation (CCM). The report endeavours to offer practical insights and strategies to businesses and policymakers, aimed at fostering the widespread adoption and implementation of CE. This involves benchmarking CCM policies, identifying key domains for SBM, evaluating high-potential CE strategies, emphasizing CE's regenerative role, and exploring gender and class dimensions in these strategies. While the report has a global scope, it gives particular attention to Mediterranean cases.

The report explores the relationship between CE, SBM, and CCM, as well as the empirical evidence, social aspects, and research gaps of the nexus using a systematic literature review of publications, interviews to key stakeholders and practitioners, and analysis of key cases.

Aligned with this circular vision, SBM prioritize long-term resilience by innovating in design, supply chains, and customer engagement, reducing environmental footprints. Yet, transitioning to a circular economy presents challenges such as labour practices, equity considerations, and economic constraints, often overlooked but critical in the process. Addressing these demands a systemic approach, possibly led by green/social entrepreneurship.

These sustainable business models, in their innovation, not only generate economic value but also foster environmental and social benefits, transforming not only products but also the underlying business structures. Essential strategies proposed to achieve these goals involve preventing pollution, recovering resources, extending resource use, maximizing efficiency, adopting circular design, and fostering demand for circular products and services.

However, despite the existence of circular business models, their market share remains relatively modest compared to traditional models, attributable to several challenges. Inertia within existing companies poses a significant hurdle in adopting circular practices, favouring new businesses. While transitioning to circular supplies might seem simpler, large companies hold more power to influence these practices compared to SMEs. Moreover, incorporating CE principles into existing companies requires significant investment and risk-taking, a challenge often faced more acutely by SMEs than larger enterprises.

The report also highlights the complexity of funding and insurance options, which further impedes the adoption of CE practices, especially for micro and small companies, due to higher initial investment costs and risk exposure associated with the CE transition. Additionally, the scarcity of inspiring precedents inhibits companies' understanding of transformation potential within their business areas, complicating the assessment of sustainability innovations' impact and their effects on the entire business network.

The examination of sectors with significant climate change mitigation potential reveals critical areas for emissions reduction. Approaches based on production and consumption provide divergent perspectives on emission responsibilities. Key contributors to emissions include energy consumption (74.7%), agriculture (15.3%), industry (6.6%), and waste (3.5%).

Notably, sectors like energy, food production, construction, and mobility show promise in delivering substantial greenhouse gas emission reductions, crucial for limiting temperature rise. Addressing emissions tied to product production and use, especially in affluent nations, remains imperative, accounting for a significant 45% of global emissions. Transforming consumption patterns in wealthy countries is essential, emphasizing a shift towards renewable energy, transportation modes, and dietary changes. Sectors like shelter, food, and mobility dominate household consumption-related emissions, urging targeted mitigation efforts. Actions such as dietary shifts, transport mode changes, and energy-efficient refurbishments hold promise in reducing climate impact. These sectors serve as pivotal domains for SMB to significantly contribute to CCM.

One of the main conclusions this report provides is how policies and institutional backing are pivotal for enabling the transition to SBM from the prevailing linear economy. For a successful transition, policies should focus on key economic sectors, employ diverse strategies, and provide clear definitions and objectives to guide stakeholders. Legal frameworks play a crucial role in shaping and enforcing CE principles, potentially becoming ineffective if lacking in ambition, clarity, or enforcement capabilities. Challenges faced by small and medium enterprises (SMEs) in adapting to CE frameworks due to cost and time constraints underscore the need for supportive policies, collaborative platforms, and protections for their economic activities. However, critiques highlight that a CE, operating within the current growth-centric economic framework, might not inherently decrease resource consumption or emissions. This underscores the need for a significant shift in economic priorities, requiring intentional political choices that prioritize action for substantive transformation.

The examination of the potential of CE on CCM reveals a strategic alignment with climate change mitigation efforts, as the CE emphasizes resource efficiency and sustainable practices. It focuses on optimized product use, longevity, and recycling to curtail emissions and reduce environmental strain. CE's systemic approach across value chains contributes to broader decarbonization and economic resilience, notably through local sourcing and renewable energy promotion. In agriculture, CE practices, like regenerative farming, enhance carbon sequestration and resource conservation. Recent studies hint at CE's potential to substantially cut global greenhouse gas emissions, with interventions like dietary shifts and regenerative agriculture offering promising emission reductions and co-benefits. While the full scope of CE's impact on national climate targets is not yet fully explored, initial estimates propose significant emission reductions if CE strategies are widely adopted.

The integration of CE principles into climate change mitigation efforts underscores the potential for substantial environmental benefits and emission reductions. CE's emphasis on resource efficiency, recycling, and sustainable practices aligns with strategies aimed at mitigation GHG emissions. Its systemic approach, applied across industries and value chains, shows promise in reducing environmental strain and fostering economic resilience. Notably, CE practices in agriculture, such as regenerative farming, hold potential for enhancing carbon sequestration and resource conservation. Although the comprehensive impact of CE strategies on national climate targets requires further exploration, initial estimates suggest significant emission reductions if these approaches are scaled and effectively implemented.

Exploring the social dimension within the nexus of CE, SBM, and CCM reveals critical considerations for a socially just transition. The report stresses the significance of context in consumer choices and the pivotal role of policy infrastructure in promoting circular practices.

Addressing the democratic aspect, the report emphasizes political legitimacy as crucial for implementing effective CE policies, highlighting methodologies like citizens' engagement and polling to amplify citizen voices. It underscores the necessity of societal acceptance and political backing, crucial for a sustainable CE implementation within democratic systems.

The report recognizes potential job displacement and economic disparities arising from CE adaptation, emphasizing the importance of quality 'green jobs,' especially in regions like the Global South.

The report advocates for gender perspectives within CE policies, aiming for gender justice by closing the gap between productive and reproductive work. It underscores the need to redefine value within CE to encompass social and environmental care, aligning with a Feminist Ecological Economics perspective. This comprehensive societal approach ensures a more inclusive, socially just, and environmentally sustainable CE.

2. Introduction

Unlike the traditional linear model of "take, make, dispose" the circular economy (CE) seeks to create closed-loop systems that mimic natural ecosystems, where waste is virtually eliminated because outputs become inputs for another process (Ellen MacArthur Foundation, 2023). **CE has the potential to drive systemic decarbonization across various sectors, but the global economy is now only 7.2% circular**; and it is getting worse every year—driven by rising material extraction and use (Circle Economy, 2023). Policymakers should grasp the impacts and benefits of the CE in the context of climate change mitigation. This understanding is crucial for advancing the adoption of CE strategies and actions within the climate agenda.

The main objective of this report is exploring (and if possible, demonstrating) the value of CE and Sustainable Business Models in the Mediterranean region in terms of climate change mitigation.

The specific objectives are:

1. Conduct a comprehensive analysis and benchmarking of existing climate change mitigation policies (CCM) based on the generation of new sustainable business models (SBM).
2. Identify key domains where climate-positive business models exert substantial impact on reduction efforts.
3. Evaluate which circular economy strategies present higher potential for climate change reduction along key domains and value chains.
4. Emphasize the regenerative role of circular economy and its systemic decarbonisation potential.
5. Exploring gender/class dimensions and roles to inform specific recommendation and nexus strategies.
6. Exploring the interdependencies between social equity, circular economy strategies, and climate change mitigation measures, with consideration for the concept of a Just Transition to Circular Economy and its significant implications

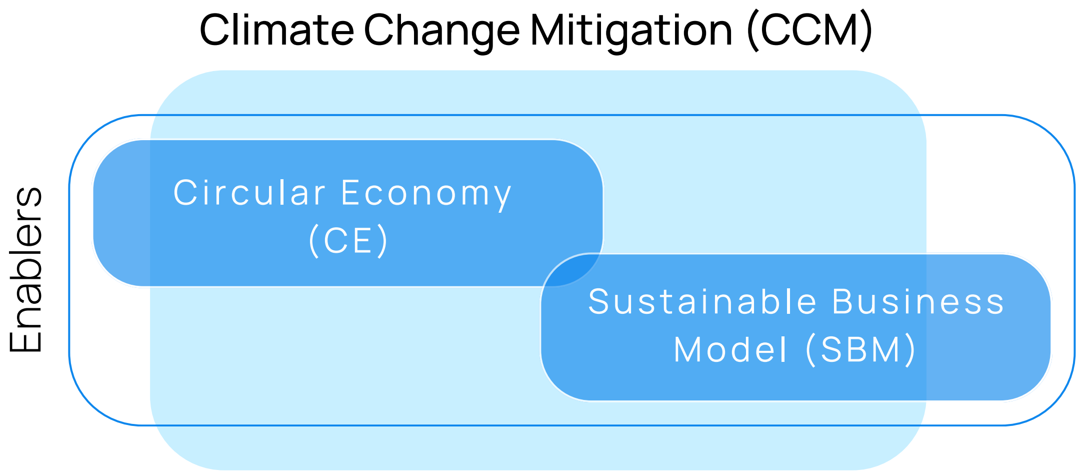
The scope of the project is global although particular focus will be given to cases from the Mediterranean region.

The structure of this report is as follows: Section 2 summarizes the methodology used in the project. Section 3 describes the relationship between the circular economy and sustainable business models. Section 4 explores the relationship between climate change and sustainable business models, and Section 5 examines the relationship between the circular economy and climate change. Section 6 describes the empirical evidence of the nexus, Section 7 discusses the social aspects of the nexus, and Section 8 identifies the research gaps. Finally, Section 9 presents the conclusions of the report.

3 Methodology

To fulfil the assessment's objectives, the Circular Economy (CE), and Sustainable Business Models (SBM) have been analysed as enablers for Climate Change Mitigation (CCM), as illustrated in Figure 1. Nevertheless, these enablers are interrelated, with some Sustainable Business Models (SBM) incorporating CE principles, though not universally. Thus, it was imperative to initially scrutinize the relationship between these two enablers. Furthermore, it is important to acknowledge that CE and SBM carry implications beyond Climate Change Mitigation (CCM), but such considerations are outside the scope of this report.

Figure 1. Scheme of the analysed nexus between CE, SBM and Climate change mitigation



Source: Own Elaboration

This report aims at analysing the relationship between the three concepts as well as the empirical evidence, social aspects, and research gaps of the nexus using a systematic literature review of publications, interviews to key stakeholders and practitioners, and analysis of key cases.

3.1 Systematic Literature Review

Several reviews have been conducted to date. For instance, Cantzler et al. (2020) or Khanna et al. (2022) looked at the nexus between CE and CCM, however, none of them specifically focused on business models or sectors with larger climate change mitigation potential.

For the review, Scopus was used as main search engine, employing three key terms- namely "circular economy", "climate change" and "business" - to be included in the titles or in the abstracts of the publications. The review excluded articles published in languages other than English. Due to the large number of records obtained, the review focused solely on articles published since 2018. Additional publications known by the authors were also added in the review process. Annex 1 describes the procedure followed to carried out the review.

3.2 Interviews

Based on the research questions of the project, the following experts were selected to be interviewed and their opinion considered in the development of the following sections:

1 **Jordi Oliver i Solà. CEO of Inèdit**, a strategic eco-innovation studio founded by pioneers of industrial ecology, Life Cycle Assessment (LCA) and ecodesign of the Autonomous University of Barcelona, with more than 14 years of experience developing solutions to integrate sustainability into the value proposition of more than 400 clients.

2 **Mario Pansera. Director of the Post-Growth Innovation Lab and coordinator of the Just2CE project**, an EU-funded initiative that aims to explore the economic, societal, gender, and policy implications of the CE paradigm (Just2CE, 2023b).

