Circular Economy Strategy Luxembourg

Strategie Kreeslafwirtschaft Lëtzebuerg

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ABBREVIATIONS AND ACRONYMS

ABP	Administration des Bâtiments Publics
AEV	Administration de l'Environnement
AGE	Administration de la Gestion de l'Eau
ANF	Administration de la Nature et des Forêts
ASTA	Administration des Services Techniques de l'Agriculture
B2B / 2C	Business to Business / to Consumer
BIM	Building Information Modelling
CE	Circular Economy
CELL	Centre for Ecological Learning Luxembourg
CFUE	Cellule de facilitation urbanisme et environnement
CIGL	Centre d'Initiative et de Gestion Local
CNFPC	Centre National de Formation Professionnelle Continue
CRTI-B	Centre de Ressources des Technologies et de l'Innovation pour le Bâtiment
CSDD	Conseil Supérieur pour un Développement Durable
EBL	Emweltberodung Lëtzebuerg
EIB	European Investment Bank
EPR	Extended Producer Responsibility
EU	European Union

FUAK	Fonds d'urbanisation et d'aménagement du Kirchberg
GSEC	Groupe Stratégique pour l'Économie Circulaire
IBLA	Institut fir Biologësch Landwirtschaft and Agrarkultur Luxemburg
ICT	Information and Communication Technologies
ILNAS	Institut Luxembourgeois de la Normalisation, de l'Accréditation, de la Sécurité et qualité des produits et services
INAP	Institut National d'Administration Publique
INFPC	Institut National pour le développement de la Formation Professionnelle Continue
LENOZ	Lëtzebuerger Nohaltegkeets Zertifizéierung fir Wunngebaier
LIST	Luxembourg Institute of Science and Technology
LSFI	Luxembourg Sustainable Finance Initiative
MEA	Ministère de l'Énergie et de l'Aménagement du territoire
MECDD	Ministère de l'Environnement, du Climat et du Développement Durable
MECO	Ministère de l'Économie
MFIN	Ministère des Finances
NECP	National Energy and Climate Plan
NGO	Non-Governmental Organisation
PaaS	Product as a Service
PAG	Plan d'Aménagement Général
PAN	Plan d'Action National
PAP	Plan d'Aménagement Particulier
PCDS	Product Circularity Data Sheet
PDS	Plan Directeur Sectoriel
PNDD	Plan National pour un Développement Durable
RDI	Research, Development and Innovation
SCRIPT	Service de coordination de la recherche et de l'innovation pédagogiques et technologiques
SDG	Sustainable Development Goals
SDK	SuperDrecksKëscht
SNHBM	Société Nationale d'Habitation à Bon Marché
TIR	Third Industrial Revolution
TRL	Technology Readiness Level

Foreword

A common vision to transform Luxembourg into a circular economy and centre of competence in the field

The current government agreement advocates the active development of the circular economy in all areas: the production of goods and services, the extension of the use phase of products, their reuse and the recovery of secondary materials. By counteracting the excessive consumption of resources, circularity creates positive impacts. It is crucial for increasing the overall efficiency of the economy and reducing our ecological footprint while at the same time supporting our efforts to protect the climate. As a driver of innovation, the circular economy contributes to the further diversification of the Luxembourg economy and to the creation of new value chains in the Greater Region.

This document details the strategy, the governance model and key sectoral action points to meet the challenge of Luxembourg's transition to the circular economy, a journey initiated in 2014 by the previous government. The strategy calls for the principles of the circular economy to be applied in a systemic way in order to respond to socio-economic and environmental concerns. To ensure implementation, the strategy relies on the commitment of all relevant public and private stakeholders and on their expertise developed in recent years.

Moreover, Luxembourg's integrated ecosystem is an important enabler of the implementation of a circular economy. It will allow the Grand Duchy to position itself as one of the leaders in the field. As Europe, and Luxembourg in particular, are poor in natural resources, the circular economy is essential to maintain our quality of life, preserve our resources and our environment and strengthen the competitiveness of our economy.

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Minister of the Economy

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Minister of the Environment, Climate and Sustainable Development

1| Executive Summary

In a Circular Economy (CE) the production and trade in goods and services, and thus the creation of socio-economic value, relies on a holistic approach to managing material stocks and flows. Such an approach takes into account both the limits and the regenerative capacities of our planet. These concepts provide a guide for many countries around the world, including Luxembourg, who wish to move to a regenerative economic model, i.e. one that gives the planet back more than it takes, and that creates lasting positive economic, environmental and social impacts. CE practices will be key to achieving a significant number of sustainable development goals (SDGs) of the Agenda 2030, either directly or indirectly.

However, implementing a CE requires a paradigm shift in value creation and profound changes on many levels to the existing socio-economic system. It is therefore necessary to provide clear vision and guidance to citizens and markets, and to involve all public and private stakeholders in jointly building new value chains for products and services.

The Grand-Duchy of Luxembourg is a frontrunner in many sectors, including finance, construction, data-driven innovation and space resources. Innovation in Luxembourg is usually driven by immediate support from institutions, well-connected business players, a business-friendly government and a culture of respectful and trusting collaboration on a national and international level. In recent years, the country has sought to position itself as a hotspot for the CE and many on-going public and private initiatives support this claim.

Based on these fruitful experiences and the recognition of the CE as a high priority by the Luxembourg government, which has made it a major feature of the 2018-2023 Government agreement, the current strategy aims to take the CE in Luxembourg to the next level. It identifies proven regulatory, financial and information management methods and tools for boosting circular initiatives, and proposes a methodology for using them in a number of key economic sectors. To deliver that, it will draw heavily on existing strategies and roadmaps, and will harness activities that are either planned or are already underway.

The success of the strategy relies on aligning all relevant stakeholders with a common vision and by coordinating activities across sectors. Great importance will be attached to defining a coherent governance and communication scheme, which will involve creating a single point of contact and assigning clear mandates and responsibilities to the various ministries and public agencies. Transposing the strategy from one sector to another and managing the communication should be organised by those closest to the sectors and markets involved, and who know best about the specific challenges and opportunities. Supported by a central governance structure, demonstration projects and illustrative roadmaps for the practical implementation of the CE in the various sectors will be developed by these actors. Their work will be based on action item lists proposed in the strategy and, with the support of the relevant stakeholders, will be delivered by co-creation processes.

The methodology is designed to be iterative and expandable beyond the ideas provided. Additional elements of guidance for developing implementation projects and roadmaps can be included, such as the lessons learnt in 2020 from the Covid-19 crisis, where greater regional or national support was sought for a number of key value chains. In this sense, the scope of the strategy should be extended beyond national borders and should also include value chains in the Greater Region.

Source: Municipality of Wiltz

2| Introduction

2.1 Rationale

Europe is poor in natural resources and crucial materials for industry, with semi-finished or finished products being imported from all over the world, including regions where domestic consumption is rapidly growing and might reduce their exports in the future. Industry in Europe, and Luxembourg in particular, is under constant threat of **raw material price increases and fluctuations,** shortages or complete unavailability. The Covid-19 crisis has laid bare the vulnerability of many international supply chains.

In addition, **climate change and other environmental damage** stemming from mass production and over-consumption of resources is becoming an increasingly costly burden. Together, they represent an additional threat to our quality of life and to the economy. The linear economic system with its cost-cutting practices all along the supply chain, such as the massive delocalisation of work to low-salary countries, not only creates unnecessary transport volumes, but also contributes to **the growing social inequalities** worldwide. Current approaches to tackling environmental problems, including awareness-raising and stricter regulations have had limited effect. In most cases, they buy time but fall short in addressing the inherent problems of our linear economic system.

These approaches need to be complemented with the new paradigm of the Circular Economy. This approach promotes the **holistic management of stocks and flows of products and materials**, while also aiming to create **positive economic, environmental and social impacts** within value chains. The CE is an opportunity to face these challenges, correct past mistakes and provide fertile ground for resilient growth and innovation. New products, services, value chains and business models need to be designed and implemented if we are to create a land of opportunity for European companies, while also increasing the overall efficiency of our economy.

2.2 The circular economy in a nutshell

In its new 'Circular Economy Action Plan' for a cleaner and more competitive Europe[1] the European Commission states that in order to achieve climate neutrality by 2050 and to counter the alarming biodiversity loss and water stress, "the European Union (EU) needs to accelerate the transition towards the **regenerative growth model that gives back to the planet more than it takes**". Furthermore, it needs to "advance towards

1 https://ec.europa.eu/environment/circular-economy/

keeping its **resource consumption within planetary boundaries**, and therefore thrive to reduce its consumption footprint and double its circular material use rate in the coming decade".

This regenerative model is expected to be delivered by a CE, where production and the trade in goods and services that create socio-economic value all rely on a holistic management of material stocks and flows, within the limits and regenerative capacities of our planet. The European Commission, like many governments around the world, including Luxembourg, are adopting CE practices as they draw up economic and environmental policies for sustainable resource management. Along with the environmental benefits, such as climate change mitigation[2], the CE is expected to provide greater resilience in the face of raw material shortages in key industrial sectors and to also help create jobs locally, especially for less skilled workers. CE practices can thus contribute directly and indirectly to achieving a significant number of SDGs[3] and the **CE should be considered first and foremost as a key instrument for implementing the Agenda 2030**.

The main principles of a CE for a sustainable resource management, regarding physical flows and stocks of products, materials and energy, are extensively described and illustrated in various previous studies for Luxembourg (see also next chapter and Appendix 1). They can be summarised as follows:

MAIN PRINCIPLES OF A CIRCULAR ECONOMY

- Adopt a systemic and holistic approach towards managing products, components and materials throughout their whole value chain.
- Distinguish between biological and technological cycles for the consumption and use of products, components and materials and aim to close biological and technological nutrient loops, thereby preserving and protecting life-sustaining ecosystems and human health.
- Design quality products that best maintain their value (economic value, usability and material value) over the whole consumption or use cycle.
- Promote the transparent provision and management of information related to products, components and materials throughout the value chain.
- Develop and deploy new business models that encourage the sharing, use of or access to a commodity rather than ownership of goods, thereby capitalising on product quality and information availability.

The deployment of CE principles and practices in different sectors is a transversal task to be carried out in a **concerted and coordinated manner between public and private actors** at various stages of the value chains. CE principles and practices are to be applied at multiple temporal and geographical scales and levels, from systems and processes down to products, components and materials. Information and communication technologies (ICT), coupled with suitable financing and taxation models, are essential factors for the successful implementation of a CE. The extensive **involvement of citizens** to foster behavioural change and the model's adoption by all societal actors is equally essential.

2 The circular economy can contribute to about 50% of the CO2 reduction needed to limit the average global temperature increase at 1,5°C (source: https://circle-economy.com/climatechange).

3 See https://ec.europa.eu/sustainable-development/goal12_en and https://environnement.public.lu/content/dam/environnement/documents/developpement-durable/PNDD.pdf

2.3 The opportunities for Luxembourg

The opportunities of the CE for Luxembourg were analysed for the first time in the study 'Luxembourg as a knowledge capital and testing ground for the circular economy', carried out in 2014 on behalf of the Ministry of Economy[4]. The concept was taken up in 2016 as a transversal thematic pillar in the so-called 'Rifkin' process leading to the formulation of the strategy 'The Third Industrial Revolution (TIR) Lëtzebuerg'[5]. The TIR strategy made a clear statement that silo thinking is not appropriate for dealing with transformative processes and that all economic sectors are interconnected and need to be addressed in a holistic way.

Since the first CE study in Luxembourg, the concept has gained momentum and been applied in numerous private and public initiatives. More recently, the CE provided the underlying principles for planning economic activity zones[6] and urban residential areas,[7] as well as defining drinking-water savings and zero-waste strategies[8] (see Appendix 4 for an extensive list of public initiatives).

In general, given Luxembourg's very open and service-oriented economy, the following gains are expected:

- The CE enables industries to capture a larger part of the value chain by developing additional services around their products, e.g. in manufacturing or construction. This can be of interest to companies that depend heavily on the import and retail of goods.
- Better control of raw material and product flows reduces the dependence on suppliers, contributing to resource productivity and greater security of supply for both companies and Luxembourg as a country, as well as lower costs for waste management.
- A sound management of natural stocks and flows, including soil, space and energy, reduces the pressure on natural ecosystems, both at a local and global level. This is especially relevant in a small country where competition for land use is high.
- Closing nutrient cycles in agriculture and reducing toxic chemical emissions in all sectors contributes to better management of the biological cycle and the preservation of biodiversity and vital ecosystem services.
- The human being is part of the biological cycle, so designing out toxic elements from material stocks and flows is crucial for a healthy food chain and living environment.
- The CE serves as a catalyst for the 'Data-Driven Innovation Strategy'[9] and for green and sustainable finance[10], thus contributing to the development of new

4 https://www.luxinnovation.lu/news/luxembourg-knowledge-capital-testing-ground-circular-economy
5 https://www.troisiemerevolutionindustrielle.lu
6 http://www.ecocirc-zae.lu
7 http://www.fondskirchberg.lu/act
8 https://environnement.public.lu/fr/offall-ressourcen/null-offall-letzebuerg.html
9 https://gouvernement.lu/de/publications/rapport-etude-analyse/minist-economie/intelligence-artificielle/data-driven-innovation.html
10 https://luxembourg.public.lu/en/invest/key-sectors/green-finance.html

activities in key service sectors that are already well-established in Luxembourg. New circular services in accounting, insurance, taxation, audit, consultancy, safe data management etc. can be exported at a European and global level.

- In addition to the economic benefits, the development of circular activities in some of the above-mentioned sectors contributes to job creation, especially for a less skilled workforce.
- Local and regional economic loops with well-documented products and materials have shown to be particularly relevant in the context of crises affecting the supply chain, as became apparent during the Covid-19 pandemic. For a number of value chains, the scope of the strategy reaches beyond national borders and includes at least the Greater Region.

