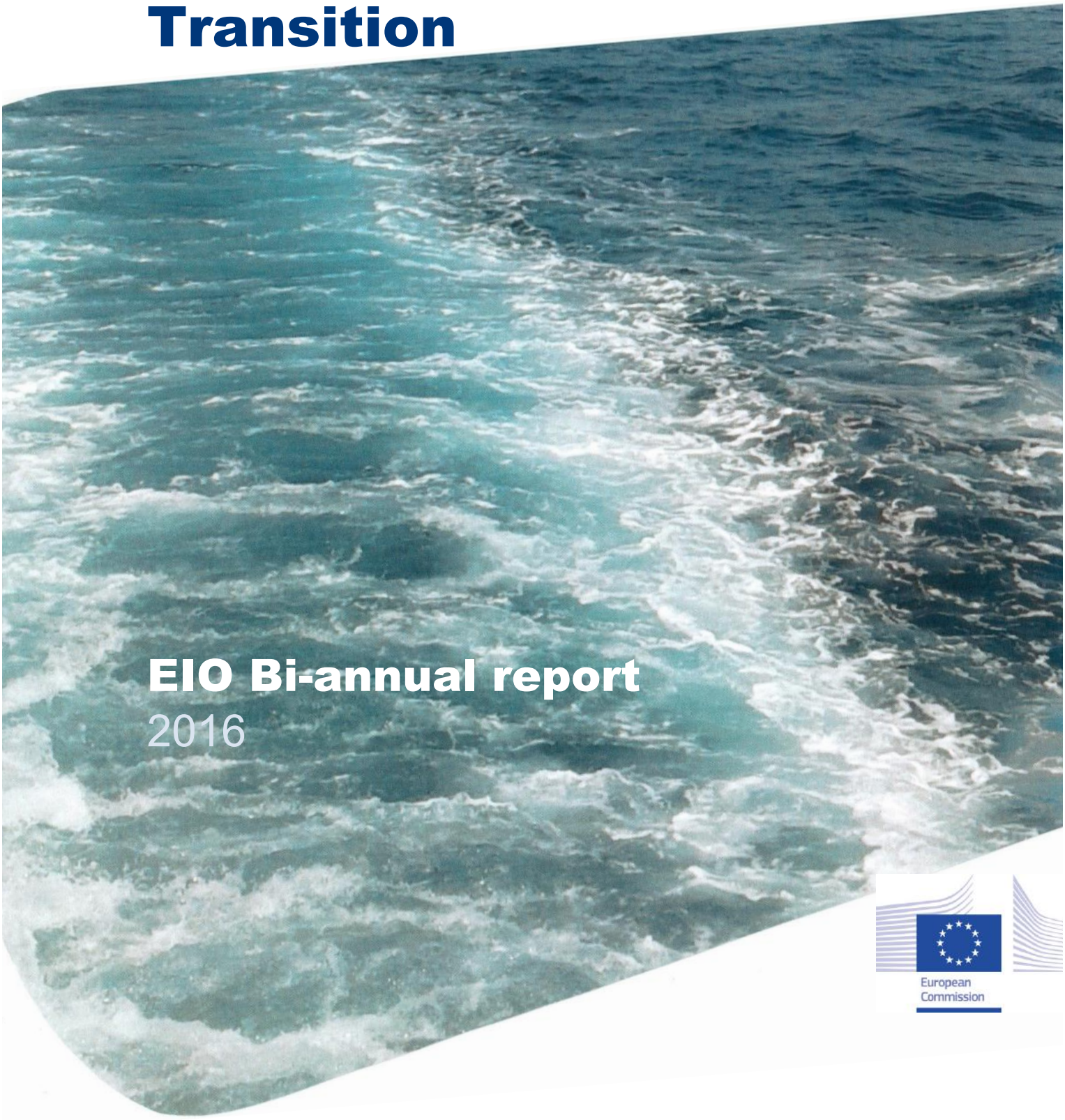
eco-innovation observatory

Policies and Practices for Eco-Innovation Up-take and Circular Economy Transition



EIO Bi-annual report

2016

European Commission

Policies and Practices for Eco-Innovation Up-take and Circular Economy Transition

EIO bi-annual report

November 2016

Asel Doranova, Laura Roman (Technopolis Group, Belgium)

Bettina Bahn-Walkowiak, Henning Wilts, Meghan O'Brien (Wuppertal Institute for Climate, Environment, Energy, Germany)

Stefan Giljum (Vienna University of Economics and Business, Austria)

Mary Ann Kong, Mathieu Hestin (BIO by Deloitte, France)

Eco-Innovation Observatory

The Eco-Innovation Observatory functions as a platform for the structured collection and analysis of an extensive range of eco-innovation information, gathered from across the European Union and key economic regions around the globe, providing a much-needed integrated information source on eco-innovation for companies and innovation service providers, as well as providing a solid decision-making basis for policy development.

The Observatory approaches eco-innovation as a persuasive phenomenon present in all economic sectors and therefore relevant for all types of innovation, defining eco-innovation as:

"Eco-innovation is any innovation that reduces the use of natural resources and decreases the release of harmful substances across the whole life-cycle".