3 **Lewis Akenji. Managing Director of Hot or Cool Institute**, a public interest think tank that explores the intersection between society and sustainability, bringing together researchers and practitioners to facilitate solutions to global problems. They coordinate the 1.5-degree lifestyles programme that investigates the impacts of consumption and lifestyles on climate change and introduces a science-based approach to link concrete changes in lifestyles to measurable impacts on climate change.

3.3 Case analysis

Given their significant importance within the current political agenda and/or consumptions patterns, three sectors have been selected for in-depth analysis: the renewable energy sector (subsection 7.1) construction sector (subsection 7.2), and the mobility sector (subsection 7.3).

4 Circular Economy and Sustainable Business Models

The CE aims at ensuring that resources remain within the economic framework rather than merely passing through. The evolution towards a CE could diminish environmental strain, generate local employment, decrease the likelihood of disruptions in raw material supply and aid in the progression towards a low-carbon economic model. Activities related to materials management contribute to over half of the GHG emissions in OECD nations (OECD, 2012) and are anticipated to represent two-thirds of worldwide GHG emissions by 2060 (OECD, 2019).

The nexus between the CE and sustainable business models represents a transformative approach to be used in economic activities. Traditional linear models, characterized by a "take-make-dispose" paradigm, are increasingly viewed as unsustainable due to resource depletion and environmental degradation. In contrast, the CE emphasizes resource efficiency, waste minimization, and the continuous loop of product design, reuse, and recycling (Mukoro et al., 2022). Sustainable business models, aligned with this circular vision, prioritize long-term resilience over short-term gains. They innovate in product design, supply chain management, and customer engagement to reduce environmental footprints. By intertwining the principles of the CE with business strategies, companies could not only ensure environmental sustainability but also unlock new economic opportunities and competitive advantages. However, the feasibility of CE and circular business models must be evaluated against trade-offs and emerging conflicts of transitioning away from a linear economy. Factors such as labour practices, equity, biophysical limits, rebound effects, and economic constraints are often overlooked. (Mukoro et al., 2022). To overcome these trade-offs, a systemic approach must be envisioned, pivoting towards a novel approach to value generation that could be provided by green/social entrepreneurship.

According to Mosangini and Tunçer (2020) a sustainable business model is defined as a model that includes not only economic value creation but also environmental and social value creation and distribution.

In short, a sustainable business provides commercial solutions to environmental challenges which are economically viable and socially empowering (Mosangini and Tunçer, 2020).

SBMs are not necessarily achieved through technology, products or service innovation alone, but also through the innovation of the business model itself (Girotra and Netessine, 2013; Yang et al., 2017). This implies changes in the way business models are conceptualized in regard to their exchanges and relations with stakeholders (Evans et al., 2017). The way a company operates and its relationship with consumers, defined by its business model, can significantly impact these practices.

Mosangini and Tunçer (2020) proposes 5+1 sustainable business strategies ranked in order of resource value retention and the level of effort required for implementation and coordination within value chains:

1. Prevent pollution and save resources: This strategy focuses on adopting more efficient production processes to reduce resource and energy use, as well as minimizing waste and emissions.
2. Recover resources after disposal: This strategy involves reintegrating by-products and waste as inputs in production processes, aiming for closed-loop management of resources.
3. Extend resource use and reduce disposal: This strategy promotes the production of long-lasting products through new processes and technologies, aiming to minimize disposal and maximize resource utilization.
4. Increase resource utilization rate: This strategy emphasizes maximizing the efficiency and productivity of resources throughout the entire product life-cycle.
5. Shift to circular supplies and design: This strategy involves adopting CE principles in product development and design, such as using renewable raw materials, promoting reuse and recycling, and designing for durability and modularity.
6. Facilitate demand for circular products and services.

These strategies focus on shifting from a product-oriented business model to a use-oriented model, where the emphasis is on providing functionality and services rather than selling products. By adopting these approaches, businesses can contribute to the CE by reducing waste, promoting resource efficiency, and creating value through sustainable practices.

Watkings (Watkins et al., 2023) establishes a list of priorities to be used by businesses based on the circularity level of each strategy, assuming that higher levels of circularity are equal to fewer natural resources and less environmental pressure associated to business, see Figure 2. To increase circularity. companies need to move towards smarter product use and manufactures.

Figure 2: Circularity strategies in order of priority based on their circularity level.

Circular economy

Increasing circularity

Rule of thumb: Higher level of circularity = fewer natural resources and less environmental pressure

Linear economy

Strategies		
Smarter product use and manufacture	R0 Refuse	Make product redundant by abandoning its function or by offering the same function with a radically different product
	R1 Rethink	Make product use more intensive (e.g. through sharing products, or by putting multi-functional products on the market)
	R2 Reduce	Increase efficiency in product manufacture or use by consuming fewer natural resources and materials
Extend lifespan of products and its parts	R3 Re-use	Re-use by another consumer or discarded product which is still in good condition and fulfils its original function
	R4 Repair	Repair and maintenance or defective product so it can be used which its original function
	R5 Refurbish	Restore an old product and bring it up to date
	R6 Remanufacture	Use parts of discarded product in a new product with the same function
	R7 Repurpose	Use discarded products or its parts in a new product with a different function
Useful application of materials	R8 Recycle	Process materials to obtain the same (high grade) or lower (low grade) quality
	R9 Recover	Incineration of materials with energy recovery

Source: (Watkins et al., 2023)

Table 1 provides some examples of companies using different sustainable business strategies based on Mosangini and Tunçer (2020) models aligned with circular economy principles.

Table 1: Examples of companies using different Sustainable Business strategies and models aligned with CE principles.

Sustainable business strategy/model		Example of companies
Prevent pollution and save resources	Cleaner and resource efficient production	• FabricAID (Lebanon): social enterprise for the apparel industry that collects, sort, upcycle and resale 2nd hand clothes, preventing the production of new textiles as well as the disposal of textile waste. • Cargobici (Spain): the company produces compostable capsules, made with a blend of organic/ecological coffees and compostable polymer.
	Zero-waste production	• EL OUIDANE (Tunisia): Biowaste revives an oasis and keeps the desert a bay. • Cafès Noveil (Spain): The company produces compostable capsules, made with a blend of organic/ecological coffees and compostable polymer.
Recover resources after disposal	Take-Back systems	• Ecoalf (Spain): Encourage return of old products for recycling of repurposing, promotinc resource efficiency. • Steelceram (Spain): The company has implemented a project to collect technical ceramic centerers used in welding plants (produced by them or other companies) to convert them into small cylinders for bowl mills.
	Biodegradable products	• Natulim (Spain): laundry detergent in form of biodegradable strips packed in carboard box. • Novamont (Italy): Design products/packaging for composting after use, reducing landfill waste.
Extend resource use and reduce disposal	Design for durability	• Klee Klee (China): is a fashion brand that promotes longer durability of their products by using long-lasting fabrics and sharing stories about the products and fabrics with their customers to inspire an emotional connection with the clothing.
	Design for reparability	• Fairphone (Netherlands): Design phone allowing easy repair, upgrade, or replacement of individual components rather than discarding the entire products. • L'increvable (France): washing machine designed to be easily repair common people (no need to be a professional).
	Re manufacturing & refurbishing	• Looptworks (UK), repurposes abandoned materials into meaningful, long-lasting and limited-edition products.
	Reuse and reselling	• BeePlanet Factory (Spain) reuses and recycles EV batteries (Spain).
	Digital Resource Exchange	• Wallapop (Spain) connects people with unwanted items to those that can use them. • Volpy (France): smartphones are assessed, bought back and exchanged directly through the app. • Back Market (France): marketplace for refurbished devices.

Sustainable business strategy/model		Example of companies
Increase resource utilization rate	Product-as-a-service	• MUD Jeans (Netherlands) lease jeans to customers instead of selling them; the company remains responsible for maintenance and recycling.
Increase resource utilization rate	Sharing Platforms	• Som Mobilitat (Spain) maximizes the utility of assets by promoting carpooling and thereby reducing the need for resource-intensive vehicle procution.
Shift to circular supplies		• Protix (Netherlands) valorises food waste into animal fodder for fish, chicken, and pets.

Source: Own elaboration
Notes: * based on Mosangini and Tunçer (2020)

4.1 Current barriers for circular business models

Although circular business models exist, their market share remains relatively modest compared to traditional businesses models. This disparity can be attributed to several pitfalls:

→ **Inertia in existing companies:** The incorporation of circular practices within existing companies is challenging because large efforts are necessary to fight against the existing linear inertia. In this regard, it is easier for new businesses and this explains that most of the circular business models are still start-ups (Inèdit 2023). On the other hand, the shift to circular supplies can be seen as the simplest strategies to implement because the core of the business structure does not need be reformulated. However, only large companies (e.g., Cafès Novell) have the power to impinge on circular practices to their providers, Small and Medium Enterprises (SME) often lack this capacity (Inèdit, 2023).

→ **Capacity to take risks:** To incorporate CE principles into an existing company, investment and risks must be taken. Often large companies have the resources to create a circular branch, while SMEs do not have such resources and face greater challenges in making structural changes (Rodrigues and Franco, 2023).

→ **Funding and Insurances options:** The barriers faced by companies adopting the CE practices in relation to funding options are influenced by the size of the business and the initial investment cost. This presents difficulties for micro and small companies due to the more complex structuring of the business and greater exposure to risk, as the CE is a new concept and not yet as established as the traditional linear system (Gonçalves et al., 2022). Same applies to insurances options. Insurances willing to support SMEs in transitioning their production systems to CE ones are minor. For example, if a SME considers switching from selling the product to leasing it, it will need funding and insurances willing to support activities and assume risks different than the ones associated to conventional business models (Inèdit, 2023).

→ **Lack of precedent:** The lack of inspiring examples hinders companies' understanding about the potential of transformation that there is within their business area. Moreover, when considering business model innovations for sustainability, how to preliminarily assess the impact of the sustainability innovations and how to understand their effects on the whole business network (Evans et al., 2017).

5 Climate Change and Sustainable Business Models

This section pinpoints economic sectors with largest climate change mitigation potential (section 5.1) and climate policy based on SBM (section 4.2).

5.1 Sectors with larger climate change mitigation potential

To mitigate climate change, a decrease of worldwide greenhouse gas emissions is imperative. Current global emissions stand at approximately 50 billion tonnes of greenhouse gases annually. To determine the most efficient strategies for emission reduction and identify which emissions are amenable to current technological solutions, it is essential to gain a comprehensive understanding of the sources of these emissions.

Within this context, there two main accounting approaches one is based on production and the other on consumption. The production and consumption- based perspectives are two extremes along a continuum, and there are various approaches to allocate responsibilities for carbon emissions (Tukker et al., 2020). Consumption Based Carbon Accounting offers an alternative to the dominant production perspective on carbon emissions, where producers of carbon emissions are seen as fully responsible for these emissions (Tukker et al., 2020). Consumption-based accounting could be used as evidence to formulate sustainable consumption policies.

Adopting either a production-based or a consumption-based approach typically yields distinct outcomes. For instance, when analysing emissions at the urban scale, solely considering the production-based perspective, which accounts only for emissions from production activities within the city, is insufficient to capture the benefits of circular measures that impact the entire supply chain of products and services. Therefore, adopting a consumption-based approach becomes essential in assessing GHG reductions in urban areas (Del Borghi et al., 2022). The following subsections describes key domains with largest climate change mitigation according to each approach.