These few examples describe the many opportunities for Luxembourg that the CE offers through the transformation of value chains and a coherent implementation of technological, social and organisational innovations.

Source : Luxtram S.A.

2.4 Purpose of the strategy

The purpose of the present strategy is **not to duplicate the extensive previous work** that was carried out in prospective studies such as the TIR process, mostly involving vast stakeholder consultation processes. Based on the fruitful experiences and the steep, collective learning curve of the last few years, it aims instead to **harness and prioritise the results** and recommendations.

The purpose of the strategy is twofold, as it should accelerate on one hand the implementation of the CE at national and regional level, while on the other hand increase the profile of Luxembourg as a CE front-runner at the international level. Due to its central position and strong ties with its neighbouring countries, Luxembourg's economy is traditionally very open and connected, and international collaboration is a prerequisite for its success. This should, of course, also hold true for an even more strongly interconnected CE.

In addition, thanks to its good social, institutional and economic connectivity, as well as its high- performing ICT and financial sectors, **Luxembourg is a promising testbed for emerging CE business models**. The holistic nature of the CE requires, however, close collaboration and information exchange throughout the value chain. New business models and ways of working need to be framed by appropriate regulation and legislation at the European, national and regional levels.

After the description of the strategy in chapter 3, we develop in chapter 4 the governance scheme needed for a successful sector-wide implementation of the CE. We also identify the tools for an efficient information flow, enabling the various public and private stakeholders to take their responsibilities and strengthen their initiatives. It is important to note that the CE strategy cannot be implemented top-down by a single entity, but needs the **contribution of multiple actors with clear mandates and their own circular goals and roadmaps** – all of which need to come together in a common strategy. This strategy should provide guidance and act as an enabler and multiplier for top-down and bottom-up initiatives at national and regional level. In chapter 5 we provide the first action item lists ('points d'action', 'Aktionspunkte'[11]) for specific sectors and topics, with the aim of aligning and strengthening the national initiatives already underway, as well as Luxembourg's international profile and networks.

The following list includes various outreach activities that have contributed over the last five years to **increasing Luxembourg's international visibility as a circular hub**. They are important for attracting the technologies that support the CE, for fostering international collaboration and for enabling the export of specific circular know-how, services and products:

11 The term 'action item list' reflects the rather loose structure of action points that are identified in the strategy, but will be formalised by means of implementation projects and roadmaps during the process.

- In 2015, in collaboration with the European Investment Bank, a study on CE Financing resulted in a report entitled 'Assessment of access-to-finance conditions for projects supporting Circular Economy' that was presented during the 'Financing the Circular Economy' event held under the Luxembourg Presidency of the Council of the EU.
- Since 2016, Luxembourg's key stakeholders have been participating in the Meta-cluster Greater Green for environmental technologies, which is co-funded by the INTERREG programme 'Greater Region.' This features work packages on the circular economy and recycling[12], as well as other sectors relevant for resource management.
- In 2017, Luxembourg hosted the 'Circular Economy Hot Spot' event, inviting people from all over the world to visit the Grand-Duchy for three days and to discover the progress made in the CE, the pilot projects underway, the support measures that have been developed and the ecosystem in place.
- In May 2018 and October 2019, the CE was the main theme of the respective state visits of the Netherlands and Belgium to Luxembourg. Conferences, workshops and onsite visits were organised and collaboration between the countries was strengthened.
- The 'Product Circularity Data Sheet' (PCDS)[13], launched in 2019 by the Luxembourg Ministry of the Economy, is an initiative being carried out with a range of international partners to develop an industry standard template for reliable data on the circular properties of products.
- The public tender for the Luxembourg pavilion at the world exhibition of 2020 in UAE-Dubai (postponed by one year because of the Covid-19 crisis) specified a circular architectural design, including criteria for a modular and dismountable construction, as well as the deployment of reusable materials.

These examples demonstrate that the CE is already a reality, not only in the country's policymaking and governance, as illustrated by the 2018-2023 Government agreement, but also in its international outreach.

12 https://www.greatergreen.eu/environmental-technology/circular-economy-and-recycling
13 https://www.pcds.lu

3| The strategy

3.1 Definition of the CE in Luxembourg

In the first comprehensive study on the CE in Luxembourg in 2014, the CE is defined as:

> *"The restorative use of materials and products in renewably powered cycles where everything is a resource for something else, generating positive economic, social and ecological impacts through improved quality and resource productivity."*

This description takes up the key principles of the sustainable management of material and energy stocks and flows. It is important, however, to understand that **there is no single definition of a CE**. The concept is derived from various schools of thought, such as Cradle to Cradle, the Blue Economy, the Performance Economy or Biomimicry[14] and it can take different shapes and focuses, depending on the intended use. It is increasingly recognised that the **socio-political implications of a CE** need to be addressed as well, in order to achieve a profound transformation of today's take-make-consume-waste mentality[15].

Although aspects of human health are considered in most definitions, the CE is not a recipe for a fair and resilient society, or for human happiness. Rather, the **CE is as a powerful tool for achieving key SDGs linked to resource consumption** over the longer term. In 2020, the Luxembourg 'Conseil Supérieur pour un Développement Durable' (CSDD) identified the priority aspects of a CE in Luxembourg, in order to provide a common understanding about the positioning of the CE in terms of sustainable development. Seven principles for a CE with positive impacts are retained in the definition (see Appendix 2 for more details): 1) creating economic, social and environmental value, 2) being systemic and holistic, 3) respecting biological and technological cycles, 4) contributing to health and well-being, 5) being regenerative and restorative, 6) prioritising diversity, 7) acting locally and showing solidarity. The principles have been adapted to the Luxembourg context and support the present strategy.

The Luxembourg 'Null Offall' (Zero Waste) strategy, presented in September 2020[16] and developed as a guide to transposing the European Directives of the Circular Economy Package[17], provides the most up-to-date visual interpretation of the CE principles. It links the value hill of the CE and the concepts

14 See e.g. https://www.ellenmacarthurfoundation.org/circular-economy/concept/schools-of-thought and Wautelet, T. (2018) The Concept of Circular Economy: its Origins and its Evolution – Working paper (DOI: 10.13140/RG.2.2.17021.87523).

15 See e.g. results from the project 'Challenges for the Implementation of Circular Economy Policies: Practices, Institutions and Hybrid Intersections' conducted at the University of Luxembourg (https://circular.uni.lu/).

16 https://environnement.public.lu/fr/actualites/2020/09/null-offall-letzebuerg.html

17 See https://ec.europa.eu/commission/presscorner/detail/en/IP_19_1480 and https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L:2018:150:TOC

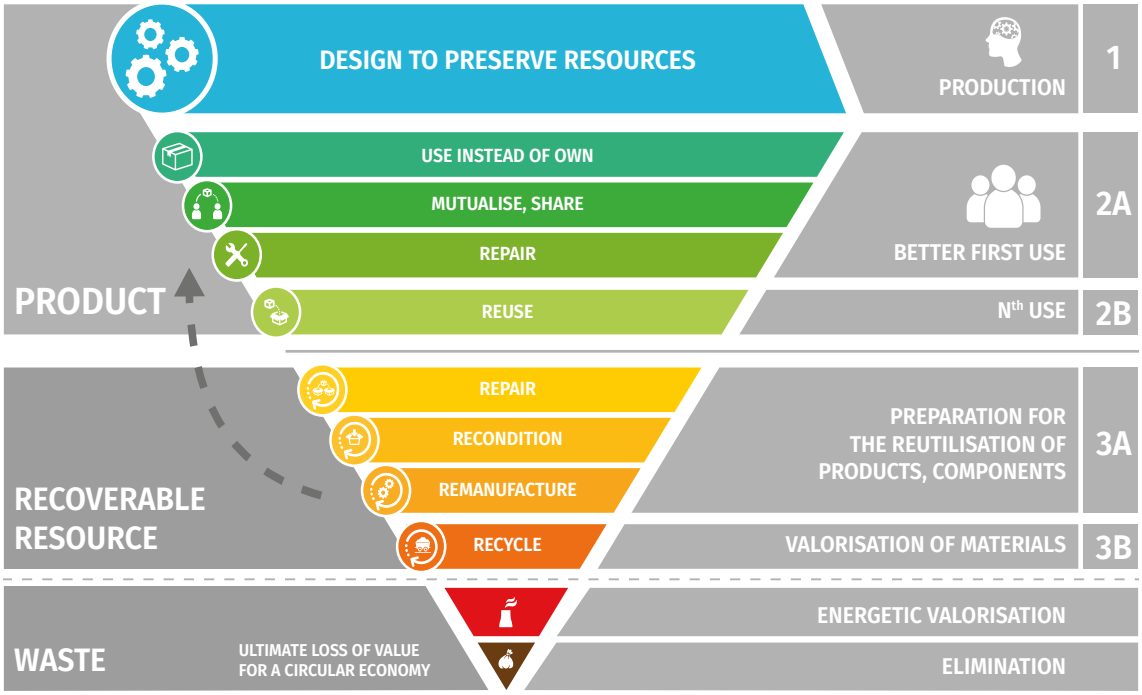

*Figure 1: The resource **diamond** for the technological cycle*

of technological and biological cycles (see Appendix 1) to the widely-used triangle of the waste hierarchy. Despite its name, **the 'Null Offall' strategy adopts a holistic approach for the management of resources and products** that goes far beyond waste management. As the CE is strongly connected to the material nature of resource stocks

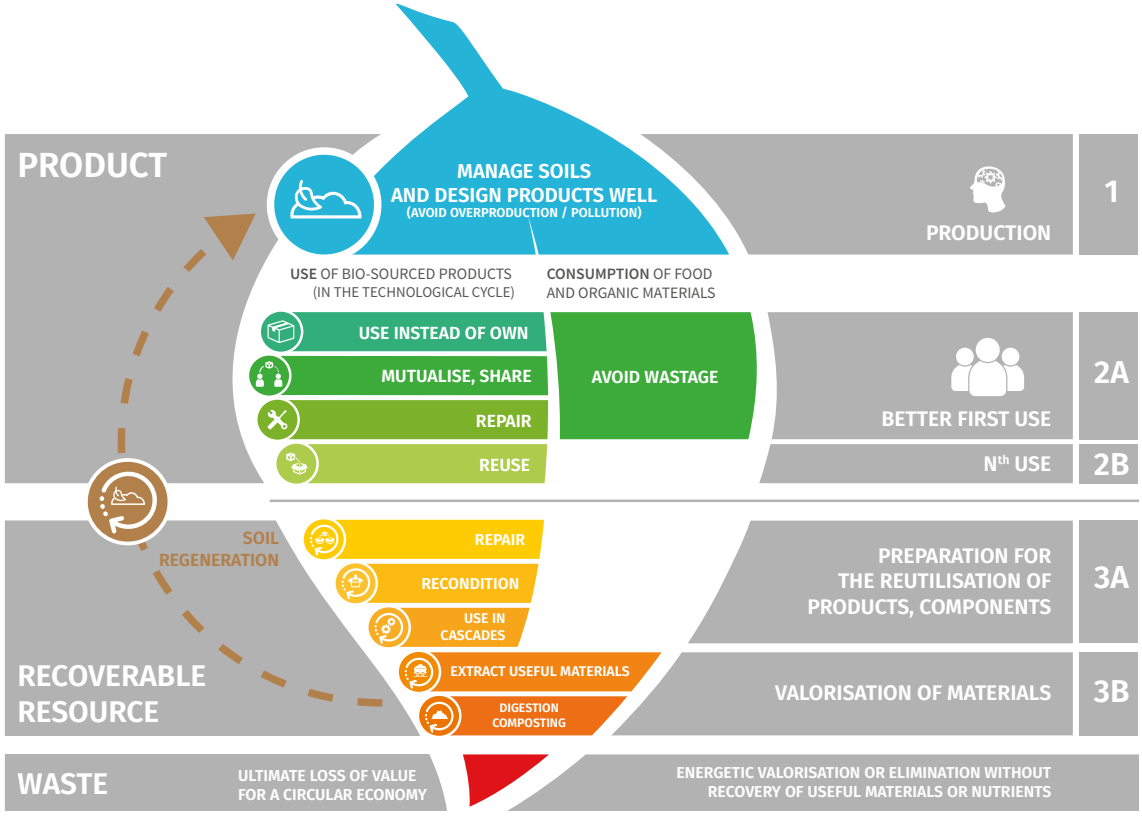

*Figure 2: The resource **leaf** for the biological cycle*

and flows, it is useful to take the resource triangles of the 'Null Offall' strategy (as shown in Figure 1 and Figure 2) as starting points for organising and aligning the methods and tools of the current strategy.

The numbers 1, 2 (A & B) and 3 (A & B) in the figures refer to the three stages of the value hill, as illustrated also in Figure 5 (see the 'Null Offall' strategy for an in-depth description[18]). The aims are to:

1| **Create value:** produce high-value materials and objects of quality that are designed to hold their value as long as possible, and encourage the recovery of value after use. The design respects biological and technological cycles, the products are modular and can easily be dismantled or deconstructed, and the components or materials can be returned to their respective cycle. The circular production process uses recovered and recycled secondary raw materials and components, and avoids the emission of toxic substances that damage human health or ecosystems.

2| **Maintain value:** Deploy and encourage measures to preserve the high value of products and materials, e.g. through repair and maintenance, taking advantage of clever design. High-value quality objects can be shared more easily among users, increasing their usage. This stage includes the first-use phase (2A), as well as the transfer of objects and products to other users (2B), thereby preventing these items from becoming waste after a first use. For the biological cycle, a distinction is made between bio-based materials that can be reused in the technological cycle (e.g. wood) and those that are consumed once (e.g. food).