5.1.1. Production-based approach

According to Climate Watch, 74.7% of the 2020 GHG emissions came from the energy use, 15.3% from agriculture and land use, 6.6 % from industry and 3.5% from waste. The largest contribution from the energy sector is coming from the energy consumed by industries, followed by energy used in buildings and transportation. Within the energy consumed in industry, the largest consumers were the iron and steel industry, followed by the chemical & petrochemical industry. The energy used by the food and tobacco production, non-ferrous metals, paper & pulp, and machinery was also significant. Within transport, road transport was the most significant, followed by aviation, shipping, rail, and pipeline activities. The agriculture and land use sector appears as the second major GHG contributor with livestock & manure having the largest contribution, followed by agricultural soils, crop burning, deforestation, rice cultivation, and then a combination of grassland and cropland. The two main industries contributing to the GHG emissions coming from non-energy use were cement and the chemical industry. Finally, the GHG emissions from waste come mainly from direct methane and nitrous oxide emissions from landfills and wastewater treatment plants.

Analysing the main sectors contributing to climate change allows to pinpoint areas where mitigations efforts are critical. Nonetheless, it is important to note that mitigation actions vary in difficulty and feasibility across sectors. According to UN Environment Programme (2023), six sectors can deliver more than the needed 30 Gt of GHG emission reductions to limit the global temperature rise to 1.5°C above pre-industrial levels, as recommended by the Intergovernmental Panel on Climate Change (IPCC). These sectors being: energy sector, food production, building and construction, nature-based solutions, industry sector and mobility sector.

Here it is important to mention that while most of today's efforts to mitigate climate change have focused mainly on the critical role of renewable energy and energy-efficiency measures, tackling the emissions associated with making products is necessary to meet climate targets (Ellen Macarthur Foundation, 2021). According to (Ellen Macarthur Foundation, 2021), 45% of global greenhouse gas emissions come the production and use of products and food.

5.1.2. Consumption-based approach

Using a consumption-based carbon accounting, two-thirds of the world's emissions are related to households' consumption (UNEP, 2020). Developed nations, in particular the wealthy, bear greatest responsibility. The carbon emissions of the wealthiest one percent exceed those of the bottom fifty percent of the global population. The wealthier group will need to cut its carbon footprint by a factor of 30, while least affluent half of the population could increase their footprint several times without exceeding emission targets (UNEP, 2020). According to (Büchs et al., 2023), Energy Demand Reduction (EDR) will be required to reach climate targets in the Global North. Equitable EDR may involve targeting high energy users while ensuring the satisfaction of needs for all, which could require increasing consumption of low energy users. (Büchs et al., 2023) estimated that capping energy use of the top quintile of energy consumers across the 27 EU MS could achieve CCM of 11.4% from domestic energy, 16.8% from transport and 9.7% from total energy consumption. Increasing consumption of low energy users in poverty reduces these savings by only 1.2, 0.9 and 1.4 percentage points, respectively. Therefore, to mitigate climate change, a transformation in consumption patterns, mainly in the wealthier countries, is necessary.

According to (Hertwich and Peters, 2009; UNEP, 2020), shelter (including its construction), food, and mobility are the most important consumption categories in terms of climate change. On the global level, 72% of greenhouse gas emissions are related to household consumption, 10% to government consumption, and 18% to investments. Food accounts for 20% of GHG emissions, operation and maintenance of residences is 19%, and mobility is 17%.

According to the review carried out by (Ivanova et al., 2020), the most impactful consumption changes to reduce climate change would be: 1) Dietary shift towards vegan or vegetarian options, 2) Transport mode shift towards active and public transport, 3) Reduction in overall travel demand, 4) Upscaling of electric vehicle, 5) Renewable based heating and electricity and 6) Refurbishment and renovation towards energy efficiency construction and equipment.
Based on the sectors with largest CC contributions and the most impactful consumption changes identified by (Ivanova et al., 2020), a list of sustainable business options is presented in Table 2. This could be understood as key domains where sustainable business models can have a substantial impact on climate change mitigation. Nonetheless, the mitigation potential

of each strategy should be assessed case by case. Table 4 shows the estimates found in literature.

Table 2: Sustainable business strategies applied in different sectors ordered by their contribution to global GHG emissions.

Sector	Subsector	Sustainable BusinessStrategies
Food	Livestock and manure	Sustainable diets: • Business models based on plant-based "meat" products. • Fire-fighting Herds" to exploit the synergies between the forestry and livestock sectors to prevent forest fires, e.g. (Ramats de focs, 2023).
	Agricultural soils	Sustainable agriculture: • Business models based on organic farming, agroforestry, and regenerative agriculture practices. • Regenerative agriculture for consumer industries (UNFCCC, 2023)
	Crop residues management	Biochar (vegetal coal produced from crop residues) is an effective and fast method for carbon sequestration and greenhouse gas reduction and also enhances soil quality and increases crop yields (Patel and Panwar, 2023).
	Forest management	Business models that focus on sustainable logging, reforestation, and afforestation projects.
		Sustainable tourism businesses that emphasize conservation, local community involvement, and low-impact travel.
Mobility	Transport mode	• Businesses that offer/use shared mobility solutions. • Businesses that develop public/collective transportation systems.
	Logistics	• Businesses offering/using reverse logistics. • Businesses offering/using bicycle logistics.
Energy	Industry	Reducing energy consumed within energy-intensive industries by, for example: • Increase resource efficiency and reduce wastage. • Increased shared of recycled input material to reduce energy-intensive virgin raw materials.
	Industry & Buildings	Renewable Energy: • Industries/Businesses using/offering renewable energy sources.
		Energy Efficiency: • Industries/businesses using energy-efficient processes. • Companies that offer energy-efficient appliances, retrofitting services, and energy management solutions contribute to reduced energy consumption and emissions.

Sector	Subsector	Sustainable BusinessStrategies
Industry	Cement	Sustainable Construction: • Companies using alternative low carbon materials. • Companies using recycled aggregates. • Companies performing selective demolition activities
	Chemical and petrochemical	Sustainable Production: • Based on Green Chemistry • Voluntary Extended Producer Responsibility Schemes. • Voluntary Landfill ban.

Source: Own elaboration.

Different companies are currently making energy-related changes, including greater electrification of their processes (e.g., the use of electric vehicles) and the implementation of renewable energy technology for self-consumption. These changes are relatively straightforward to implement since they do not necessitate alterations to their business models, but they are not enough to achieve a low carbon and CE. For a low carbon and CE more structural changes are need in the businesses, and such changes are requested already in the design phase, where products should be design for durability, reusability, and recyclability. The most effective CE strategies encompass those that ensure effective extended producer responsibility, companies actively seeking to reclaim their products, transform them, and reintegrate them into the economy (Inèdit, 2023). For this purpose, implementing reverse logistics has become a necessity for organizations, but it is a multifaceted process with unique requirements compared to traditional logistics. For this reason companies often face challenges in designing and implementing reverse logistics programs due to a lack of knowledge and experience (Mallick et al., 2023). To encourage these more structural changes in the business model of companies, they need political support and the collaboration of various actors within the product's production chain.

Furthermore, while interested on using renewable energy sources is growing, little is known about the end-of-life of the equipment used to provide renewable energy such us photovoltaic panels and windmills. This can be motivated by the fact that while the climate agenda has set clear targets on the % of renewable energy in the electricity mix and electrification of transport, measures promoting the circularity of the equipment generating renewable energy are still missing.

5.2 Climate change mitigation policies based on SBMS

Policy and institutional support will be crucial to creating an enabling environment for implementing circular business models towards a transition from the predominant linear economy model (Mukoro et al., 2022). Climate change mitigation policies that are based on the generation of new sustainable business models not only help in mitigating the impacts of climate change but can also create new economic opportunities, social cohesion, and employment in various sectors.

It is important to note that such policies should be directed towards pivotal sectors of the economy, utilize diverse strategies, and articulate explicit concepts and objectives, using clear definitions to avoid confusion. This approach is designed to empower the involved stakeholders in formulating a comprehensive business plan for the transition towards a production chain that adheres to the principles of the CE (Recircula, 2023).

The legal framework not only crucially shapes the development of the CE, but also determines the ability of businesses to adapt to the new CE framework. If legislation lacks ambitious, clarity, or effective enforcement capacity, there is a risk that it may become a form of "greenwashing" rather than a transformative tool with enough strength to incentivize the transition (Recircula, 2023). However, as mentioned in section 3.1, SMEs face challenges in undertaking structural changes in their production lines, both in terms of the costs involved and the time frame for implementing these changes. If the legal framework for a CE does not take into account the disadvantaged situation of SMEs and lacks clear policies to support their transition, promote collaboration among competitors, and safeguard their economic activities, evidence suggests that only large enterprises will have the capacity to adopt these changes and, consequently, survive (Hot or Cool Institute, 2023) to potential future legal and market barriers. This could potentially lead to a deterioration of the economy supported by SMEs enterprises, which are the backbone of the Euro-Mediterranean economy, accounting for over 90-95% (OECD, 2018) of all firms in absolute figures.

On the other hand, the existing legal framework for a CE is related to one of the main criticisms of its actual development, which questions its ability to address climate change without a fundamental shift in economic priorities. In other words, if the primary objective of the economy remains centred on increasing GDP, even with an improvement in the efficient use of material and energy resources, this efficiency alone may not lead to a reduction in overall resource consumption, and as a result, emissions will not decrease (Just2CE, 2023c). Furthermore, if the main goal of the global economy (economic growth) is not addressed, the concept of CE becomes somewhat abstract and apolitical, potentially serving as a mere marketing instrument or a means to attract public subsidies and private investments without fostering substantial transformation. This implies that the transition towards a CE requires not only collaborative efforts among stakeholders, but also that the stakeholders themselves actively take part to this transformation and adjust their goals to the requirements of the CE (Just2CE, 2023b).

Table 3: Climate change policies based on generation of new sustainable business models.

Policy	Sustainable BusinessStrategies
Green Financing: Governments and financial institutions are providing incentives and low-interest loans to businesses that focus on sustainable practices. This encourages the development of green businesses and technologies.	The European Investment Bank committed to aligning all financing activities with the Paris Agreement by 2020 (European Investment Bank, 2020).
Carbon Pricing: Implementing carbon taxes or cap-and-trade systems makes emitting carbon dioxide more expensive, thereby incentivizing businesses to reduce their carbon footprint and invest in sustainable technologies.	Canada implemented a federal carbon pricing system for provinces without their own carbon pricing mechanisms (Government of Canada, 2023).
Renewable Energy Targets: Governments set targets for the percentage of energy to be sourced from renewable sources by a certain year. This promotes the growth of renewable energy businesses.	The recast Renewable Energy Directive 2018/2001/EU established a new binding renewable energy target for the EU for 2030 of at least 32%, with a clause for a possible upwards revision by 2023.
CE Initiatives: Policies that promote a CE encourage businesses to design products that can be recycled or reused, reducing waste, and promoting sustainability.	EU Adopted Circular Economy Action Plan to promote sustainable consumption and reduce waste.
Green Public Procurement: Governments can lead by example by purchasing goods and services encouraging businesses to offer sustainable products.	EU guidelines for Green public procurement.
Pay-as-you-throw (PAYT): Waste management fees modulated based on the amount of mixed waste delivered to the waste management system.	PAYT schemes implemented in cities such as Treviso (Italy) encourages waste reduction and incentivizes recycling.
Food waste prevention: policies aiming at reducing food waste encourage businesses to optimize resources accordingly.	France implemented national policies against food waste in supermarkets (Mourad 2016); Italy implemented a law to reduce food waste and encourage donation of leftover food to charity (Gazetta Uficiale della Republica Italiana 2016).
Eco-labeling and Certification: Certifications for products and services that meet certain environmental standards. This helps consumers make informed choices and promotes green businesses.	EU Ecolabel [1] helps consumers make truly sustainable choices. EU energy labelling and ecodesign legislation helps improve the energy efficiency of products on the EU market [2].
Research and Development Grants: Grants to businesses and institutions researching and developing sustainable technologies.	LIFE and Horizon Europe projects.
Sustainable Diets promotion:	European 'farm to fork' initiative aims to ensure sustainable diets are affordable and accessible; proposed legislation to address food linked to deforestation.