3| **Recover value:** In this stage, the materials or products have lost their initial usability, e.g. through wear or breakdown, and have become waste from a legal point of view. But the product, component (3A) or material (3B) should be recovered, recycled and reintroduced through a new production process. Biosourced materials are used in cascading loops and the biological nutrients returned to the soil to maintain productive eco-agro systems.

Value is understood in this context not only as economic value, but also as the value of resources -- such as materials, energy or water -- consumed during the production and delivery of the products. The value of a material or product is also intrinsically linked to the **availability of information on the quantity, quality and composition** of its stocks and flows. Efficient management and sharing of this information from the design phase onwards, throughout the whole val-ue chain, is crucial for the CE. It keeps the functionality and usability of products, components and materials at the highest level of the resource triangles, thereby avoiding the creation of waste. **ICT, are essential enabling tools for a CE** (e.g. electronic sharing platforms or material passports).

18 https://environnement.public.lu/fr/offall-ressourcen/null-offall-letzebuerg.html

3.2 Vision for a circular Luxembourg

An ambitious vision for a circular Luxembourg was elaborated in the stakeholder consultation process of the 'Rifkin' study and is described in the TIR report for Luxembourg as follows[19]:

"Luxembourg will be the first circular nation, where new business models based on the product as a service principle become standard.

All public procurement will be aligned around the circular economy. Contracts will be performance-based. Luxembourg will have developed know-how around eco-design and product life assessment. Luxembourg will have an adapted resilient infrastructure that promotes local renewable energy production, storage and sharing, short and local resource loops, a continuous water loop and reverse logistics. In addition, the new infrastructure, designed to fully integrate CE principles, will be able to manage (in terms of storage and calculation) a large set of data, linked to each product. Luxembourg will have created a legal framework that allows the exchange of product related information between suppliers, by guaranteeing a level of confidentiality. The national tax system will support companies implementing a circular approach. Luxembourg will gain the technical experience to make life cycle assessments and evaluate how circular a business is. An effective local network will be backed by a strong financial sector.

Moreover, Luxembourg will establish a detailed national measurement system to determine both quantity and quality of the different material flows. Luxembourg needs to become a key actor in the greater region in order to establish regional and/or local supplier communities and will contribute significantly to close these loops. In addition, Luxembourg will implement a series of seamless chemical and biological loops."

This vision has not lost any of its relevance and the TIR report provides hints about the essential tools and methods for implementing a CE, such as **eco-design, public procurement, a supportive regulatory and fiscal system or life-long learning and training**. Key infrastructure for the efficient and r**esilient management of renewable energies, water and other material stocks and flows** is mentioned, along with **transparent and reliable data and information** linked to these flows, which is highly important. The report also recognises that various **economic cycles need to be tackled at the level of the Greater Region**, in collaboration with neighbouring countries and the EU.

In the following chapters, we will identify the aforementioned tools and methods in more detail, evaluate their potential for supporting the relevant sectors in Luxembourg, and outline the public and private stakeholders who need to be involved. We will also review on-going initiatives, with the aim of linking them to the strategy.

19 https://www.troisiemerevolutionindustrielle.lu

3.3 Stakeholders

The major public stakeholders for implementing the CE are both at the level of the **state, with its ministries, administrations and agencies, and at the municipal level**. At the national level, the main drivers of the strategy are the ministries and administrations dealing with the management of the economy, the financial framework, spatial planning, resource management, food production, climate action, environmental protection, consumer rights and health, etc. Crucial support for this work is provided by digitalisation, research and education[20].

Various national agencies and organisations that depend on -- or are funded by -- various ministries support the central administration in carrying out specific missions. **Municipalities, as well as municipal syndicates** and organisations, play multiple roles as regulators, enablers, sponsors or promoters of a CE, and operate in closer proximity to citizens, associations and companies.

The non-public sector embraces basically all other societal stakeholders, **from a company offering circular products and services down to the individual citizen**, who is increasingly contributing to the economy as a 'prosumer' rather than a passive consumer (e.g. energy cooperatives or urban gardening). Like the public sector, many associations and organisations formulate and advocate their own interests -- from professional bodies and trade unions to NGOs -- and are therefore important stakeholders for implementing the CE in Luxembourg.

As mentioned in the previous chapters, collaboration should also extend beyond the national borders, to include wider parts of the **value chains at the level of the Greater Region.**

3.4 Circular tools and methods

A key objective of the present strategy is to identify and describe the appropriate tools and methods for developing the roadmaps that will deliver the vision described in the previous section. These resources are mainly aimed at policymakers and public stakeholders, but also include their private partners. We distinguish **three main categories of tools**, which provide different types of incentives or support to societal players, and which **are ideally combined** to achieve the best results:

1| **Regulatory framework:** a set of laws, regulations and standards that impose mandatory actions or constraints, or that provide guidance and guarantees, including certification schemes and public procurement.

20 The missions and responsibilities of ministries might change over time, therefore, we prefer to point out the core competences involved.

2| **Financial framework:** a set of financial instruments to provide incentives, either positive or negative, to influence behaviour, correct market distortions or help to mitigate risks (e.g. insurance policies). It includes non-financial instruments for supporting circular business models.

3| **Knowledge creation and management:** a set of actions and tools for creating and transferring knowledge, including strategic documents, guidelines, consultancy, awareness-raising, training and basic education. Research, development and innovation (RDI) activities play a central role in creating knowledge and testing concepts, e.g. through pilot projects[21]; ICT provide key instruments for knowledge and data management.

Meanwhile, it is well understood that the implementation of a CE requires close collaboration throughout business or value chains. A single company can hardly introduce a circular business concept such as Product as a Service (PaaS) if suppliers do not provide suitable raw materials, including information on their composition. Equally, there can be no progress if customers do not buy the concept, if the service is disadvantaged by the taxation system or hindered by national administrative borders, or if the bank does not provide the loan needed to set up the business.

The different categories of tools and methods should be used to **bring stakeholders together, across the value chain, with the aim of creating and preserving high value and high quality** with minimal material and energy input. The tools should also be used to recover products, components, materials and nutrients in the technological and biological cycles.

To achieve this, new business models are needed, such as the performance economy which, in view of its importance, is described in more detail in Appendix 3. As already identified in the TIR study, ICT are key enablers for the CE as well as these new business models, as they make it possible to collect, manage and share data on material and product stocks and flows in real-time. Transparent and reliable information on products and services empowers companies and prosumers along the value chains, making it a prerequisite for the sharing economy.

Along with a supply push and demand pull using innovative business models and enabling tools, a clear long-term commitment to supporting the transition from a linear to a circular economy is needed. **With its entrepreneurial tradition, the Luxembourg State is well positioned to successfully deploy CE projects, using an intelligent combination of regulatory, financial and communication tools**, thus providing long-term visibility to companies investing in CE products and business models.

21 It should be noted that the deployment of categories 2 and 3 relies also on specific sets of regulation and standardisation in category 1. Pilot projects are not identified as separate category as they are, anyway, mandatory milestones along the deployment of circular concepts.

3.5 Where do we stand today?

As mentioned in the previous chapters, **the CE has gained considerable momentum in the last five years in Luxembourg** and is recognised as an essential tool for building a more sustainable and resilient country. It is fully embedded in the 2018-2023 Government agreement under many relevant topics. In this chapter, we want to present its current status of development, in order to identify missing links and to take that development further. A non-exhaustive but impressive **inventory with publicly (co-) funded and CE relevant methods and tools in Luxembourg** is provided in Appendix 4. The inventory is organised from a public stakeholder perspective as the strategy should primarily reflect the short and mid-term measures to be taken by the Government. The items identified in Appendix 4 are categorised using the three-level classification introduced in the previous chapter.

In addition to these intangible assets, a range of practical, more tangible pilot projects and full implementations have already been completed by both public and private actors. To raise further awareness of the CE, to promote best practice and to connect public and private stakeholders within circular value chains, the strategy calls for the setting up of comprehensive inventories of circular activities (see chapter 4 on governance).

Implementing a CE has the best chance of success if **multiple regulatory, financial and knowledge management measures are deployed in a concerted way**, either throughout the value chains of specific sectors or even across sectors. Table 1 provides a compilation of exemplary generic key measures, extracted from the inventory in Appendix 4, and links them to the three stages of the value hill and the resource triangles (see Figure 1 and Figure 2 for the technological and biological cycle, respectively): create, maintain and recover value. This differentiation is important, as the measures for the three stages differ, but they have to be coherent over the whole value chain.

Training and RDI activities, including pilot projects, are positioned in the third category under level 1 – value creation, but they can also extend to the various stages of the value chain and touch upon topics related to categories 1 and 2, as illustrated by the arrows in Table 1. Their scope depends on the maturity of the circular concept or action (e.g. expressed in technology readiness levels - TRL) or the observed knowledge gaps.

The categorisation of measures set out in Table 1 will provide the basis for developing concrete action plans in chapter 5 and a further rollout of the circular economy in Luxembourg. To align and prioritise action within value chains and across sectors, it is important to define a **governance framework and to assign clear responsibilities and mandates to key stakeholders**, as described in the next chapter.

	CATEGORY 1	CATEGORY 2	CATEGORY 3
LEVEL RESOURCE TRIANGLE	**REGULATIONS AND STANDARDS**	**FINANCIAL ASPECTS**	**KNOWLEDGE CREATION AND MANAGEMENT**
(1) CREATE VALUE	- Public procurement procedures include circular business models and criteria - Quality criteria and labels for circular products and services - Resource management regulation, including spatial planning	- Business and accounting models taking into account the full cost of ownership (e.g. product as a service) - Subsidies for supporting the development of circular business models, projects and infrastructures	- Transparent data and information on labels, criteria, and the circularity of products and services along value chains - Tools, methods and guidelines for circular design and production, e.g. eco-design, considering the whole use/life cycle and systemic impacts - Information and training for all stakeholders with respect to circularity - RDI activities, including pilot projects
(2) MAINTAIN VALUE	- Regulatory framework to guarantee value conservation (e.g. right to repair) - Regulatory framework and standards for reuse, repair and sharing activities, including liability and insurance issues	- Incentives (such as support schemes, subsidies or taxation) for correcting market distortions (e.g. economic valuation of ecosystem services) - Incentives that encourage resource efficiency and value conservation (e.g. repair, maintenance, take-back)	- Quality information on repair, reuse & sharing services (e.g. digital platforms)
(3) RECOVER VALUE	- Quality criteria and standards for the reuse of materials, components and products[22]	- Incentives that encourage reuse and recycling of materials, components and products	- (Digital) information on quantities, composition and functionality of reusable materials, components and products

Table 1: *Generic categories of methods and tools to support a circular management of stocks and flows at different stages of the resource triangles*

22 From a legal point of view, it is important to distinguish for these criteria and standards whether the materials, components and products have become waste or not. Overall, the CE aims at eliminating the concept of waste. In this strategy, we put mainly forward the preservation and recovery of the value of materials, components and products, independently of the definition of waste.

4| Governance

4.1 The key players and tools

The circular economy requires a systemic change. Most actions needed for its implementation do not work as standalone measures, as they have repercussions in other areas and have to be supported by additional actions and other stakeholders. **Multiple levers need to be operated simultaneously to allow the transition from a linear to a circular economy.**

For a company, the CE can only work if it is fully integrated into its development strategy and if the board and management have made it a common objective. For a country, the CE needs to be a common political goal for all members of government.

At a practical level, circularity principles must be included in all public projects. Any initiative must be looked at from a circular perspective, so that it can become an enabler and a driver for the transition. Not everything can be done perfectly from the start, but no opportunity to take the first steps should be missed. **A passionate, innovative and highly motivated, yet realistic approach is required.**

The good news is that the national CE is already a key part of government strategy and that many interesting initiatives are under development or planned, illustrating a high degree of motivation to implement the CE in Luxembourg. But to be fully effective, the CE requires a centralised, continuous governance structure that can:

- Collect and redistribute information about on-going and planned initiatives, thereby bringing public and private stakeholders together.
- Capitalise on the experiences and results of both successful and less-successful initiatives, and establish a strong central knowledge hub on the CE.
- Use this knowledge to help identify and remove regulatory, organisational or financial barriers to a CE. This would include taking initiatives at a European level if the problem cannot be solved by an individual country.
- Increase the success of individual initiatives by providing national and international visibility, thereby creating business opportunities for companies.

The concrete support actions identified in Table 1 for implementation need to be carried out at various levels by the relevant stakeholders, using the tools and methods in a coordinated way within their respective policy and activity fields. The crucial first task for governance is to set up a **permanent consultation and coordination process amongst the key drivers of the CE in Luxembourg.**

The key drivers are identified in the 2018-2023 Government agreement, through the multiple citations of the CE in policymaking. The drivers are the Ministry of Energy and Spatial Planning (MEA), the Ministry of the Economy (MECO), the Ministry of the Environment, Climate and Sustainable

Development (MECDD) and the Ministry of Finance (MFIN), but also the Ministries of Mobility and Public Works, Housing and Agriculture. Close support is also needed from the public bodies dealing with digitalisation and consumer protection.

To further develop and implement Luxembourg's CE strategy, the following tools are put in place.

- The national CE coordination unit
- The CE stakeholder consultation platform
- The Internet portal 'Circular Economy Luxembourg'

Further tools may be added over time, according to need.

4.2 The national CE coordination unit

The national CE coordination unit is composed of one representative each from the MEA, MECO, MECDD and MFIN. The unit meets on a regular basis, with organisational and administrative support from the MEA, and capitalises on the work carried out by the 'Groupe Stratégique pour l'Économie Circulaire (GSEC)' up to early 2019. It welcomes and consults with other members, ministries, administrations and public agencies, according to the topic. Among others, the unit's key missions are to provide:

- A single point of contact for all questions and suggestions related to a CE in Luxembourg, engaging with all the various stakeholders.
- A knowledge base for CE actions in Luxembourg, through regular discussion with other public and private organisation as identified in chapter 3.
- Systematic alignment of the CE strategy with other national strategies, such as the National Plan for Sustainable Development (PNDD), the spatial sectorial development plans (PDS), the National Energy and Climate Plan (NECP), the 'Null Offall' strategy, the Data-Driven Innovation Strategy, the Luxembourg Sustainable Finance Initiative, etc.
- Continuous monitoring and a proactive approach to integrating CE principles into the regulatory and legislative framework, including the new waste and resources law, tax reform, energy efficiency in buildings, public procurement, etc.
- Identification of new CE opportunities and new ways of overcoming potential barriers (regulatory, financial, organisational, etc.) to the implementation of projects.
- Advice for setting up or strengthening public credit and subsidy lines in the state budget, as well as financial support tools (e.g. investment funds, fiscal measures) for the deployment of circular projects, in close cooperation with the financial sector.
- Development of partnerships abroad, and the monitoring of Luxembourg's representation in key European and international initiatives related to the CE. This provides an opportunity to benefit from international know-how, experience and best practices, and to also promote the country as a CE testbed (e.g. the EU CE stakeholder platform). This mandate includes specifically liaising with the authorities in the Greater Region and

the BENELUX Union, along with the European Commission via Luxembourg's permanent representation in Brussels.

On a regular basis, at least every six months, the unit reports to the Ministers in charge for political approval and endorsement of the activities and action plans.

4.3 The CE stakeholder consultation platform

In order to inform, involve and support public and non-public organisations other than governmental bodies, the national coordination unit regularly arranges events that are open to all interested stakeholders. These events are a chance to present the major CE advances and developments in Luxembourg and the Greater Region, to collect feedback from stakeholders, to identify new opportunities and to foster collaboration.

4.4 The Internet portal 'Circular Economy Luxembourg'

To provide more visibility about the CE in Luxembourg, both nationally and internationally, a governmental internet portal is being created. It can be run independently of the CE responsibilities of the various governmental organisations. The purpose of this portal is wide-ranging, but notably to:

- Present and explain the government's strategy on CE and link it to other strategies, where relevant.
- Highlight priority developments and display best circular practice in Luxembourg.
- Provide a focal point for all requests and suggestions related to the CE in Luxembourg.
- Capitalise on the CE experience to date, communicate around that experience and encourage new stakeholders to get involved.
- Connect the national context with developments at the European and international level (e.g. taxonomy project, green finance, ISO standardisation).

Updates to the platform will be communicated in a regular newsletter to subscribers.

Although the concept of a CE is familiar to many stakeholders, the portal will continue to raise awareness and offer an easily accessible entry point for the general public, providing examples of key initiatives and activities.

In a second stage, the portal should be complemented by a more extensive internet inventory or marketplace of circular actions, products and services. Such a platform is important for generating interest, connecting commercial and non-commercial actors (e.g. municipalities, but also NGOs and the civil society) and fostering demand for

circular innovation[23]. Being more complete, this database of actions and initiatives could be set up like the web platform www.aktioun-nohaltegkeet.lu or be integrated into this platform. Publishing information about an action on this official CE platform would provide a quality check and approval, according to the CE principles of the current strategy.

23 See e.g. the Knowledge Hub of Circle Economy in the Netherlands: https://circle-lab.com/knowledge-hub

5| Circular action item lists and roadmaps for Luxembourg

5.1 Methodology

It should be clear by now that the transformation of our economy from a linear to a circular model is a long-term project involving the whole of society. In the various sectors, public and private stakeholders need to collaborate on the value chains of products and services. However, **public authorities have a specific responsibility for providing a favourable regulatory framework and incentives (including the financial aspects), for raising awareness and for supporting implementation projects.**

Previous studies and strategies, such as the initial CE study from 2014, the TIR process, the circular economic activity area methodology, the 'Null Offall' strategy and the PNDD, have yielded a set of thematic and organisational action points for boosting the CE in Luxembourg[24] that remain valid today. Many of these actions have been initiated, as illustrated in Appendix 4, or have yet to be launched. The purpose of the present strategy is, again, not to come up with completely different trajectories, but to build on existing knowledge and experience. The aim is to speed up the implementation of the CE by aligning and connecting ideas, activities and stakeholders. The methodological approach is three-fold:

I| Building on the results of previous national studies and consultation processes, along with more recent strategic documents such as the CE action plan of the European Commission, we describe a number of synoptic **action item lists** for specific topics and sectors. These lists use the classification framework proposed in Table 1. In addition **to useful tools and methods**, the action item list identifies **key stakeholders** and **potential implementation projects**. The lists here are to be considered as starting points. Other topics will be added, based on the continuous feedback from public and private stakeholders.

II| In a second step, **one or more key public stakeholders** that are expected to **take the lead** on these topics and sectors will be consulted by the national CE coordination unit, and their mandate will be defined. They **will make arrangements for the means and resources needed to develop more elaborate thematic or sectoral im-**

24 As an example, the 2014 study 'Luxembourg as a knowledge capital and testing ground for the circular economy' exhibits in Figure XVII (p.61 in report 'Study Highlights') an organogram for national circularity initiatives and associated stakeholder platforms or task forces, which cover both sectoral and transversal approaches.

plementation projects. An action item list can be used in one or more implementation projects. Where possible, projects will build on existing ideas and initiatives, such as the thematic objectives of the 'Null Offall' strategy[25], and will mobilise the associated public and private stakeholders, including municipalities. The examples of implementation projects provided in the next chapter are tentative and will need to be given a clearer framework during the process.

III | For these projects, **roadmaps are developed as a co-creation process**, similar to the methodology designed for implementing the CE in economic areas[26]. The co-creation scheme is a guideline and can be simplified, but the key feature is the **systemic and participatory approach**. The process is led by a public stakeholder, in collaboration with the national CE coordination unit. The roadmap is a strategic plan that describes the major milestones for **deploying regulatory, financial and knowledge management tools and methods** (either already existing, e.g. Table 1, or identified as missing) to achieve one or more circular goals or desired outcomes. The individual roadmaps also identify the human resources, infrastructure and equipment needed to deliver the implementation projects and **highlight the connections between different topics**. Depending on the maturity of the concepts, RDI activities and pilot projects can be integrated. The social implications of the roadmaps should be addressed as well.

An additional element of guidance for setting up the roadmaps are the lessons learnt from the Covid-19 crisis, such as seeking greater regional or national support for a number of key value chains in order to guarantee basic societal and economic services, e.g. healthcare.

Figure 3 provides a schematic representation of a roadmap for a project, illustrating the alignment of actions items in the three categories to support the implementation process.

The next chapter covers sectoral action item lists that build on current or planned initiatives that can be deployed rapidly (within the next three years) by the key public stakeholders. Step II is of crucial importance. For the roadmaps to be successful, the **key stakeholders have to take ownership of the actions in their specific fields of competence**, a task that cannot be carried out by a third party. In addition, intimate knowledge of the sectors is needed to come up with plausible, realistic roadmaps and to implement them successfully. To align and prioritise actions along value chains with their specific public and private stakeholders, the lists are organised from a **sectoral point of view**.

25 Indeed, the 'Null Offall' strategy also comes up with roadmaps for implementing its specific objectives for designing out waste. As both strategies are closely aligned, these roadmaps can be easily integrated as implementation projects into the present CE strategy.

26 http://www.ecocirc-zae.lu

Progress towards the CE is monitored and documented through the CE governance tools, as described in the previous sections of this chapter. Overall, **the process is iterative**. New action item lists can be added if necessary, facilitated by the central CE governance bodies. After political approval, they are then transformed into roadmaps and are implemented according to the methodology.

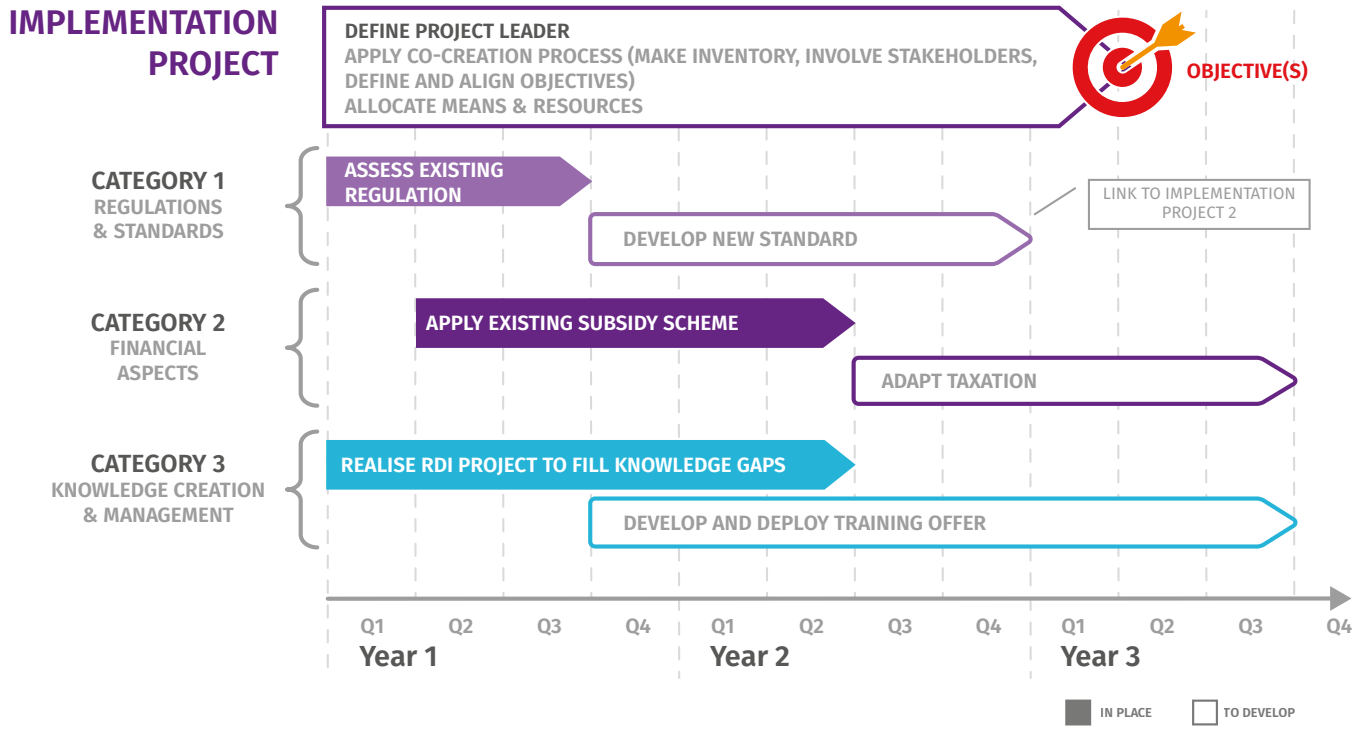

Figure 3: *Roadmap for an implementation project, illustrating the alignment of action items (examples)*

5.2 Sectoral action item lists[27]

5.2.1 Construction

A wide range of factors, including its importance for the domestic economy, the large quantities of stocks and flows of materials involved, its direct and indirect energy consumption (grey energy in materials), and its use of other precious resources such as soil, water etc., mean that the construction sector is a priority area for a CE in Luxembourg, as in many other countries. It enables key tools, such as public procurement or material passports, to be used on a large scale in collaboration with state and municipal promoters, thus creating new markets for innovative companies. Circular construction not only targets new buildings, but can also help to preserve value

27 The order of presentation of the sectoral action item lists is alphabetical and does not reflect priorities.

through innovative renovations. Encouraging the use of wood and other bio-sourced materials for construction has positive climate impacts (storage of CO_2 instead of emissions during production) and is an integral part of the strategy. Other concepts for reducing the environmental impacts of construction materials are production methods with lower energy intensity, e.g. for concrete, or the design for disassembly and recovery of components in new buildings, e.g. for steel beams. On top of these more energy-related aspects, construction materials and methods need to preserve other resources as well, such as the water cycle, and to nurture the physical health and mental comfort of building occupants and users.

The upcoming conversions of numerous brownfield sites into residential and commercial areas offer promising opportunities for real-life testing and implementation of CE principles in the construction sector. Needless to say, from a systemic point of view, the construction process has to be embedded in urban and spatial planning processes. Designing for value involves the sharing and restoring of space and land, which are limited resources in Luxembourg, as well as the promotion of biodiversity.

Key methods and tools

	CATEGORY 1	CATEGORY 2	CATEGORY 3
LEVEL RESOURCE TRIANGLE	**REGULATIONS & STANDARDS**	**FINANCIAL ASPECTS**	**KNOWLEDGE CREATION & MANAGEMENT**
(1) CREATE VALUE	- Integrate circular criteria in public procurement for construction (such as PaaS business models) - Develop the material passport approach for better traceability of materials and products; evaluate the usability of the PCDS for describing the circularity of construction materials - Integrate circular criteria in spatial planning instruments (PAG/PAP) and construction regulation (e.g. 'règlements sur les bâtisses'), for better use of resources and space	- Introduce the Total Cost of Ownership as a decision support tool for circular solutions - Integrate circular construction in the subsidy scheme for municipalities of the 'Pacte Climat' 2.0 - Promote PRIMeHouse subsidies (and LENOZ certification[28]) including circular criteria (healthy materials, deconstruction)	- Set up a database of circular construction materials and products (including health aspects) - Integrate circularity in guidelines for sustainable construction, as well as for spatial and urban planning - Promote the use of the BIM methodology to manage information across the construction value chain - Align training for the sector and ensure its provision
(2) MAINTAIN VALUE	- Expand the concept of Extended Producer Responsibility (EPR) to the Construction Sector - Develop a regulatory framework for the reuse of materials, components and products in the construction sector, including water, in buildings	- Explore incentives (such as support schemes, subsidies or taxation) for the reuse of stock (materials, components and products) and encouraging circular flows in cascades (e.g. reuse of treated greywater)	- Set up a marketplace (physical and digital) for deconstruction materials (including interior elements), focus on cascaded use for wood (see also 'bio-materials') - Extend the guideline for deconstruction to reusable (non/waste) products and components
(3) RECOVER VALUE	- Develop a regulatory framework for the reintroduction of recovered and recycled materials, components and products in the construction market	- Explore incentives adapted to the reuse of recovered and recycled materials, components and products in the construction sector	- Set up a marketplace (physical and digital) for recycled deconstruction materials (including interior elements)

Table 2: *Key circular methods and tools for the construction sector*

28 'Lëtzebuerger Nohaltegkeets Zertifizéierung fir Wunngebaier', see https://logement.public.lu/fr/lenoz.html.