[1] Regulation (EC) No 66/2010 of the European Parliament and of the Council of 25 November 2009 on the EU Ecolabel (Text with EEA relevance)
[2] https://commission.europa.eu/energy-climate-change-environment/standards-tools-and-labels/products-labelling-rules-and-requirements/energy-label-and-ecodesign/about_en#Energylabels

Policy	Sustainable BusinessStrategies
Promotion of Sustainable Agriculture: Policies that promote sustainable farming practices, such as organic farming, agroforestry, and permaculture, help in mitigating the impacts of climate change while also creating new business opportunities.	Danish Organic Action Plan led to increased provision of organic food in state-linked outlets (Sørensen et al. 2016).
Promotion urban access regulation: supporting low-carbon mobility behaviours and decreasing private car-use through urban policies.	Low/Zero emission zones or other access regulation
Green Infrastructure Investments: Governments invest in green infrastructure such as public transportation, energy-efficient buildings, and water conservation systems. This also creates business opportunities in the construction and maintenance of these infrastructures.	Next Generation EU funds to invest in green infrastructure like public transportation, green buildings, and water conservation projects.
Promotion of Eco-tourism: Governments are promoting eco-tourism, which emphasizes responsible travel to natural areas that conserves the environment and improves the well-being of local people. This creates sustainable business opportunities in the tourism sector.	COSME program (EU). Renowned for eco-tourism initiatives promoting sustainable travel and conservation of biodiversity.

Source: Own elaboration.

6 Circular Economy and Climate Change

To date most governments, have climate targets but not all of them have a CE agenda. Regarding businesses, most aim at reducing GHG emissions, and they incorporate some circular practices as soon as they identify their potential for GHG emissions reduction (Inèdit, 2023). Understanding the implications of CE in terms of climate change is crucial for businesses, policymakers, and stakeholders to address the transition towards a circular and low-carbon economy.

- **CE emphasizes the efficient use of resources.** By reducing the need for resource extraction and optimizing the utility of products and materials, CE strategies not only conserves resources but also diminish the energy-intensive processes associated with extraction, manufacturing, and waste management, leading to significant carbon savings. By designing products for longevity, repairability, and recyclability, the CE minimizes the need for frequent product replacement. This approach results in the conservation of resources and a reduction in waste, subsequently leading to decreased emissions over time. Diverting waste from landfills and incineration, through recycling, reduces direct GHG emissions from these disposal options.

- **Both CE and climate change mitigation necessitate a systemic approach that encompasses the entire value chain.** This comprehensive perspective ensures that solutions in one domain do not inadvertently cause issues in another, paving the way for genuinely sustainable results. By addressing various facets of the carbon challenge, such as promoting shared mobility to decrease the number of vehicles produced or emphasizing energy-efficient construction to cut city energy consumption, the CE can contribute to a broader systemic decarbonization.

- **CE increases the interest on local sourcing** and thus reduce climate change impacts associated with long transportation distance supplies of the linear and global economy. Moreover, it offers economic resilience against volatile commodity prices, which can be intensified by climate-induced supply chain disruptions.

- **CE principles applied to agriculture emphasize soil health, biodiversity, and water conservation.** Regenerative agriculture practices, such as cover cropping, agroforestry, and no-till farming, enhance carbon sequestration in soils, turning farmlands into carbon sinks (EMF, 2021). In this regard, is important to remark the potential of the urban environments to manage properly the organic waste generated by households and larger waste generators, such as restaurants, to converted into high quality compost to be used later in agriculture as fertilizers. This could close the circle of the organic nutrients while reducing the dependence on mineral fertilizers and the impacts associated with their production. A proper management of the organic waste prevents the landfilling of this matter and the GHG emissions associated to this practice.

- **The CE advocates for the use of renewable energy sources,** diminishing the dependence on fossil fuels. This shift not only conserves resources but also directly curtails CO_2 emissions. However, attention should be given to the material transition associated with the energy transition, going from fossil intensive technologies to clean technologies that are based on strategic critical materials whose circularity is still in its infancy (Gielen, Dolf; Papa, 2021; IEA, 2023a).

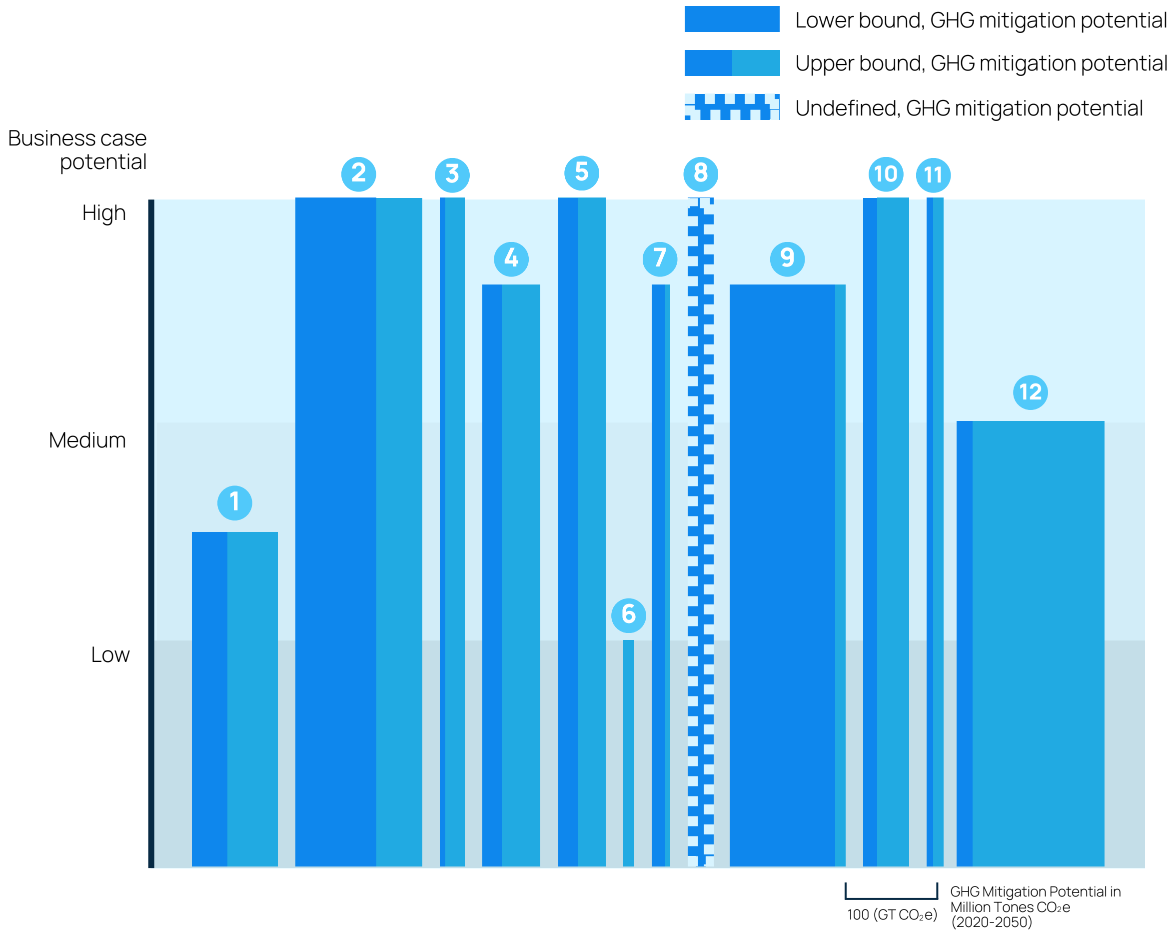
While the relationship between both concepts is theoretically clear, the potential of CE strategies to help reach climate goals at the country scale has been little explored to date (Serrano et al., 2021). However, some recent publications provide initial estimates. For example, Serrano et al. (2021) proposed a methodology to quantitatively assess the potential of CE strategies to reach national targets for climate change mitigation. The method pinpoints key emitting sectors and links those with relevant CE strategies with climate change mitigation potentials. They demonstrate the applicability of the methodology using the case of Chile. Within this country, a potential reduction of 37% of the national GHG emissions, relative to a BAU scenario, could thus be anticipated in 2030, if savings from CE implementation —mainly in the energy sector— were implemented. Hailemariam and Erdiaw-Kwasie (2023) found that progress towards a CE significantly improves environmental quality via reducing C02 emissions and that business strategies promoting recycling and CE practices play an important role in environmental sustainability by reducing emissions.

The 2021 Circularity Gap Report reveals that adopting CE practices could cut worldwide greenhouse gas emissions by 39% if applied across various industries and countries (Haigh et al., 2021). The report also highlights that a significant 70% of emissions originate from the extraction, processing, and management of materials, underscoring the urgency for intelligent resource management strategies. Beyond its primary goal of fostering a sustainable and equitable environment, the CE has the potential to offer additional advantages, including the enhancement of biodiversity and the generation of employment opportunities.

Circle Economy and Shifting Paradigms investigated how the CE could reduce GHG emissions in low- and middle-income countries and estimated the socio-economic and environmental co-benefits that circular mitigation interventions can bring (Hoodzaad et al., 2021). The study identifies the top ten circular interventions that could be most effective for countries where the Global Environment Facility (GEF) operates [3], assessing their commercial viability and potential for reducing greenhouse gas emissions, as illustrated in Figure 3. The interventions with the greatest potential for mitigating emissions include shifting dietary habits (intervention 12 in Figure 3), adopting regenerative agriculture and agroforestry practices (intervention 2), and fostering eco-innovation within industrial clusters and informal networks (intervention 9). Among these, regenerative agriculture and agroforestry not only promise significant emission reductions but also present a strong case for business profitability. Eco-innovation ranks next in terms of commercial prospects, while dietary changes are seen to have moderate potential for business success.

[3] Recipients of GEF support are developing countries and countries with economies in transition.