Key stakeholders

The MEA, in collaboration with the MECDD, MECO, Ministry of Public Works, Ministry for Housing, MFIN, Ministry for Digitalisation (through the Facilitation unit for urban planning and environment - CFUE), Ministry of Home Affairs, and their respective agencies (with a focus on public developers).

Implementation projects (examples, to be completed and refined in the individual roadmaps)

- Foster and demonstrate CE approaches in public buildings (planned and executed by public developers such as ABP, Fonds du Logement or SNHBM), e.g. by using the BIM methodology and integrating material passports (including PCDS approach) to trace the circularity of components and materials (that can be disassembled and reused/recycled). Another option is to use PaaS business models, including tendering for leasing and maintenance services for components and equipment, with a focus on the Total Cost of Ownership[29].
- Implement the concept of a digital (and physical) marketplace for secondhand construction components and materials, as developed by Luxinnovation (CleanTech Cluster).
- Test the concept for the high-value recycling of concrete, as well as alternative production methods, to reduce energy consumption (project supported by Luxinnovation).
- Implement demonstration projects for the cascaded use of water in buildings (e.g. reuse of treated greywater for toilet flushing and irrigation).
- Integrate CE principles in spatial planning regulations and tools, such as PAG, PAP and construction permits.

5.2.2 Education & training

While the basis of the CE seem logical and easy to grasp, implementation requires new approaches to the production and distribution of goods and services. More importantly, it also needs fundamental changes in consumption patterns and our perception of socio-economic and ecological value. As explained before, the CE requires the genuine involvement of citizens and the adoption of the model at all levels of society, starting with the younger generations who will be responsible for deploying at a larger scale the initiatives being launched today.

The principles of the CE have to be translated not only into a range of awareness-raising activities, but also into educational curricula and disciplines. These include the natural sciences and engineering, as well as economic, social and legal sciences, at the level of basic and continued training (lifelong learning). Vocational training must also include practical courses that are adapted to the needs of the various sectors and support professional reorientation and reintegration. That said, circular solutions require interdisciplinary and holistic thinking, as they involve collaboration between various stakeholders and multiple value chains. As for

29 The concept is particularly important for social housing projects and their caps for market prices.

other areas, digital literacy is a prerequisite for fully integrating ICT as a powerful tool and needs to be taught at all levels.

Developing and deploying this education and training curricula is therefore a central pillar of the CE strategy. It explains why there is a specific chapter on this topic, although knowledge creation and management activities also feature in all the other action item lists and roadmaps. Good coordination of education and training contents between the various sectors is another important task, as it encourages synergies and establishes high quality as a target.

Key methods and tools

	CATEGORY 1	CATEGORY 2	CATEGORY 3
LEVEL RESOURCE TRIANGLE	**REGULATIONS & STANDARDS**	**FINANCIAL ASPECTS**	**KNOWLEDGE CREATION & MANAGEMENT**
(1) CREATE VALUE	- The educational framework also targets legal aspects, e.g. for public procurement	- The educational framework also targets economic sciences, e.g. for topics such as PaaS business models	- Propose a coherent educational framework for developing and implementing training modules at various levels, and address the different stakeholders, from primary education to life-long training
(2) MAINTAIN VALUE	- Regulatory support for actions in category 3	- Financial support for actions in category 3	- Offer skills training and guidelines for repair and maintenance, e.g. in trades and the construction sector, but also through citizen initiatives (e.g. repair cafes) - Provide awareness-raising and comprehensive information on sharing initiatives
(3) RECOVER VALUE	- Regulatory support for actions in category 3	- Financial support for actions in category 3	- Offer skills training and guidelines for repair and maintenance, guidelines on secondhand products and markets

Table 3: *Key circular methods and tools for education & training*

Key stakeholders

The Ministry of Research and Higher Education, Ministry of Education, Children and Youth, Ministry of the Civil Service, Ministry of Labour, Employment and the Social and Solidarity Economy, Ministry of Consumer Protection and their agencies (SCRIPT, INFPC, CNFPC, INAP, etc.); also the University of Luxembourg and other educational/training organisations, both public and private.

Implementation projects (examples, to be completed and refined in the individual roadmaps)

- Realise an inventory of basic and further training to foster knowledge and skills about the CE at different educational levels; to be based on prospecting future needs and including transverse core modules, along with specific training courses to be integrated into various disciplines.
- Offer comprehensive training for repair and maintenance services, developed in collaboration with resource centres and stakeholders from the social and solidary economy.
- Support awareness-raising and training facilities in various regions, e.g. the circular innovation hub in Wiltz.

5.2.3 Finance

As for sustainable finance, where Luxembourg has become a leading global centre for international investors in green and sustainable assets, the financial community can be a catalyst in a national circular economy. Firstly, by becoming familiar with circularity and its underlying concepts; as by developing specific expertise, the financial sector will be able to support industries and firms that adapt to circular business models (e.g. upfront purchase of material for PaaS models). Secondly, by leveraging the international finance and fund ecosystem in Luxembourg, the financial sector can become an early adopter of circular concepts. It could offer new products and services to international markets and investors, such as the Luxembourg Green Exchange[30] and the LuxFLAG labelling[31] initiatives. In addition, the broader ecosystem of the financial sector can be a major promoter of public incentive programs that are adapted to circular business models.

As to the latter, the potential financial incentives for individual sectors and activities, such as grants or taxes that are geared to the circular economy, are transversal. They need to be defined in close collaboration with the Ministry of Finance, as shown in the individual action item lists. They are, therefore, not considered as a specific item action list for the finance sector. Instead, they are part of a broader set of horizontal enablers that can be applied across various national demonstration projects and roadmaps.

30 https://www.bourse.lu/green
31 https://www.luxflag.org/

Generally speaking, the financial sector's role in supporting the emergence of circular business models is multifaceted. It ranges from venture capital fund raising for start-ups and private equity investments in innovative SMEs that are active in CE, to dedicated insurance and banking products that reflect the specifics of circularity.

A comprehensive roadmap for a more sustainable finance sector was developed in 2018 by MECDD and MFIN[32]. The Luxembourg Sustainable Finance Initiative (LSFI) was then launched this year to coordinate and help implement such a roadmap[33]. Moreover, MECO and MFIN recently launched a study to identify priority areas to support the emergence of circular business models, including in the area of finance.

To avoid unnecessary duplication, the circular topics that specifically involve the Luxembourg finance industry and its international dimension should be integrated within these existing initiatives. Key public stakeholders taking the lead on this topic are MFIN, working closely with MECDD and MECO, as well as Luxembourg for Finance and the aforementioned LSFI.

32 https://gouvernement.lu/en/actualites/toutes_actualites/communiques/2018/10-octobre/04-sustainable-finance.html

33 https://lsfi.lu/

5.2.4 Food & biomaterials

A resilient and high-quality food sector is at the heart of societal health and welfare. From a CE point of view, the human being is part of the biological cycle and the food industry needs to preserve the natural ecosystems that support food production. As an example, artificial fertilisers such as phosphate are mined from non-renewable resources and are largely dispersed in the environment in a non-recoverable way (mainly washed into the seas), thereby endangering food security in the future. The CE seeks to close nutrient and water cycles in order to regenerate productive soils in local and regional agro-ecosystems. This can be achieved with mixed farming systems that provide high-value carbohydrates or proteins for human consumption, while also allowing for a cascaded use of nutrients and the improvement of soil fertility e.g. through carbon sequestration.

Bio-sourced materials or biomaterials are also extensively used for other non-food applications, e.g. for bio-sourced industrial products, energy production (e.g. biogas) or in the construction sector (e.g. insulation materials or wood). As natural biological production capacity is limited by the available land, forest or sea, a cascaded use of materials helps to avoid competition between usages. For example, valuable molecules can be extracted from organic waste or residues from biogas production (see also the resource leaf for the biological cycle in Figure 2).

Production capacity can also be extended and diversified by promoting alternative land-based farming systems such as horticulture, by creating additional growing areas, e.g. in greenhouses on rooftops, or by using innovative approaches such as biotechnology and artificial intelligence. Collective urban farming contributes to social cohesion and fosters an appreciation of food over the whole value chain. However, as with horticulture, it might also lead to increased water consumption due to irrigation needs. To exploit the full potential of the bio-economy, transparent and resilient value chains for food, biomaterials, nutrients and water need to be established and managed. All relevant stakeholders need to be involved, with a specific focus on restoring and preserving valuable ecosystem services.

Key methods and tools

	CATEGORY 1	CATEGORY 2	CATEGORY 3
LEVEL RESOURCE TRIANGLE	**REGULATIONS & STANDARDS**	**FINANCIAL ASPECTS**	**KNOWLEDGE CREATION & MANAGEMENT**
(1) CREATE VALUE	- Support the development of transparent labels on resource consumption for food and biomaterial production and processing, e.g. 'Holz vun hei' - Reinforce regulations for keeping toxic additives out of bio-sourced value chains - Review regulations for the installation of greenhouses, e.g. on rooftops - Use public procurement for responsible food consumption (seasonal, regional, low packaging) - Support the development of CE principles within the new strategic plan (reform of the Common Agricultural Policy)	- Prepare financial incentives through the Common Agricultural Policy for integrating CE framing practices	- Extend the urban farming strategy, including rooftop greenhouses and industrial-scale urban production for better use of space and systemic added value - Promote sustainable, resource-efficient and resilient agricultural production systems for delivering ecosystem services (strategic plan - CAP reform, agro-environment-climate measures, eco-schemes) - Promote organic agriculture through the PAN-Bio 2025 strategy - Foster RDI on sustainable production or harvesting and cascaded use of food and bio-sourced materials (e.g. potential analysis on national wood sourcing by ANF) - Encourage short supply chains, community-supported agriculture, bottom-up initiatives for urban gardening and social cohesion - Collaborate with local food chains for responsible procurement and promote fair trade practices at all levels

	CATEGORY 1	CATEGORY 2	CATEGORY 3
LEVEL RESOURCE TRIANGLE	**REGULATIONS & STANDARDS**	**FINANCIAL ASPECTS**	**KNOWLEDGE CREATION & MANAGEMENT**
(2) MAINTAIN VALUE	- Define a regulatory framework prohibiting the destruction of edible food - Set criteria and standards for the reuse of treated water for irrigation	- Explore incentives (such as support schemes, subsidies or taxation) that would reduce food loss and waste	- Act on the reduction of food loss and waste, including digital sharing platforms, consider concepts such as 'nose to tail' and 'leaf to root', promote education in food nutrition and sustainable food - Set up (physical and) digital information exchange platforms and marketplaces, e.g. for wood in construction
(3) RECOVER VALUE	- Define a regulatory framework, national standards and objectives for nutrient and material recovery from organic ***waste*** streams (including e.g. phosphate from wastewater)	- Explore incentives that create value for recovered nutrients and materials from organic ***waste*** streams and wastewater	- Provide information on national nutrient flows, including waste streams such as compost or sewage sludge - Tackle the challenge of pollution by heavy metals and other potentially harmful substances

Table 4 : *Key circular methods and tools for the food & bio-sourced materials sector*

Key stakeholders

The Ministry of Agriculture, MECDD, MECO, MEA, MFIN, Ministry of Consumer protection and respective agencies ASTA, ANF, AGE etc.

Implementation projects (examples, to be completed and refined in the individual roadmaps)

- Deploy the urban farming strategy;[34] and make available its tools for producing local food and for closing water and nutrient loops, including innovative and systemic concepts such as GROOF[35].
- Promote alternative protein sources for animal feed (such as insects, algae and duckweed), recover heat from biogas production, support the use of by-products from the food industry, grow protein-rich varieties locally e.g. lupines or alfalfa, use hemp cake from hemp production to become less dependent on soybean meal imports.
- Use livestock, particularly ruminants, to help the ecosystem with the maintenance of natural reserves and marginal lands, vineyards and orchards, instead of using machine-driven maintenance to clear shrubs and weeds, or using pesticides; see livestock production as a converter of raw biomass into products with high nutritional value.
- Optimise the access to and use of water (irrigation facilities) to support horticulture production (by creating closed water loops and nutrient cycles); promote combined horticulture/aquaculture systems, such as aquaponics; develop aquaculture as a high-value protein source for human consumption.
- Explore the possibility of recovering phosphorous and other valuable chemicals or organic materials from sewage sludge, along with digestate from biogas production or wastewater to meet national recovery targets (to be fixed). Promote the best use of manure, focusing on slurry refinement – extracting high-value ingredients, minerals and energy.
- Set up pilot projects for collecting concentrated wastewater from dwellings (e.g. using vacuum technology), producing energy by anaerobic digestion and recovering the nutrients for fertilisers.
- Promote the use of bio-sourced materials in construction, e.g. through showcase construction projects with local and bio-sourced materials and components, promoting modular construction and the reuse of material in cascades. Use the 'Holz vun hei' label when selecting wood-based materials; other materials of use to the construction sector, such as hemp and wool, now offer new markets to agricultural value chains.
- Develop sustainability criteria for natural raw materials, such as wood biomass from managed forests, while considering trade-offs with other ecosystem services.
- Set up an innovation hub for promoting and supporting the development of bio-sourced materials, covering the whole value chain from production to processing and reuse/recycling. Focus on the systemic added-value for various actors, e.g. growing bio-materials for construction (e.g. insulation, paint) in drinking water protection zones, offering the potential for local processing and markets.

34 See https://www.urbanfarming.lu/

35 Greenhouses to Reduce CO_2 on Roofs: https://www.cdec.lu/groof/

5.2.5 Industry

Manufacturing is a key player in the CE as it consumes large amounts of raw materials, energy, water etc. to produce goods and services. Many studies have shown that circular design principles and circular business models help industry to reduce not only its costs and uncertainties when purchasing raw materials, but also its environmental impact. Reaching out to the B2B or B2C customer in the value chain by offering PaaS concepts also gives companies a better understanding of their customers' needs and enables them to refine their offerings.

Collaboration within or across value chains can also increase the resilience of the industrial ecosystem. Bearing this in mind, industrial companies and the wider economy would benefit from assessing the value chains of new activities, including their need for human skills and their resource consumption at an early stage. By doing so, synergies with existing activities can be identified, while social and environmental impacts could be mitigated. Such a strategy can be enhanced by integrating CE principles in the planning or extension of economic activity areas in a spirit of industrial ecology.

Key methods and tools

	CATEGORY 1	CATEGORY 2	CATEGORY 3
LEVEL RESOURCE TRIANGLE	**REGULATIONS & STANDARDS**	**FINANCIAL ASPECTS**	**KNOWLEDGE CREATION & MANAGEMENT**
(1) CREATE VALUE	- Develop a scheme for transparent, standardised and reliable data management in circular value chains, based on the PCDS - Support the development of shared infrastructure and services in economic activity areas through spatial planning instruments (PAG/PAP) and construction regulations - Develop a regulatory framework to support circular business models - Develop public procurement guidelines to support the market for circular products - Support the development of administrative services for circular businesses (ex: legal advisory, finance, etc.)	- Explore incentives (such as support schemes, subsidies or taxation) adapted to PaaS business models for high-value goods and products - Deploy subsidy schemes for industry such as Fit4Resilience and Fit4Circularity to develop new and resilient business models - Integrate circularity criteria into subsidy legislation, allowing higher co-financing rates for circular projects	- Provide information and training on design principles and schemes, fostering the development of circular products and business models - Provide support and training on the development of circular economic activity areas, provide guidelines for building strong industrial ecosystems
(2) MAINTAIN VALUE	- Develop a regulatory framework to support secondary raw material and product markets	- Explore incentives adapted to the reuse and sharing of goods, including maintenance and repair services	- Support the development of collaborative platforms amongst companies for sharing resources (including waste heat, for example), equipment and space
(3) RECOVER VALUE	- Develop a regulatory framework to support recycled raw material and product markets	- Explore incentives adapted to the reuse of recovered and recycled materials and products	- Support the development of collaborative platforms amongst companies for reusing recycled materials and products

Table 5: *Key circular methods and tools for the industrial sector*

Key stakeholders

MECO, MFIN, MECDD, MEA, MFIN, Ministry of the Middle Classes and Tourism, Ministry of Digitalisation, and their respective agencies.

Implementation projects (examples, to be completed and refined in the individual roadmaps)

- Scale-up the PCDS initiative: test various products in various markets, build partnerships, develop standards and auditing schemes.
- Launch a joint study of MECO and MFIN to develop Luxembourg as a circular business hub, including the finance sector.
- Support pilot projects in economic activity areas for implementing circular design principles, and eliminating regulatory and organisational barriers (e.g. for the sharing of space, buildings and equipment or managing resources such as energy or water in cascades).
- Close the loop on product and material value chains, e.g. plastics in the Greater Region (project Luxinnovation). Apply the concept to critical value chains for the economy and society (lessons learnt post Covid-19).
- Launch the 'Circular Economy Design Challenge', managed by the Creative Industry Cluster (Luxinnovation), aiming to increase knowledge of circular design in Luxembourg.
- Realise the 'Circular Hotel Interiors Project', a pilot project to implement PaaS models in the building interior sector in Luxembourg and the Greater Region, featuring public circular procurement.

5.2.6 Retail

The retail sector covers the broad range of everyday products such as electronics, textiles and furniture used by companies and citizens. They represent a substantial volume and wide variety of materials, so the action item list needs to include multiple roadmaps and rely heavily on the 'Null Offall' strategy. However, some features are transversal, such as the municipal Resource Centres (former Recycling Centres) which are open to both private individuals and companies.

For the retail sector, the end consumer or user plays a crucial role when it comes to supporting and implementing CE principles, due to the sheer market size and opportunities. Specific attention needs to be given to adapting the regulatory and financial framework, and preventing or mitigating risks, e.g. in the value chains of secondhand products and materials. A targeted awareness-raising and communication policy also needs to be established.

On the other hand, a widespread up-take of CE principles by the retail sector could have a major impact on traditional B2C retail schemes, which are highly linear and mono-directional. So, shop owners need to be involved and given new business opportunities, e.g. by promoting PaaS business models.

Key methods and tools

	CATEGORY	CATEGORY 2	CATEGORY 3
LEVEL RESOURCE TRIANGLE	**REGULATIONS & STANDARDS**	**FINANCIAL ASPECTS**	**KNOWLEDGE CREATION & MANAGEMENT**
(1) CREATE VALUE	- Integrate circular criteria in public procurement for consumer products that are purchased by public bodies (such as PaaS business models) - Support the development of criteria and labels for describing the circular properties of products, e.g. repair potential for electronics or reusability and recyclability of textiles. Align with PCDS	- Explore incentives (such as support schemes, subsidies or taxation) adapted to PaaS business models for high value goods and products	- Support the use of circular labels for products in online platforms, such as 'Lëtzshop' - Apply eco-design tools for consumer goods and products, at national and European level - Develop makerspaces to promote circular design and creation
(2) MAINTAIN VALUE	- Extend the EPR concept to more products streams - Develop a framework for a 'right to repair', including access to spare parts (original or 3D printed) - Clarify liability and insurance issues for all stakeholders in the context of the sharing economy, as well as for repair and reuse	- Explore incentives adapted to the reuse and sharing of consumer goods and products, including maintenance and repair services	- Support the setting up of marketplaces (physical and digital) for the sharing and reuse of consumer goods - Further develop online platforms that promote repair services - Develop a national platform to promote the multiple use of service packaging, based on regulatory and financial incentives
(3) RECOVER VALUE	- Develop a regulatory framework for the reintroduction of recycled consumer products in the market (e.g. SDK 'Ressourcenpotential')	- Explore incentives adapted to the reuse of recovered and recycled consumer goods and products	- Establish guidelines for the design of Resource Centres and services, supporting a circular economy, in collaboration with actors from the social economy - Improve recycling processes to increase the quality of recycled material (RDI)

Table 6 : *Key circular methods and tools for the retail sector*

Key stakeholders

MECDD, Ministry of Consumer protection, MECO, Ministry of the Middle Classes and Tourism, in collaboration with MFIN, Ministry of Digitalisation, Ministry of Home Affairs and their respective agencies.

Implementation projects (examples, to be completed and refined in the individual roadmaps)

- Foster circular procurement guidelines for municipalities being drawn up by My-energy (and EBL) and make them available to companies.
- Develop a national platform to promote the multiple use of service packaging in the HORESCA sector, including takeaway outlets and restaurants, and in the retail sector.
- Set up a digital 'Right to repair' platform, providing information about the reparability of products, information on repair services (including quality labels), and open-source blueprints for additive manufacturing of spare parts.
- Transform Recycling Centres into Resource Centres, offering additional services for the recovery, repair and recycling of products, which can be made available to platforms for secondhand goods (physical and/or digital). Collaborate with actors from the social economy.
- Support the retail sector in setting up circular value chains for high-value goods.

6| Conclusions and Outlook

Since the first study on the potential of the CE in Luxembourg in 2014, the concept has gained considerable momentum and is today an important principle for development policies in various economic sectors. The CE is, moreover, a key instrument for implementing the Agenda 2030. The present strategy seeks to align and strengthen the initiatives of public and private stakeholders at different levels by providing a coherent governmental framework.

This framework builds on the many achievements to date, underlining the value of earlier work and experience. It creates a close bond between the various public stakeholders and defines clear responsibilities. It proposes a single point of contact for all CE matters in Luxembourg, so that questions can be passed on to the relevant stakeholders, along with a methodology for identifying the key circular topics. The methodology is designed to produce roadmaps for implementing circular value chains, using a toolbox of regulatory, financial and information measures. The roadmaps are defined and deployed under the lead of one or more ministries, following a co-creation process with all relevant stakeholders, thereby underlining the collaborative nature of the CE. Item lists for further action have been identified for the following sectors and topics (in alphabetical order): Construction, Education and training, Finance, Food & biomaterials, Industry and Retail.

This is an iterative process, starting from a number of ideas and concepts that are either already being exploited or are considered to be relevant, based on prior experiences. New topics can be added and more stakeholders can be involved to reflect changing political and socio-economic realities. This flexibility makes it possible to align with new trends at European and international level, an important feature of an open and highly-connected economy such as Luxembourg's.

Last but not least, the CE strategy will play a major role in promoting Luxembourg and the Greater Region as an attractive testbed for innovative business ideas and companies. By identifying missing links and niches in existing business ecosystems, it will encourage our domestic entrepreneurs to create new products and services, or allow new ecosystems to grow with external support. Communication, awareness-raising and training are essential for involving not only companies, but also other stakeholders, especially citizens, so that all parties can enjoy the overall economic, environmental and social benefits expected from the CE.

7| Appendices

Appendix 1

Key concepts of a circular economy

The CE is a holistic approach that addresses the negative impacts made at every stage of the product life cycle, including design, production and use. It seeks to maintain or even increase the value of a product or material and to encourage its reintegration into continuous loops, thereby eradicating the concept of waste.

Three principles are the basis of this approach:

1. Doing a lot of good, instead of doing less damage

As all human activity has an impact on our environment, aiming at neutrality and zero impact is a difficult, if not impossible task. The choice is therefore not between a negative impact or no impact, but between a negative or a positive one (Figure 4). A lot of damage has been done in recent decades and measures are needed to repair it. The circular economy seeks to create positive impacts and to develop an economic and social model that is regenerative, improving the environment through human action. The focus is on 'doing good', rather than being 'less bad.' This message of making a positive impact inspires more creativity and motivation -- especially among the younger generation -- than the traditional, negative approach, which has had limited success in tackling environmental issues.

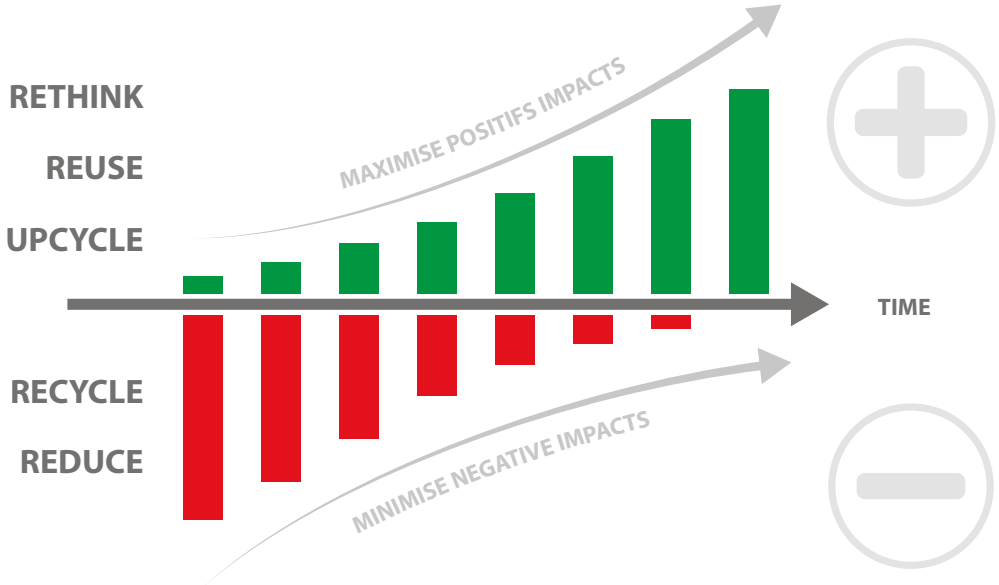

Figure 4: *Creating positive impacts rather than only reducing bad ones (adapted from MBDC)*

2. *Creating value and retaining it at the highest level*

Most business cases involve the use of resources, including materials and energy, to increase the value of a product throughout the production cycle until it reaches its highest value, when acquired by the customer. In the linear economy, the use phase is often quite short and the value is rapidly destroyed afterwards, generating zero or even negative value if disposal costs are taken into account. The linear system has been optimised since mass production became possible during the first industrial revolution and remains the most profitable model for companies today. But it is also the most resource-consuming and damaging for the environment.