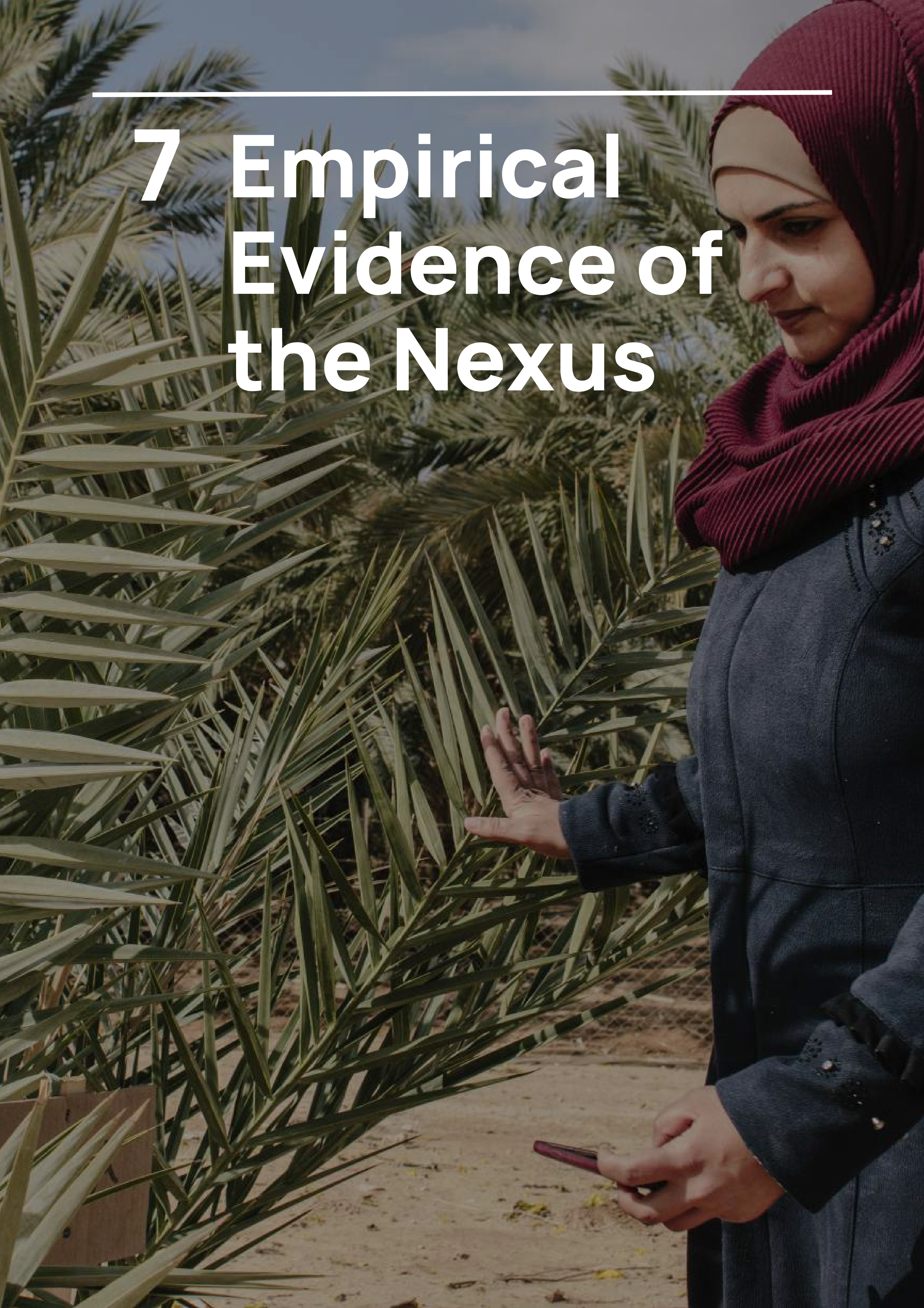
Figure 3: Business case and GHG mitigation potential of the 10 most promising circular intervention for GEF countries of operation.



1. Improved livestock management: Reduce emissions from livestock through productivity improvements, improve manure management and introduce anaerobic digestion of manure.
2. Regenerative crop production and agroforestry: Invest in cropland management practices that regenerate soil health, and increase biodiversity and carbon sequestration, including the use of agroforestry and mixed cropping.
3. Bioeconomy and bio-based materials: Scale the mechanical and chemical processing of agricultural and forest residues to produce bio-based construction materials (and other industries).
4. Reducing food losses from harvest to processing: Enhance harvest methods and timing, and improve the capacity to safely store, transport and process food products.
5. Reducing food waste at the retailer and consumer stages: Reduce food waste through improved inventory management, the development of secondary markets for imperfect food products or products near their expiry date and improved value-chain management.
6. Closing the loop on urban organic residues: Recover and separate organic residues from urban solid waste and wastewater for composting, biogas production, water and nutrient recovery to support urban and peri-urban farming.
7. Redesign, reuse, repair, remanufacture of products and recycling of glass, paper, metals and plastics: Enhance the collection, sorting and processing of materials and recyclables, diverting waste from landfills and incineration to increase the availability of secondary resources.
8. Making the renewable energy transition circular: Implement a life-cycle approach to renewable energy generation and storage capacity through design for disassembly, improved repairability, circular business models and the use of recycled materials.
9. Eco-innovation in industrial clusters and informal networks: Apply industrial symbiosis approaches to industrial parks and create formal and informal networks to encourage the use of secondary resources across industries.
10. Circular design in construction: Design buildings for improved energy efficiency and minimise waste in the construction process by applying passive design, and modular and offsite construction.
11. Non-motorised and shared transport: Prioritise non-motorised transport, vehicle sharing and public transport in urban development.
12. Shifting to healthier and more sustainable diets: Shift to healthy diets that bridge the nutrition gap for lower-income brackets, while curbing meat consumption by diversifying diets to include more plant or insect-based protein.

Source: (Hoodzaad et al., 2021)

7 Empirical Evidence of the Nexus



The empirical evidence linking CE, climate change and sustainable business models is gathered in the literature in the form of case studies, surveys and industry reports, pilot projects to test circular practices, etc. Through the reviewed articles, some quantitative estimates on tangible benefits of sustainable and circular business models in terms of CCM potential were found (see Table 4). Moreover, it was possible to identify three main drivers, namely:

- **Policy and Regulation aligned with CE and CCM:** Most of the reviewed studies revolves around the fundamental role of policies and regulation aligned with CE principles to establish the essential infrastructure for the transition towards CE (Brunnhofer et al., 2020; Khalifa et al., 2022; Khanna et al., 2022; Majeed and Luni, 2020; Niwalkar et al., 2023; Ozili, 2021; Towa et al., 2021). In the context of the biorefinery industry, for instance, it has been observed that a regulatory risk exists due to the fragmented and inconsistent nature of current policies and regulations, which consequently place bio-based products in less favourable positions compared to fossil-based products (Brunnhofer et al., 2020). Fossil fuel subsidies exacerbate the situation.

- **Funding the transition to CE,** using traditional financing mechanisms, is proving critical. Ozili (2021) identifies several financial risks associated with the CE that could impact banks and other financial institutions, if not properly managed, such as : (i) not all waste being recyclable, which means a 100% CE cannot be achieved; (ii) the high cost of recovering waste; (iii) the excessive technological and engineering lenses used by CE practitioners; (iv) the reduction of production and consumption of new resources and new goods; (v) the strong need for public subsidies and i government support; (vi) the low return on investments due to hidden risks, considered inherent in circular models. On the other side, the banking sector can also have financial benefits from the CE transition, for example: (i) greater loan diversification opportunities, (ii) promoting responsible banking and sustainable banking, (iii) increased lending to circular clients and the recycling sector which means more profit for banks, and (iv) correcting the bad perception about banks in society. Some benefits of the CE to other financial institutions include the following: (i) issuance of special insurance policies for reused product; (ii) greater sustainability-adjusted return on investment; (iii) greater funding to microfinance institutions; and (iv) more opportunities for collaborative funding to circular businesses.

- **Supply chain problems:** The exponential demand for materials driven by different sectors, such as the renewable energy sector, may trigger supply chain problems. Circular economy business models could help to reduce the dependence of this sectors from virgin material consumption. For instance, cooper, ranking as the third most produced metal globally after iron and aluminium, holds significant importance in both traditional sectors like construction and infrastructure, as well as emerging technologies such as wind generators and solar photovoltaics. As the need for copper continues to rise, exploring sustainable approaches becomes imperative. Ciacci et al. (2020) delves into the future of copper demand, recycling practices, and their implications for greenhouse gas emissions in the EU-28. The findings underscore the potential environmental challenges, particularly a significant emissions gap, associated with current consumption patterns. However, they also highlight promising scenarios, particularly one emphasizing green technology and more equitable lifestyles, which could pave the way for a CE with the capacity to preserve natural capital and address climate change. This envisioned future, as suggested by Ciacci et al., (2020), calls for transformative changes in our current material production and consumption patterns.

As can be seen in Table 4, the quantitative estimates found in the reviewed articles encompasses practices in different sectors. Special attention has been given to three cases due to the relevance and particularity of their sectors: 1) circular renewable energy (described in subsection 7.1), 2) digitalized building sector (described in subsection 7.2) and 3) shared mobility (described in subsection 7.3).

Table 4: Estimations on CCM potentials in the 43 articles shortlisted

Sector	Sub-field	Description	Geographical scope	CMM Potential	Reference
Agriculture	Closed loop	Pork production	Spain	-11%	(Cantzler et al., 2020)
	Waste-to-energy	Landfil biogas recovery	Spain	-2,68 kg CO2-eq per functional unit	
		Cassava pulp for ethanol production	Thailand	-85%	
		Co-digestion of cow dung	India	-13%	
	Recycling	Phosphorus from sewage sludge and compost	Austria	-28%	
	Efficiency	Least-emitting producers of beef and lanmb	NA	-15-31%	
	Regenerative agriculture	Regenerative annual cropping with intensification	NA	-15 to 22 billion tonnes CO2	(Hoodzaad et al., 2021)
		Nutrient management	NA	-2 to 12 billion tonnes CO2	
		Perennial staple crops	NA	-15 to 31 billion tonnes CO2	
		Abandoned farmland restoration	NA	-12 to 20 billion tonnes CO2	
		Silvopasture	NA	-27 to 42 billion tonnes CO2	(Hoodzaad et al., 2021)
		Multistrata agroforestry	NA	-11 to 20 billion tonnes CO2	
		Tree intercropping	NA	-15 to 24 billion tonnes CO2	
		Indigenous peoples' forest tenure	NA	-9 to 13 billion tonnes CO2	
		Improved rice production	NA	-9 to 14 billion tonnes CO2	
		Biohar	NA	-37,8%	(Patel and Panwar, 2023)
Livestock	Sustainable management	Livestock management	NA	-6 to 72 billion tonnes of CO2	(Hoodzaad et al., 2021)
		Managed grazing	NA	-16 to 26 billion tonnes of CO2	
		Small-scale anaerobic digesters for manure	NA	-1,9 billion tonnes of CO2	
	Bio-digesters	17.000 biodigesters for manure	Kenya	-365.200 tonnes of CO2	

Sector	Sub-field	Description	Geographical scope	CMM Potential	Reference
Diet	Sustainable diet	Plant-based foods, low amounts of animal source foods, more unsaturated than saturated fats and limited amounts of refined grains, highly processed foods and added sugars.	NA	-15 to -166 billion tonnes of CO2	(Hoodzaad et al., 2021)
Industry	Recycling	Iron & concrete	NA	-60 to 90%	(Cantzler et al., 2020)
Industry	Eco-innovation	Collaborating to create joint value	NA	-97 to -108 billion tonnes of CO2	(Hoodzaad et al., 2021)
Industry	Circulating raw materials	Circulating steel and getting more value from the steel we use	NA	-1 billion tonnes of CO2	(EMF, 2021)
Raw materials	Bio-based materials	Alternative materials, especially plastics, derived from waste streams or sustainable sources	NA	-5.6 to -22.5 billion tonnes of CO2	(Hoodzaad et al., 2021)
Electricity	Recycling and reuse	Renewable energy technologies	NA	-60%	(Cantzler et al., 2020)
Transportation	Substitution	Alternative fuels	NA	-60 to -70%	(Cantzler et al., 2020)
Transportation	Road infrastructure	Green procurement	NA	-50%	(Cantzler et al., 2020)
Transportation	Repurpose	Lithium-Ion batteries	Germany	-10% to -22%	(Schulz-Mönninghoff et al., 2021)
Transportation	Non-motorised and shared transport	Walkable cities, cycling infrastructure, public transit, and carpooling	NA	-19 to 40 billion tonnes CO2	(Hoodzaad et al., 2021)
Clothing	Product/ service system (PSS)	Wool T-shirts as an alternative to synthetic t-shirts using PSS	UK	-60%	(Bech et al., 2020)
Buildings	Reuse	Concrete structures	NA	-10% to -60%	(Cantzler et al., 2020)
Buildings	Substitution	Timber	NA	-40% to -60%	(Cantzler et al., 2020)
Buildings	Use	Intensified use of buildings	NA	-50%	(Cantzler et al., 2020)
Buildings	Bio-based materials	Bamboo as a regenerative construction material	Indonesia	-0.1 tonnes CO2 per capita, per year	(Hoodzaad et al., 2021)
Buildings	Circular design	Passive house design	NA	-27 to -32 billion tonnes of CO2	(Hoodzaad et al., 2021)
Buildings	Circular design	Green and cool roof	NA	-0,6 to 1.1 billion tonnes of CO2	(Hoodzaad et al., 2021)
Buildings	Circular design	ColdHubs	Nigeria	-462 billion tonnes of CO2	(Hoodzaad et al., 2021)

Sector	Sub-field	Description	Geographical scope	CMM Potential	Reference
Waste management	1% increase in the recycling rate of municipal waste		Europe	-0.02% to -0.4%	(Hailemariam and Erdiaw-Kwasie, 2023)
	Composting, anaerobic digestion, wastewater reuse and wastewater nutrient recovery from Urban organic residues		NA	-1.5 to -2.2 billion tonnes of CO2	(Hoodzaad et al., 2021)
	Reuse, remanufacturing, and repair		NA	-5 to -6 billion tonnes of CO2	
Food loss and waste	Eliminating waste in the food industry		NA	-1.4 billion tonnes by 2050	(EMF, 2021)
	Preserving and extending life food	Using hermetic bags, metal silos or gum Arabic coating that prevents ripening	Asia, North Africa, Wet and Central Africa, Latin America, South and Southest Asia and Sub-Saharan Africa	-9 to -51 billion tonnes of CO2	(Hoodzaad et al., 2021)
	Collaborating to create a joint value	Improving packaging, coatings and incorporating digital technology		-5.7 to -32 billion tonnes of CO2	
		Mobile app connecting HORECA sector with food leftover with consumers willing to order fresh food at a reduced price	Middle East and North Africa	-9.5 tonnes of CO2	
General	Ambitious CE scenarios		NA	-8.2% to -34%	(Aguilar-Hernandez et al., 2021)
	Reuse, repair		Belgium	-0.91%	(Towa et al., 2021)
	Use intensification		Belgium	-0.84%	
	Sharing		Belgium	-0.47%	
	Design improvement		Belgium	-0.33%	
	Shifting from product sales to leasing with take-back		Kenya	-12% to -70%	(Mukoro et al., 2022)

Source: Own elaboration.

7.1 Circular renewable energy

As the world's economies strive to achieve climate neutrality and move away from fossil fuel energy sector, addressing the material intensity of the renewable energy sector is essential. While renewable energy is pivotal in mitigating climate change, it must not exacerbate environmental and socio-economic impacts related to the extraction of virgin materials.

Hutchings et al. (2023) developed a comprehensive action plan for industry, policy makers and investors to align the renewable energy sector with CE principles. This plan is based on three main levers:

1. Circulate equipment and materials
2. Rethink business models
3. Rething materials choices

The circular transition of this strategic sector is crucial to avoid environmental problem shifts often seen in the linear economy.

It is crucial that the materials used in new renewable energy infrastructures are recoverable at the end of their operational life. For existing infrastructure, it is vital to prolong the life of current assets by maximizing their lifespans. According to Federzoni (2023), more than 50% of the photovoltaics (PV) panels dispose in Europe can be repair to be reused and most of them are retired after 10 years of used while still have 15 year of lifetime left. Thus, there is a huge potential to prolonging the lifespans of PV panels.

In Saint-Loubès, near Bordeaux, ENVIE and Soren launched a social business model in 2022, focusing on the preparation for reuse and recycling of solar panels using innovative approaches for both processes. The preparation for reuse line includes a rigorous testing process that second-hand PV panels must pass before being sold. Envie 2E Aquitaine aims to resell 5% of the 4,000 tons of solar panels it processes annually. This resale approach is five times more profitable than selling secondary materials obtained through recycling. They also employ an advanced recycling technique that allows them to recover 95% of the PV materials. The social dimension of the partnership is led by the social enterprise ENVIE, which works to create employment opportunities for long-term unemployed individuals, particularly women, through refurbishing and selling used goods (RREUSE, 2022).

To estimate the climate change mitigation potential of this business model, a detailed carbon footprint estimation is necessary. However, some estimates can be done using average assumptions. It could be assumed that for each new PV panel displaced by a 2nd-hand PV panel, approximately 40 kg of CO2 equivalent are avoided [4]. Additionally, using second-hand PV panels instead of new ones avoids the extraction of raw materials.

Alternatively, it could be considered that the 10,000 panels prepared for reuse annually [5] generate 4 MW of solar energy per year[6], they displace the equivalent electricity mix generation and its associated carbon footprint.

[4] Here it is assumed that the carbon footprint of an average PV panel (of around 20Kg) is about 40 kg CO2, based on https://www.solar.com/learn/what-is-the-carbon-footprint-of-solar-panels and https://www.renewableenergyhub.co.uk/main/solar-panels
[5] 5% of the 4000 tons of panels treated annually, with an average weight of 20 kg.
[6] Assuming that each panel has a capacity of 400 W and a performance rate of 80%.

In addition, there are the avoided GHG emissions related to the recycling part. These depend on the recycling technology used and the amount and quality of the materials recovered. The technology, provided by ROSI, enables the plant to recover 99% of the silicon and 95% of the silver (EIT Raw Materials, 2021). Assuming each panel contains about 1.4 kg of silicon and 0.2 g of silver, the plant can recover approximately 5,580 tons of silicon and 0.8 tons of silver annually. This avoids emissions associated with extracting these virgin raw materials, which are 1.8 kg CO_2e/kg for silicon and 1,200 kg CO_2e/kg for silver, according to IEA PVPS (2020). Additionally, there are avoided emissions related to recycling of other fractions such as glass, aluminium, and copper, also recovered in the process, as well as the avoided emissions from landfilling or incinerating these resources."

7.2 Construction sector

The construction sector accounts for about 40% of global greenhouse gas emissions, 50% of global material extraction, and 37.5% of total waste generation in the EU.
(Bron et al., 2022)

These figures are expected to increase as the demand for new buildings and infrastructure grows due to population growth, urbanization, and economic development. However, the current linear model of construction, based on the take-make-consume-dispose paradigm, is not sustainable in the long term. It depletes natural resources, generates large amounts of waste, and contributes to climate change and biodiversity loss.

Additionally, the conventional construction industry has lagged in its evolution compared to other sectors like manufacturing, commerce, or transportation. Consequently, its productivity growth has been significantly slower than in other economic areas (011h, 2023a). Construction projects tend to be distinct and one-of-a-kind, characterized by their complexity, slow progress, and high maintenance demands. This leads to inefficiencies, substantial financial discrepancies, and notable deviations in project timelines. Moreover, these conventional construction practices often overlook critical considerations regarding environmental impact (011h, 2023a; Inèdit, 2023).

By applying CE principles, such as reducing, reusing, and recycling materials, the construction sector can reduce its environmental footprint, enhance its resource efficiency, and create new business opportunities and social benefits. This is especially important for regions with large demand of new buildings due to rapid population growth (Bron et al., 2022).

Most emissions associated with buildings result from their operations (mainly heating and cooling), but the embedded emissions in building materials still account for 28% of construction-related emissions (Bron et al., 2022). According (Bron et al., 2022), the circularity of the construction sector in Europe could increase from 30% (2020) to 50% by 2040 applying different measures such:

- **Extending the lifespan and sustainability of existing buildings by upgrading them with energy-efficient technologies and materials.**
- **Using less material and more innovative designs to reduce the weight and volume of buildings and their components.**

- **Sourcing materials from renewable or recycled sources, such as wood, bio-based plastics, or green steel and cement.**
- **Designing buildings and components that can be easily taken apart and reused or recycled at the end of their lives, rather than demolished and landfilled.**

Moreover, for a more circular construction industry there should be collaboration across the value chain. the required exchange of information that requires this collaboration can be facilitated by digitalization. In fact, this applies in all type of sectors for their transition towards circularity. For example, (Hutchings et al., 2023) mention this collaboration as key leverage for the circularity of renewable energy.

The digitalization of the entire building process is the core of the business model developed by 011h, a technology company dedicated to construction based in Barcelona and founded in 2020. 011h proposes a construction model using digital technology to connect and streamline the entire process and stakeholders, , while also incorporating sustainable materials and design principles.

011h reduces the CO2 emissions applying:

1. Passive design
2. Materials such as wood, with a very low embedded carbon impact
3. Circular-economy principles in the design criteria of the system of components
4. Automatization of the calculation of CO2 emissions from very early stages to maximise efficacy in decision making in the project
5. Energy efficiency of the installations
6. Use of primary energy from renewable source (011h, 2023a).

011h first building was Habitat Hospitalet, a building with 8 housing units in collaboration with Renta Corporación, reducing construction time by 35% and CO2 emissions by 90%. Currently, a development of 51 housing units for AEDAS Homes is being finalized, and another one consisting of 56 social rental housing units has been initiated in Barcelona by IMHAB (011h, 2023b).

7.3 Sustainable mobility

Private cars and vans were responsible for more than 25% of global oil use and around 10% of global energy-related CO2emissions in 2022 (IEA, 2023b). The urban transport within many cities is responsible for air pollution at levels which far exceed those considered safe by the World Health Organization (Hoodzaad et al., 2021).