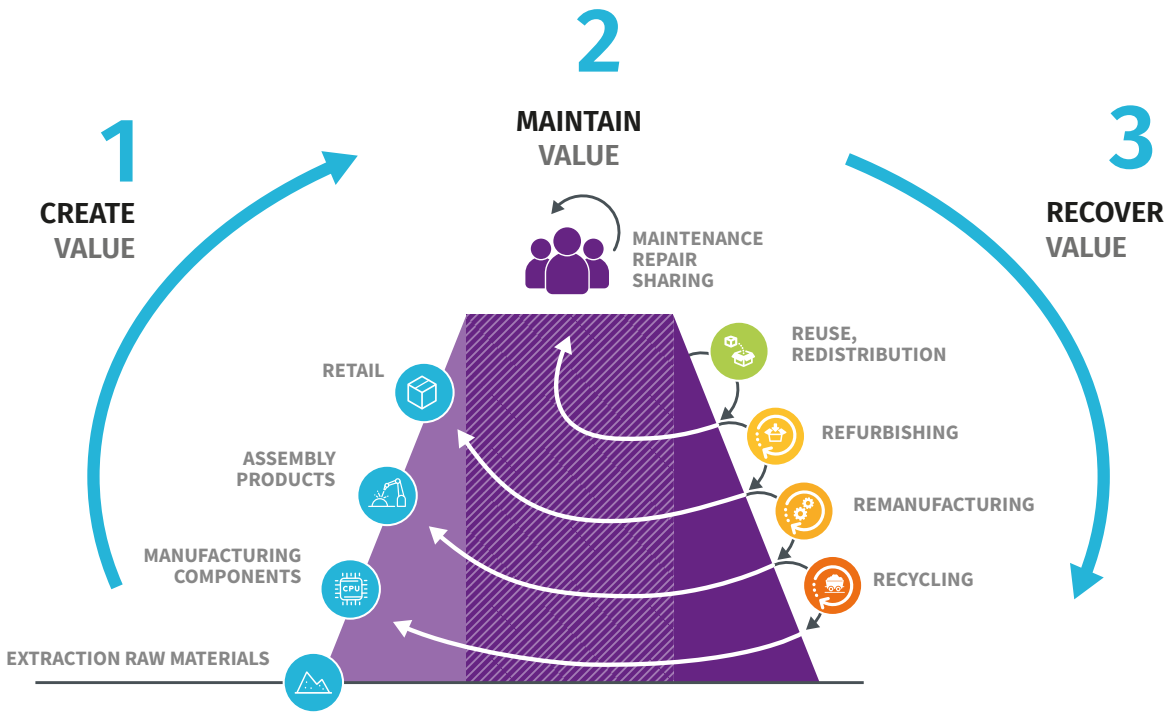

Figure 5: *The value hill in a circular economy (Source: 'Null Offall' strategy Luxembourg, adapted from Circle Economy)*

The circular economy is a system in which value is retained (Figure 5). Products and business models are designed to have much longer and efficient use phases, often involving sharing schemes, for example. After the first-use cycle, value is restored by reusing, repairing, reconditioning, remanufacturing and recycling. Value destruction is thereby slowed and the value, ideally, never reaches zero. All materials and components with value are returned to the economic cycle.

3. *Closing the nutrient loops*

Today, the composition of most products is unclear and there is no clear guidance on how to close the loop at the end of the use phase, which leads to inefficient recycling. To avoid becoming waste, products have to be designed for either the biological or the technical cycle (Figure 6).

To enter the biological cycle, materials have to be non-toxic and biodegradable. This enables them to become nutrients for the biological organisms by which they will be consumed, generating natural products that can be reused as renewable materials in economic cycles. The biological cycle is the logical pathway for products that are consumed and cannot be recovered (e.g. food). It draws on ecosystem services that are delivered 'for free' by nature and that need to be protected and regenerated.

The technological cycle is about returning materials and components to the manufacturers, so they can be used as inputs for new products. The technological cycle is ideal for products that will be used rather than consumed, and can therefore be easily recovered if designed accordingly.

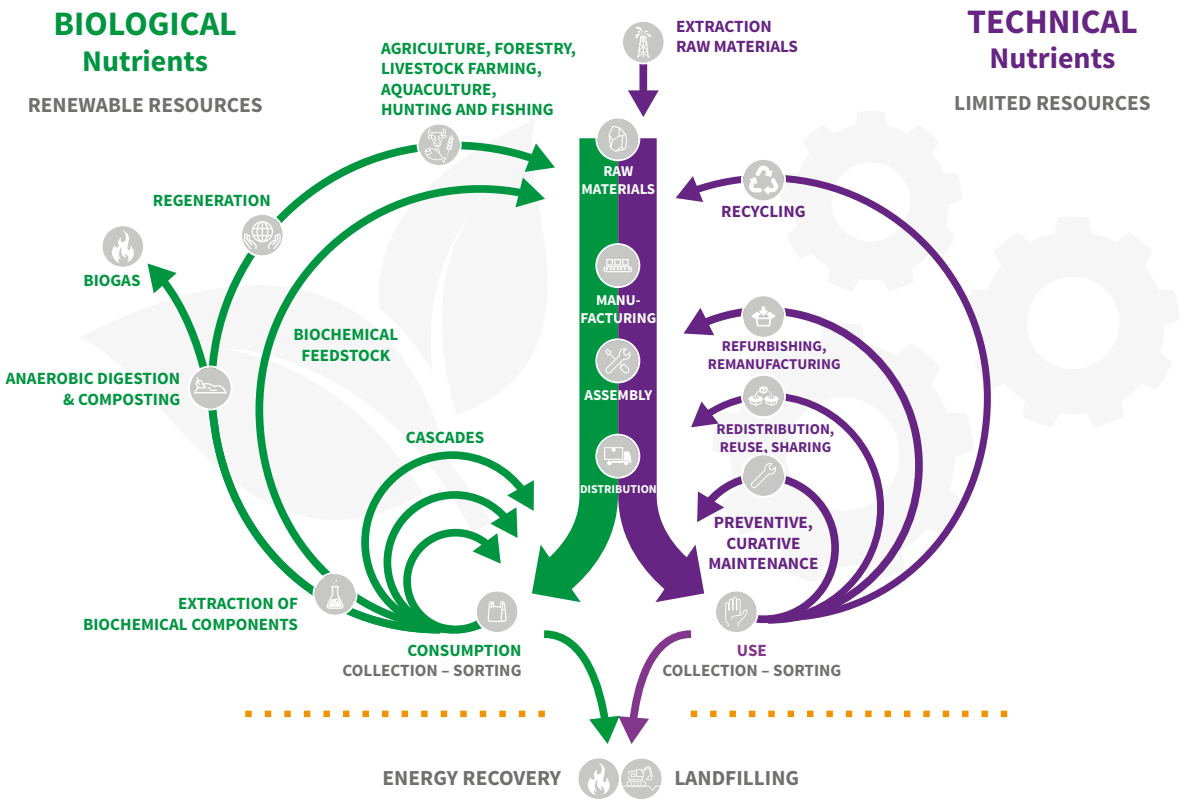

Figure 6: *Biological and technological cycle (Source: 'Null Offall' strategy Luxembourg, adapted from Ellen MacArthur Foundation)*

In theory, the two cycles need to be clearly separated, although crossovers are possible. Bio-sourced materials for instance are not necessarily biodegradable, as they may start life in the biological cycle before later being transferred to the technical cycle.

It is important to note that simply designing for one of the cycles is not sufficient. Business plans need to ensure that it is in every stakeholder's interest for materials and components to stay in their appropriate cycle along the value chain and that they can and will be recovered.

Principles of a circular economy for Luxembourg, as defined by the Higher Council for Sustainable Development (CSDD)

THE CIRCULAR ECONOMIE IS BASED ON **7 FUNDAMENTAL PRINCIPLES**:

The Circular Economy (CE) is an economic model that preserves resources, generates overall positive impacts and increases the resilience of the system.

1 | Value creation
2 | Systemic and holistic
3 | 2 cycles
4 | Health, well-being and positive impacts
5 | Restorative and regenerative
6 | Focus to diversity
7 | Local and supportive

Value creation

The CE is a disruptive economic model for creating, maintaining and sharing economic value. By its nature, the CE also creates ecological value and social value.

Systémique and holistic

The CE relies on an interdisciplinary, systemic, holistic and collaborative approach.

2 cycles: a biological cycle and a technological cycle

The CE eliminates the notion of waste by relying on two cycles, the biological cycle and the technological cycle. Each product must be designed or programmed to evolve permanently in either of these two cycles, although some materials or products can move from one cycle to the other, if designed accordingly.

Health, well-being and positive impacts

The CE favours the creation of positive impacts both on human beings and on nature. The mere reduction of negative impacts is not sufficient for a sustainable development. Health and well-being are among the most important positive impacts created by a CE.

Restorative and regenerative

The CE is restorative and regenerative by design. It preserves and strengthens ecosystem services and supports biodiversity. The technological cycles are designed to maintain or even increase the quality of resources and products.

Focus on diversity

A CE promotes the diversity of solutions in all areas, relating to technical, economic, ecological or socio-cultural aspects.

Local and supportive

In Luxembourg, the CE encourages local and inclusive solutions and favours proximity cycles.

The 7 principles of the circular economy have been developed in a participatory process initiated by the CSDD (Nohaltegkeetsrot) in late 2019-early 2020, with representatives from the private sector, from different ministries as well as from the research community. The Nohaltegkeetsrot believes that these principles, defined to support the transition from a linear to a circular economy, are valid more generally to ensure a resilient and regenerative economy, required for a sustainable development.

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The performance economy

Value chains that are both linear and highly compartmentalised are highly inefficient. Product responsibility is passed on and often ends up as a costly burden to society. Disposing of a product and repairing the damage it has caused is left to the public, whereas the profits are shared along the production chain. It would be too simple to blame manufacturing companies alone as they are trapped in a linear system, forced into a rat race and a mass consumption market that rewards the highly efficient production of disposable goods. Low-cost country competition, eroding technological leadership and decreasing control over value chains are adding additional pressure. In the existing linear system, highly innovative and efficient circular products are often not generating the required benefits to the developers or providers.

The performance economy is a powerful model for implementing the circular economy as it aligns the interests of the provider and the user of a product. Today, those interests are very often in opposition. In a performance economy, companies do not sell products but performance. The providers agree to deliver a result and, in principle, are free as to how to deliver it. Providers remain responsible for their product all along the value chain and take it back after use. They are penalised for poor performance but also rewarded for good performance. It should not be confused with renting or leasing models that do not include the idea of reward for performance. Central heating offers a useful example. You can buy a boiler (product) or lease/rent one (product including a service), and you can pay for the heat/calories delivered (pay per unit). In a performance economy, you purchase a pleasant indoor climate (results-oriented).

The performance economy is challenging, but offers great opportunities as it requires new skills and services. It unlocks great potential for innovation and competitive advantage, along with new sources of income based on usage rather than consumption, while at the same time reducing dependence on raw material imports.

The performance economy, often also referred to as the functional economy, is part of the Product Service System family as described by A. Tukker (Figure 7)[36].

36 A. Tukker (2014) Eight types of product–service system: eight ways to sustainability? Experiences from SUSPRONET. Bus. Strat. Env. 13, 246–260.

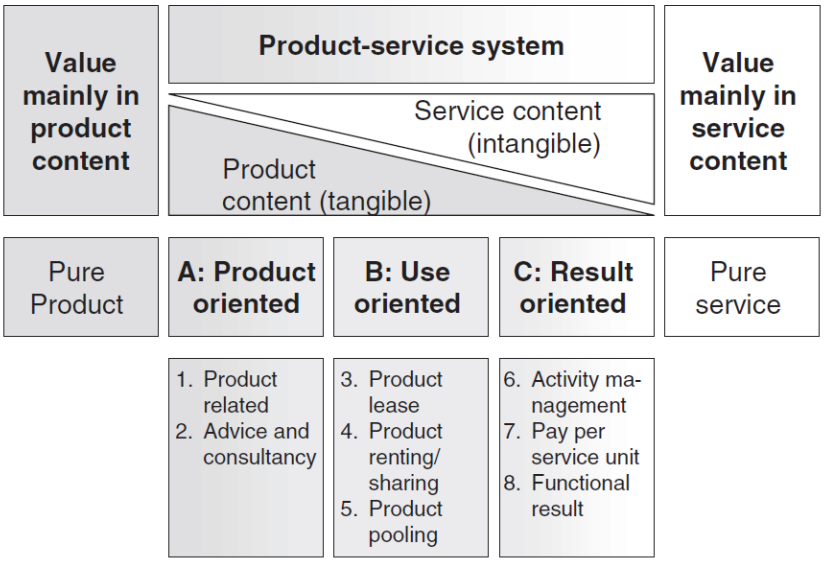

Figure 7: *The product service system family (Source: A. Tukker)*

The functional result or performance economy offers the biggest opportunities, but is also the most ambitious and complex of the results-oriented models. For some sectors, it may be too early to adopt these models. However, buy-back, pay-per-unit and activity management models are positive intermediate steps and are often necessary on the way to achieving a performance economy. The three results-oriented schemes are service-driven, with product ownership residing with the provider.

Scientific literature recognises the potential of the performance economy. It can dematerialise an economy, create jobs, boost innovation and provide new business opportunities and profit centres for companies, while also increasing competitiveness and creating closer relationships with customers. Moreover, the performance economy delivers social and environmental benefits.

However, the market penetration of this economic model remains low, as it generates substantial transition costs and risk premiums. It also requires a systemic change for companies, their value chains and the overall economy. Despite this, it creates opportunities for service-oriented, open and integrated economies like Luxembourg's that can develop new skills and services to address these challenges.

The performance economy has been used for many decades in niche markets with high-value products (e.g. Rolls Royce jet turbines) but has been too costly to implement for cheaper goods. However, new technologies like robotics, automation and the 'Internet of Things' (IoT) are dramatically reducing costs and the first examples of performance business cases with cheaper products are starting to appear (lighting, washing machines, etc.). These new technologies are enablers, but they also require new business models and the time now seems right for a broad implementation of the performance economy. Table 7 illustrates the opportunities that can be derived from the technical, financial and regulatory challenges for a CE.