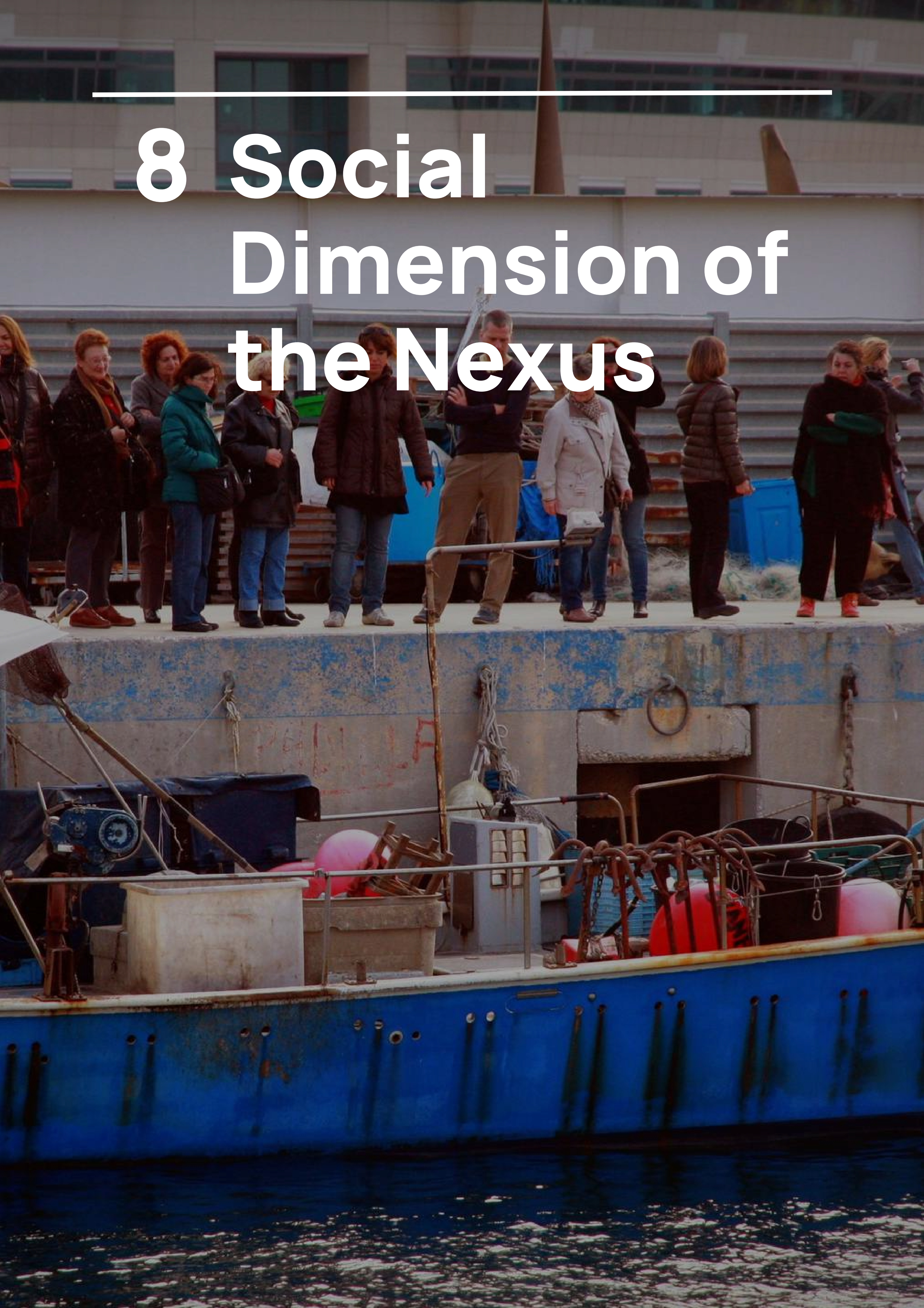
Intervention towards more sustainable mobility includes promoting and creating infrastructure to incentivize walking, cycling, and the utilization of public transport (Hoodzaad et al., 2021). Carsharing services can also potentially lead to a reduction in the number of cars in cities due to their potential in replacing privately owned vehicles in well-designed transportation systems (Shams Esfandabadi and Ranjbari, 2023).

The International Resource Panel estimates that if 25% of drivers shift to car-sharing, GHG emissions could be reduced by 10%. Shifting 25% of trips to shared rides would reduce emissions by 20% (Hoodzaad et al., 2021). However, although carsharing services are expected to lead to a reduction in negative environmental impacts through more intensive vehicle utilization and lowering the need for new vehicles, the 'rebound effect' resulting from the activities of these services should not be neglected (Shams Esfandabadi and Ranjbari, 2023).

In this regard, Som Mobilitat is a non-profit community-driven cooperative working since 2016 to build a smooth, effective electric car-sharing service in Catalonia. Organized into local groups, Som Mobilitat emphasizes a commitment to walking, cycling, and public transport and offers shared electric vehicles for routes without alternative options. It currently has 37 local networks, 3,494 members and a fleet of 50 vehicles. The fleet includes vehicles owned by the cooperative or individuals, enterprises, and public institutions (p2p). Access to these vehicles is facilitated through a digital platform, utilizing a web app. Over the period from 2021 to 2023, the kilometres covered through the Som Mobilitat service have contributed to a reduction of 516 tons of CO_2 emissions (Som Mobilitat SCCL, 2023). Som Mobilitat is also working to incorporate new sustainable mobility services into the platform, such as bike-sharing, motorbike-sharing, car-pooling, and ridesharing. Their future aim is set on the autonomous vehicle as a shared resource.

Additionally, as part of the European network REScoop Mobility, Som Mobilitat collaborate with other sustainable mobility cooperatives to address global mobility challenges and establish a successful social model as an alternative to profit-driven private mobility initiatives across Europe. This effort is conducted under the umbrella of the REScoop.eu cooperative federation.

8 Social Dimension of the Nexus



In previous sections, the strategies of CE that companies could consider applying for their circular transition have been examined, as well as difficulties faced by industry to become more circular and the fundamental role of politics in creating the conditions to support such transition. However, as suggested throughout the report, this transition should also be socially accepted and inclusive for all. In this regard, the following section presents the social dimension of the nexus between the CE, SBM and CCM. Firstly, it introduces the concept of "social acceptance", emphasizing the importance of considering public perspectives, involving citizens in decision-making processes, and establishing political legitimacy for the implementation of effective CE practices. Secondly, it presents the conceptual framework of "Just Transition to a CE," which emphasizes not only environmental sustainability but also social justice.

8.1 Social acceptance

The framing of the CE, particularly from the European Union's viewpoint, has predominantly emphasized business interests while disregarding aspects related to lifestyle and well-being of citizens. Furthermore, the discourse tends to overlook the pivotal question of how resource extraction, importation, manufacturing, and employment conditions may exacerbate social tensions and relocate problems from one region to another, and from urban to rural areas, both within Europe and globally. The European Union's policy approach lacks a comprehensive understanding of these dynamics and its social consequences (Hot or Cool Institute, 2023).

When discussing sustainable lifestyles, there is a common misconception that it merely entails "changing one's behaviour", suggesting that individuals should exclusively opt for environmentally friendly products. However, this oversimplified notion does not capture the full complexity of the matter. The context in which decisions and choices are made plays a pivotal role, as consumers often lack significant control over the choice architecture and the available options. The same occurs from a production perspective. Understanding this context is crucial to increase the market share of circular business models.

According to "The Attitude Facilitator Infrastructure Framework", developed by the Hot or Cool Institute, the implementation/adoption of circular economic policies need attitudes (i.e., beliefs and perspective), facilitators that bridge de gap between attitudes and tangible actions, and infrastructure. Using waste management as an example, on the one hand, there are individuals and businesses showing a willingness to participate in recycling. However, in the absence of well-defined recycling policies, improved recycling standards, accessible recycling facilities, and cost-effective recycling methods, the essential facilitators and infrastructure for effective recycling are missing.

The effectiveness of these three determinants hinges on the political legitimacy to establish public trust and widespread acceptance. When policies enjoy the support and approval of citizens, their likelihood of successful implementation increases significantly. Engaging methodologies such as citizens' assemblies, polling, and citizen panels, as well as the involvement of consumer groups, present deliberate means for amplifying the voices of citizens (Hot or Cool Institute, 2023).

It is crucial to recognize that without legitimacy and active citizen participation, a CE initiative may falter, and risk being perceived as an unsuccessful experiment within a democratic system. In essence, legitimacy is vital to ensure that CE practices are not only ecologically effective but also socially and politically viable (Hot or Cool Institute, 2023).

8.2 Just transition

A Just Transition to a CE ensures that this shift is not only environmentally sustainable but also socially just. Furthermore, the success of a transition towards a sustainable CE does not merely depend on the development of new technologies but also in the reconfiguration of the governance of productive processes into more democratic and participatory mechanisms of designing and managing technology (Just2CE, 2023a).

As industries adapt in response to CE strategies and climate change mitigation measures, there is a potential for job displacement from traditional sectors to emerging ones. This activity shift can either exacerbate or alleviate economic disparities. For instance, while new job opportunities can uplift lower-income groups, the transition can also lead to job losses in traditional sectors.

People are essential for driving CE interventions since skilled workforce is necessary for it, but to make this change beneficial for workers and environment, it is important to aim towards jobs that benefit the environment but also that improve the workers conditions. While the circular economy might create 'green jobs,' their quality is not always assured, and this should be a priority for a just transition. Attention should be placed on the Global South, since activities such as waste collection are often labour-intensive and deemed low-quality (Circle Economy et al., 2023).

Moreover, the current systematic ways of approaching production processes lack gender differences considerations within the organization, but also at the consumer end. For a just transition, gender justice principles should be considered. CE has the potential to promote gender justice, yet it has not actively pursued this goal. Achieving this would require a broader transformation, redefining the value produced in CE to encompass both paid and unpaid work (Just2CE, 2023c).

Failing to adopt a gender perspective in circularity-related policies can result in a CE generating or perpetuating inequalities, including women’s heightened exposure to unsustainable work conditions and waste-related hazards, among others challenges (Albaladejo et al., 2022). Women are often more vulnerable to the impacts of climate change due to their roles in agriculture, water collection, and household responsibilities.

Just CE policies should warrantee that women have equal access to resources, such as land and education, and job opportunities. The CE’s emphasis on local and shared resources can help bridge gender gaps which can directly benefit women. Women’s involvement in decision-making processes related to climate-positive and sustainable business models is essential. Their unique perspectives and experiences can lead to more holistic and effective solutions than traditional ones. However, gender justice in CE does not merely involve including women in value-oriented processes but pivots on making CE care-oriented. For true gender justice, the CE must aim at closing the loop between productive (i.e. valued) and reproductive (i.e.

devalued) work (Just2CE, 2023c). According to the work done within the JUST2CE project adopting a Feminist Ecological Economics (FEE) perspective, a gender-just CE would recognize the unpaid services provided in households, communities, and nature to sustain human life (Just2CE, 2023c). The same project deliverable (D1.3) emphasizes the importance of redefining value to include social and environmental care. Most CE projects have focused on "how" to produce circularly but not on "what" or "how much" to produce. The "what" question relates to issues of democracy, participation, gender, and global justice that are in turn connected to the capacity of any society to reflect on what kind of technological futures its members desire (Just2CE, 2023).

To ensure that everybody benefit from this transformation, the key aspects shown in Figure 4 are mandatory.

Figure 4: Aspects to consider for a just circular economy transition.

Protecting Workers

- Ensuring that workers in traditional sectors receive the training, support, and opportunities they need to thrive in emerging sectors.
- Ensure fair and safe working conditions.

Gender Responsive

- Women's involvement in decision-making processes.
- Ensure Women's access to resources and opportunities.

Community Engagement

- Addresses local needs, creates opportunities, and does not exacerbate existing inequalities.
- Reflect on what kind of technological futures local community desire.

Economic Diversification

- Diversifying economies to include green industries, sustainable agriculture, and renewable energy can provide new opportunities from communities, especially those historically reliant on unsustainable industries.

Community protection

- Prioritize the protection of marginalized communities that are often more vulnerable to the impacts of climate change, due to their geographical locations, socioeconomic status, and limited access to resources.