CHALLENGES	OPPORTUNITIES
Transition costs Providers experience cash flow constraints as they keep ownership and the ROI will be achieved over a much longer period of time	**New financial tools** Develop innovative financial tools to provide stakeholders with the necessary financial resources.
Accounting Retaining ownership leads to inflated balance sheets.	**Circular accounting guidelines and expertise** Develop guidelines and the required know-how to implement an innovative accounting methodology that reflects reality in a fair way and, if necessary, adapt accounting regulations.
Taxation Depreciation and the related tax benefits are not applicable when buying performance.	**Taxation incentives** Develop a taxation model that does not penalise performance solutions, compared to linear ones
Contracting Agreeing on the type of performance to offer and under what conditions, as well as verifying the deliverables, are complicated tasks.	**Business lawyer skills** Develop the skills among business lawyers to draft contracts that give reassurance to providers and their customers.
Insurance Insuring a measure of performance and clarifying the liabilities in case of product failure and litigation is a hurdle to the performance economy.	**New insurance products and skills** Develop new insurance products and develop skills to define the respective responsibilities of providers and their customers.
Value proposition Defining the most profitable performance value proposition is often beyond companies that are used to product-based models.	**Identify value propositions** Develop know-how to identify the right value proposition for the right market at the right time.
Design Besides developing new business models, products need to be redesigned to fit the performance economy.	**Creative Industries** The creative industry can develop know-how and offer design services to make products fit for circular and performance business models.
Data Circular economy models and performance offerings, in particular, require access to product and performance data, often in real- or quasi real-time.	**Data Hub** Develop the required standards, skills and infrastructure to provide secure data services to the circular and performance economy.

Table 7: *Examples of challenges leading to potential new business opportunities in a performance economy*

The complexity of the performance economy is an advantage for Luxembourg as it has an integrated environment that can move fast and bring all the relevant stakeholders together to create the required ecosystem. The national economy also has the required strength in key areas like business consultancy, finance, insurance, accounting and data management. At the same time, it can be an attractive test market as public procurement is moving towards more innovative tenders, which include aspects of the circular economy.

Inventory of major, publicly (co-)funded and CE-relevant methods and tools in Luxembourg, as of mid-2020

	CATEGORY 1	CATEGORY 2	CATEGORY 3
STAKEHOLDER [37]	**REGULATIONS & STANDARDS**	**FINANCIAL ASPECTS**	**KNOWLEDGE CREATION & MANAGEMENT**
MINISTRIES AND ADMINISTRATIONS			
MINISTRY OF AGRICULTURE			- PAN-Bio 2025 strategy for promoting organic agriculture - Antigaspi.lu strategy for reducing food waste - Urban farming strategy in collaboration with MECDD (www.urbanfarming.lu)
MINISTRY OF (THE) ECONOMY	- Circular public procurement for a modular and dismountable parking & innovation hub for the 'Mobility Innovation Campus' - Pilot on circular public procurement for hotel interiors to be launched, following feasibility study in 2018/2019 (http://positiveimpakt.eu/en/portfolio/circular-hotel-interiors) - Tender for Luxembourg World Expo Pavilion 2020 in Dubai, including circular criteria - Product Circular Datasheet (PCDS) for transparent and standardised information on circular materials (www.pcds.lu)	- Fit4 Circularity and Fit4Resilience subsidy programmes (see also Luxinnovation) - Joint study with the Ministry of Finance on developing Luxembourg as a circular business hub, including CE Financing - Pioneering investment subsidies: offering a bonus of 20% of eligible costs if investments aim to implement the CE in a company	- Strategy for implementing circular principles in economic activity areas (www.ecocirc-zae.lu), work also continued by the MEA – Spatial Planning Department - Conference on financing the CE, organised in collaboration with the EIB (https://www.eib.org/en/events/financing-the-circular-economy)

37 The stakeholders in the subcategories are listed in alphabetical order.

	CATEGORY 1	CATEGORY 2	CATEGORY 3
STAKEHOLDER	**REGULATIONS & STANDARDS**	**FINANCIAL ASPECTS**	**KNOWLEDGE CREATION & MANAGEMENT**
MINISTRY OF ENERGY AND SPATIAL PLANNING	- Positive list of healthy materials, with focus on indoor air quality		- 'Éco-urbanisme' guide for urban planning standards to incorporate CE principles
MINISTRY OF (THE) ENVIRONMENT, CLIMATE AND SUSTAINABLE DEVELOPMENT (MECDD) & ENVIRONMENT AGENCY (AEV) NATURE AND FOREST AGENCY (ANF) WATER ADMINISTRATION (AGE)	- Implementation of CE principles in the waste management framework - 'Pacte Climat' for certifying energy management at municipal level, including CE principles (to be extended in version 2.0), carried out by Myenergy - Study on public procurement for the 'Holz von hier' label - Development of sustainability criteria for natural raw materials like woody biomass from managed forests, while also considering trade-offs with other ecosystem services	- Taxation of resource consumption through new waste & resource law - PRIMeHouse subsidy scheme for sustainable construction, in collaboration with Ministries of Housing and Energy - International Climate Finance Accelerator (www.icfa.lu), in collaboration with MFIN, and Luxembourg-EIB Climate Finance Platform	- 'Null Offall Lëtzebuerg' strategy for implementing new waste & resources law, transposing the European directives of the CE package - Strategy on the management of sewage sludge, including nutrient recovery - Urban farming strategy in collaboration with Ministry of Agriculture - Guidelines for the selective deconstruction of buildings and the creation of inventories for the reuse of materials, in collaboration with LIST - Strategy to save drinking water in Luxembourg, based on CE principles - RETHINK project and recommendations by Oekozenter & similar pilot projects on resource management - Luxembourg Sustainable Finance Initiative (LSFI) in collaboration with MFIN (www.lsfi.lu)
MINISTRY OF FINANCE	- Sustainability bond framework LuxFlag, Luxembourg Green Exchange (LGX)	- Application of the reduced VAT rate for various circular services, such as bike repair - Joint study with the Ministry of Economy on developing Luxembourg as a circular business hub, including CE Financing - International Climate Finance Accelerator (www.icfa.lu), in collaboration with MECDD,and the Climate Finance Platform that Luxembourg has set up with the EIB	- LSFI, in collaboration with MECDD

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STAKEHOLDER	**REGULATIONS & STANDARDS**	**FINANCIAL ASPECTS**	**KNOWLEDGE CREATION & MANAGEMENT**
MINISTRY OF HOUSING & FONDS DU LOGEMENT, SNHBM	- LENOZ certification scheme for sustainable houses		- Pilot projects with aspects on circular construction: 'Wunne mat der Woltz', 'Nei Schmelz', and 'Elmen'
MINISTRY OF PUBLIC WORKS & ADMINISTRATION OF PUBLIC WORKS (ABP)	- Public procurement guidelines, including environmental criteria - Methodology and database on healthy materials for indoor air quality		- Guideline for the sustainable construction of public buildings
STATE (CO-) FUNDED AGENCIES AND ORGANISATIONS, PUBLIC INSTITUTIONS			
CFUE			- Integration of CE principles in urban planning processes, e.g. for economic activity areas (https://digital.gouvernement.lu/fr/le-ministere/cellule-facilitation-urbanisme-environnement.html)
CRTI-B	- 'Technical clauses' for construction, including environmental criteria		- 'Guideline for sustainable construction & renovation', including LCA-based criteria for materials & health aspects - Various working groups, including on non-destructive demolition
CSDD			- Definition of 7 principles for CE in Luxembourg through a stakeholder consultation process - 2020 update of ecological footprint calculation for Luxembourg
FONDS DU LOGEMENT			- Guidelines for circular construction in large-scale urban developments, e.g. 'Wunne mat der Woltz' and 'Nei Schmelz'
FUAK			- Guidelines for urban development, based on CE principles (www.fondskirchberg.lu/act)

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STAKEHOLDER	**REGULATIONS & STANDARDS**	**FINANCIAL ASPECTS**	**KNOWLEDGE CREATION & MANAGEMENT**
ILNAS	- Key stakeholder in the development of PCDS and other standards/labels, including management and verification		
LUXINNOVATION		- Delivery of the Fit4Circularity and new Fit4Resilience (including circular principles) programmes on behalf of the MECO	- Clusters offering consultancy on circular principles, e.g. industrial production for the construction sector (e.g. CleanTech & Wood Cluster) - Creative Industry Cluster challenge on circular design - Offer-Demand project, aiming to match demand for CE solutions in urban development projects with appropriate offers from the private sector - Plastic Loops project, aiming to build more localised circular loops for plastics
MYENERGY	- Delivery of the 'Pacte Climat' for certifying energy management at municipal level, including CE principles (to be extended in version 2.0) - Tenders for circular public procurement by municipal authorities (e.g. furniture, consumables)	- 'Pacte Climat' includes subsidies for municipal authorities	- 'Pacte Climat' includes consultancy and training
ŒUVRE NATIONALE DE SECOURS GRANDE-DUCHESSE CHARLOTTE (PHILANTHROPIC ORGANIZATION)		- 'Yes we care 2' funding programme for demonstration projects, including circular and social aspects	
SCRIPT			- Education module on the CE for secondary school classes ('Division de l'innovation pédagogique et technologique')
SNHBM	- Integration of circular construction criteria in planning and tendering procedures for the urban development project 'Elmen'.		

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STAKEHOLDER	**REGULATIONS & STANDARDS**	**FINANCIAL ASPECTS**	**KNOWLEDGE CREATION & MANAGEMENT**
SDK	- Various labels for separate waste collection and a better resource recovery, e.g. 'Ressourcenpotential'	- Take-back system for 'Ecobox', reusable and recyclable container for food leftovers	- Various awareness-raising and training activities, including CE principles - www.flecken-a-leinen.lu online tool for promoting repair and sharing services
MUNICIPALITIES AND MUNICIPAL ORGANISATIONS / SYNDICATES			
CIGL DIFFERDANGE (& SIMILAR EXAMPLES FROM OTHER DISTRICTS)		- Subsidised repair and reuse initiatives, e.g. 'Okkasionsbuttik', 'Velosbuttik', and 'Butzebuttik' (http://www.cigl-differdange.lu/fr/activites.html)	
EMWELTBERODUNG LËTZEBUERG (EBL)	- www.NOBE.lu tendering tool for green procurement		
MUNICIPALITY OF SCHIFFLANGE	- Development of tendering procedures for public infrastructure in new economic activity area 'Op Herbett', integrating CE criteria		- Studies integrating the CE in the planning procedure for new economic activity area 'Op Herbett'
MUNICIPALITY OF WILTZ (HOTSPOT EC)	- Public procurement for municipal buildings includes CE criteria, e.g. town hall, industrial building, new primary school (with focus on healthy materials) - Overhaul of construction permit regulations to include CE criteria		- CE project manager hired by municipality - Various training and awareness-raising initiatives: circular innovation hub, reintegration workshop 'Klimbim', local guided tours, etc. - Collaboration with local businesses in an economic activity area for better resource management (following study on regional material flows)
NATURPARK MËLLERDALL			- LEADER project CIRCLE for awareness-raising about the CE for citizens and companies
PROSUD			- 'Circulab Sud' training programme for primary schools on the CE.

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STAKEHOLDER	**REGULATIONS & STANDARDS**	**FINANCIAL ASPECTS**	**KNOWLEDGE CREATION & MANAGEMENT**
SYNDICAT DES EAUX DU SUD (SES) (& OTHERS)			- Pilot project for growing bio-sourced materials without fertilisers or pesticides in drinking water protection zones, e.g. flax oil for coatings or miscanthus grass for construction materials
VILLE D'ESCH-SUR-ALZETTE		- Active support for local initiatives and NGOs focusing on the CE, e.g. Transition Minett (project Reconomy, Facilitec), Upcycling BENU, etc.	
VILLE DE LUXEMBOURG			- Studies for the development of the 'Hollerich' urban area include CE criteria - Study for a resource centre (new recycling centre), including CE elements (repair, reuse, etc.)
RESEARCH, DEVELOPMENT AND INNOVATION (RDI)			
BENU VILLAGE ESCH			- Exploratory initiative for an EcoVillage built from recovered materials and featuring upcycling activities (www.benu.lu)
CELL			- 'ÄERDSCHËFF' pilot project, a participatory construction project using recovered materials, in collaboration with ABP (https://www.cell.lu/project-list/actiongroups/)
IBLA			- Showcase project to optimise organic material cycles in Luxembourg's wine sector - Study to update ecological footprint calculation for Luxembourg, on behalf of CSDD

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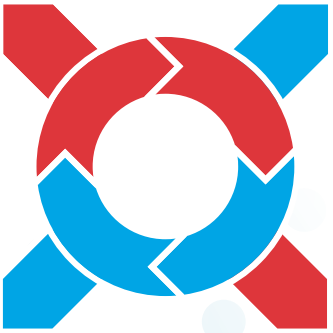
STAKEHOLDER	**REGULATIONS & STANDARDS**	**FINANCIAL ASPECTS**	**KNOWLEDGE CREATION & MANAGEMENT**
LIST	- Ecopact tool for the calculation of Environmental Product Declarations (EPD), competences in LCA linked with the CE		- Green Innovation Centre: integrated open innovation research infrastructure for environmental and industrial biotechnology in Luxembourg, demonstration of enabling technologies for the circular bio-economy - Project on Adhesive-Free Timber Buildings: featuring composite modelling & simulation https://www.nweurope.eu/media/6498/brochuredigitalfinal1_toweb_20190515rev.pdf
PÔLE D'INNOVATION NEOBUILD			- European Interreg project GROOF (Greenhouses to Reduce CO2 on Roofs, https://www.cdec.lu/groof/): multiple-use roof space for food production and energy efficiency
UNIVERSITY OF LUXEMBOURG			- RDI projects on eco-construction, including modularity and deconstruction, concrete recycling, alternative construction materials, etc. (https://econ4sd.uni.lu/work-packages/) - RDI projects on the challenges of implementing CE Policies, with a focus un SMEs (https://circular.uni.lu) - 'Food Water Energy Nexus' project (https://sustainabilityscience.uni.lu/nexus-futures-about-the-project-new/?lang=en)



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