Resource Access

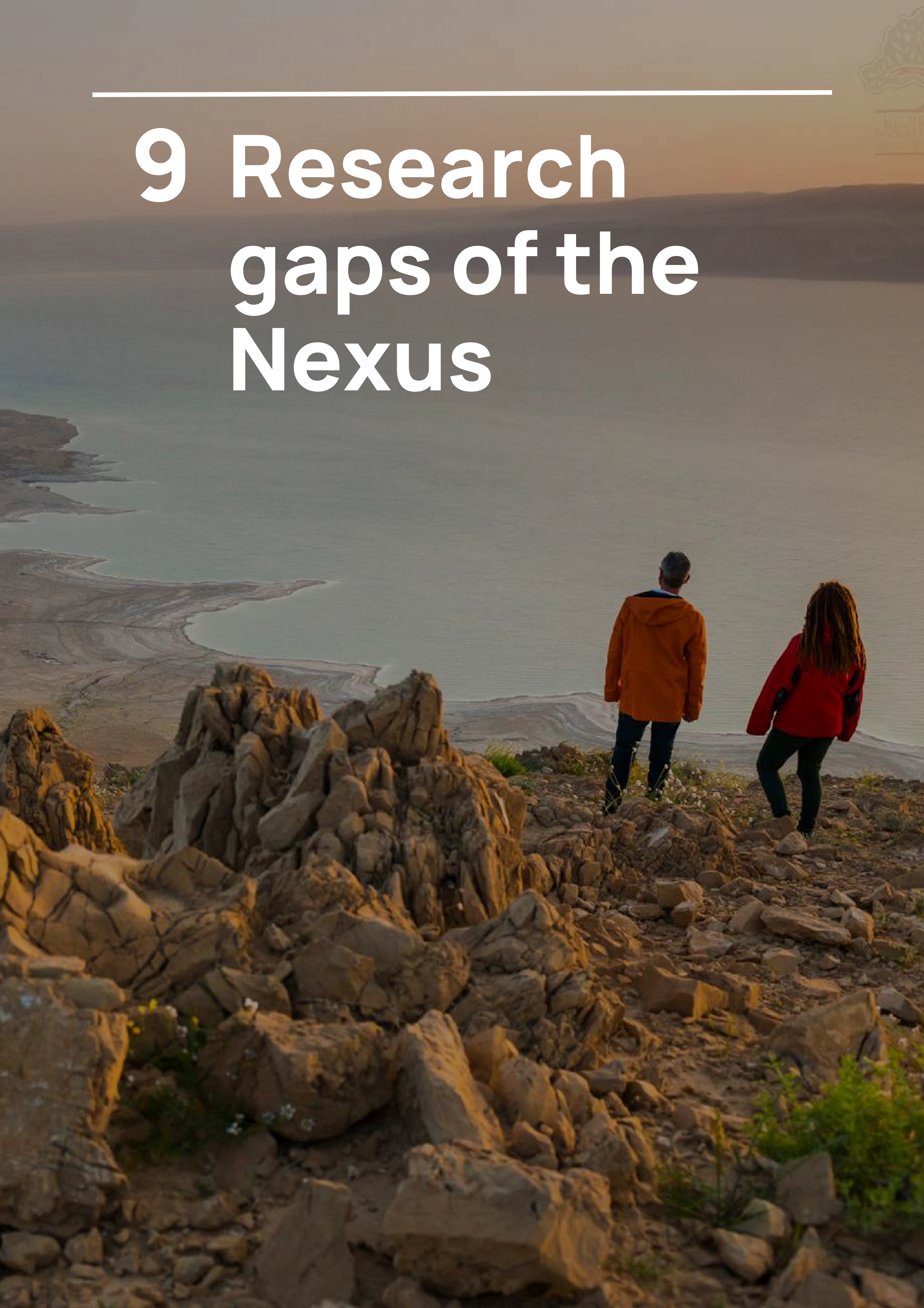
- Ensuring that job opportunities arising in the CE transition are accessible to all.
- Democratize access to resources, promoting equity.
- Ensuring that circular solutions are also affordable and accessible to all.

Consumer Behaviour

- Promote equitable sustainable consumption across society.

Source: Own elaboration.

9 Research gaps of the Nexus



The nexus between the CE, SBM and CCM is a growing area of research. While significant strides have been made in understanding their interplay, several research gaps persist.

- **Understanding behavioural aspects in demand and supply side is pivotal to harness the impacts of the nexus.** From one side, there is a need to delve deeper into consumer behaviour, understanding their perceptions, preferences, and willingness to engage with businesses adopting circular models. On the other side, while many sustainable business models are theoretically sound, there are barriers to their widespread adoption. Understanding these barriers, whether they are financial, cultural, technological, or regulatory, is pivotal for the adoption of CE practices by businesses that aim at becoming climate positive. Moreover, the adoption and success of circular business models can vary based on cultural and regional factors. Comparative studies across different cultural and geographic contexts are missing in literature. Identifying these nuances is crucial for effective policy design and business strategy.

- **While the qualitative benefits of integrating CE principles into business models are recognized, there is a need for standardized quantitative metrics to measure their impact on climate change mitigation** and to communicate such impact in a rigorous manner (avoiding greenwashing) (Khanna et al., 2022). The adoption by the industry of the Product Environmental Footprint methods developed by the EC is still nascent (Joint Research Center, 2021). Moreover, comprehensive life cycle inventories to benchmark new products and services to estimate impacts of business models and circular practices, are limited.

- **While most studies focus on the short-term benefits of adopting circular practices, studies assessing the long-term viability and resilience of such business models are limited.** Moreover, some sustainable business models might offer short-term climate change mitigation benefits, their long-term sustainability and impact are not always clear.

- **Research on how policy and regulatory frameworks can be optimized to support the nexus is still emerging.** While some policies support either the CE or SBM or climate change mitigation, research on integrated policy frameworks that address the three concepts simultaneously is sparse. The interaction between climate change policies with other policies (e.g., economic, trade, social) and the combined impact on sustainable business models is a complex area that needs more exploration.

- **Most of the innovation carried out to date has been centred on technology.** While technology is seen as an enabler of the CE, research on how to design, adopt and manage such technologies is disregarded (Potting et al., 2017).

- **Holistic research approaches that bridge disciplines** like economics, environmental science, sociology are still evolving.

10 Conclusions

This working paper has explored the transformative potential of the Circular Economy (CE) and Sustainable Business Models (SBM) to address climate change mitigation, with a particular focus on the Mediterranean region.

The analysis into key domains where climate-positive business models can have a substantial impact revealed that sectors such as food, construction, energy, and mobility in the Mediterranean region should be prioritised. By adopting circular principles, these sectors could reduce their carbon footprint. However, the challenges in the adoption of circular business models, particularly for Small and Medium Enterprises (SMEs), identified in the work should be addressed.

SMEs' little leeway for circular transition resource allocation should be harnessed due to its importance within the economy. As mentioned by Lewis Akenji, SMEs constitute "the social fabric of cities and towns represent the real economy" (Hot or Cool Institute, 2023).

Within the legislative process, the "Attitude Facilitator Infrastructure Framework" could be useful as a tool to ensure public acceptance and engagement of the proposed measures. Otherwise, positive impacts from legislation could be smaller than expected.

The CE strategies involving an effective Extended Producer Responsibility scheme, shifting from a product-oriented business model to a use-oriented model, providing functionality and services rather than selling products seem to be the most impactful ones. However, distributional effects of such models should be carefully addressed since they could lead to concentration product's ownership. The analysis highlighted the importance of innovating not only in the technology but also in the business strategy/structure. Legislation and public funding should move towards these directions.

As for private investments CE offers financial benefits such as diversification opportunities, responsible banking promotion, increased lending to circular clients, and enhanced perception of banks. SMEs, however, face the greatest funding challenges as banks and insurers perceive higher risks in supporting them in comparison to large companies or startups.

As illustrated in the report, CE has not only a decarbonisation potential, but it can also play a regenerative role by restoring natural systems and enhancing biodiversity. This aspect is particularly crucial for the Mediterranean region, which faces unique challenges such as water scarcity, energy insecurity, and environmental degradation.

The report highlighted the need for policies that not only promote circularity and climate mitigation but also ensure social equity. The intersection between SBMs, Just Transition to Circular Economy can mitigate climate change while delivering social value and cohesion. This holistic approach is essential for sustainable development, particularly in the Mediterranean region where social and economic disparities are pronounced.

In conclusion, this report underscores that the Circular Economy (CE) and Sustainable Business Models (SBM) are not merely theoretical constructs but solutions that can contribute to mitigate climate change. However, the transition to these models is accompanied by significant challenges, particularly for Small and Medium Enterprises (SMEs). To realize the full potential of CE and SBM, policymakers, businesses, and communities must collaborate to embrace circular and just strategies that mitigate climate change.

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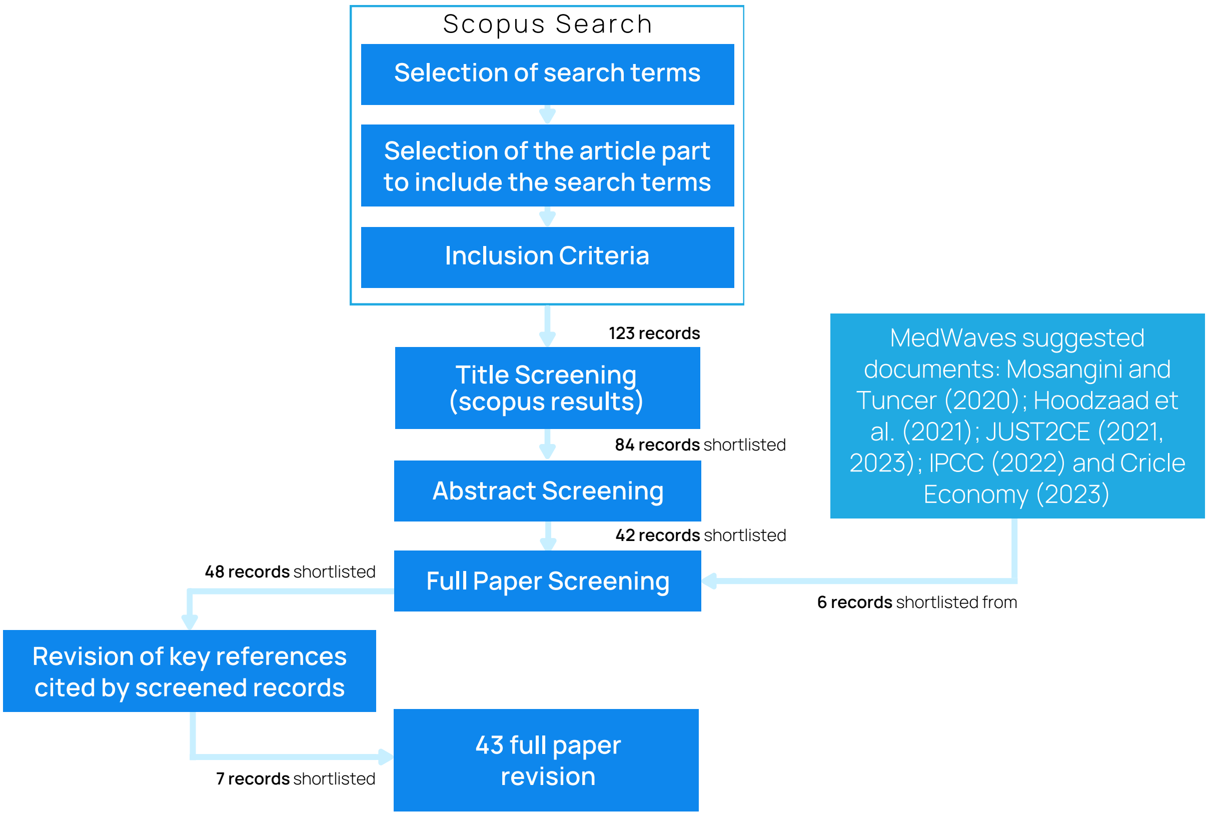
Annex 1: Details of the systematic literature review

Figure 5 provides an overview of the screening process employed for the systematic literature review to identify empirical evidence of the CCM potential associated with the adoption of CE strategies and/or circular business models.

Using the abovementioned search criteria, a considerable number of records were obtained from Scopus. Following a thorough screening of titles and abstracts, records meeting the project's relevance criteria were identified. However, access was limited to a subset of these shortlisted records. Furthermore, additional records previously known to the authors were integrated into the review process after the initial screening.

These records underwent download, and their full texts were meticulously screened. Subsequently, pivotal references emerged from this scrutiny, earmarked for inclusion in the comprehensive paper revision phase. Ultimately, a substantial collection of articles was included in the exhaustive paper revision phase.

Figure 5: Overview of the screening process used to carry out the systematic literature review.



Source: Own elaboration.

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