To find out more, visit **www.eco-innovation.eu** and **ec.europa.eu/environment/ecoap**

Acknowledgments

We would like to express our gratitude to the country experts for their work effort for the preparation of the country reports and good practice examples and we would also like to recognise the contributions of the members of the EcoAP High Level Working Group for their feedback on the EIO country reports. The authors would like to Paola Migliorini for her valuable comments and the review of this report.

A note to Readers

Any views or opinions expressed in this report are solely those of the authors and do not necessarily reflect the position of the European Union. A number of companies are presented as illustrative examples of eco-innovation in this report. The EIO does not endorse these companies and is not an exhaustive source of information on innovation at the company level.

Table of contents

List of figures

List of tables

List of good practices

List of boxes

Executive Summary

The Eco-Innovation Observatory (EIO) is a EU-funded initiative collecting and analysing information on eco-innovation trends and markets in Europe. The annual reports (EIO 2011, EIO 2012, EIO 2013, EIO 2014) introduce and exemplify the concept of eco-innovation and analyse findings of the EU Member States' eco-innovation performances based on targeted indicator systems. They also reflect on emerging trends and developments in the European Member States in the context of resource efficiency and, based on the rapidly expanding pool of good practice examples of the European countries, undertake foresight assessments on the future orientation of eco-innovation.

Each EIO annual report (AR) has a special thematic focus: The first AR (EIO 2011) specified the role of material resources and resource efficiency for eco-innovation, the second AR (EIO 2012) focused on business opportunities of eco-innovation, the third AR (EIO 2013) on the issue of how different stakeholders can contribute to building a green economy, and the fourth AR (EIO 2014) focused on how a transition to a circular economy could be enabled.

This report further expands the focus on circular economy aspects of a resource-efficient society and strategies to cope with the challenges of these strongly intertwined concepts. Eco-innovation for a circular economy means contributing to resource efficiency. However, closed loop circulation is no easy task in a predominant linear economic system and calls for systemic, social, organisational, process, marketing, product, and design eco-innovation.

What is eco-innovation?

"Eco-innovation is any innovation that reduces the use of natural resources and decreases the release of harmful substances across the whole life-cycle" (EIO 2011).

Recently, the **understanding of eco-innovation has evolved** more and more from a customary understanding of innovating to reduce environmental impacts towards a renewed understanding of innovating to minimise the use of natural resources and the release of harmful substances over the whole life cycle, i.e. in the design, use, re-use and recycling phases of products, materials *and* services related to them. New concepts such as sharing, leasing and remanufacturing also contribute to those eco-innovation efforts. The motivations behind these innovations are not necessarily environmental; rather they often make good business sense, with environmental benefits a favourable side-effect.

32 good practice examples have been selected from the 28 Eco-Innovation Observatory country profiles and featured in this annual report. They altogether provide **evidence for the multifaceted and impressive eco-innovation potential of the EU MS**.

The vision: eco-innovation as a means to reach a resource-efficient and circular economy in Europe

There are manifold approaches to reduce the resource use of the economy and increase resource efficiency and circularity. In the context of circular economy the 3 R's are most widely known: reduce, reuse and recycle. But—considering the fact that the 3 R's are mainly focused on the end of the life-cycle, i.e. waste options—further concepts have been brought onto the agenda: waste prevention, sharing/leasing, repair, remanufacturing, and—finally—recovery. These concepts also include other stages of the life-cycle, including the design and use phase.

The vision is to deploy eco-innovation as a means to move towards a resource-efficient circular economy in Europe by intelligently applying all those concepts at those levels where they contribute best, e.g. sharing and reusing electronic goods and clothes, prevention of food and packaging waste, or recovery of critical materials and fertilizers, etc.

Top down and bottom-up circular economy challenges

In Europe, the circular economy concept has been embedded in a policy context that refers to the green economy concept and the ambitions for a resource-efficient and low-carbon society. As this report reveals, the performances across EU countries concerning eco-innovation, resource efficiency, recycling and circularity, infrastructures and measures vastly diverge.

While the benefits of a circular economy transition are increasingly recognised by government, businesses and civil society, there are many barriers hindering investments in necessary measures at the EU, national, regional and local levels. At the same time, there is a need to address and involve key actors and stakeholders for such a fundamental transition: industry and businesses, citizens, civil society and NGOs, research and development, governments.

The circular economy transition will be powered by a combination of bottom-up movements and societal developments and top-down changes of framework conditions from governments. In this respect, the transformative potential of urban and regional developments like repair cafés, sharing, reuse and refurbishment and waste prevention initiatives are needed as much as organisational innovation in businesses like re-manufacturing, repair, maintenance, recycling and eco-design, which include many business opportunities for SMEs. At the same time, government policies should secure favourable framework conditions pushing for different types of eco-innovation that play a role for future citizens and businesses and induce behavioural and lifestyle changes that are more sustainable than existing solutions.

For a successful implementation, a mix of policy measures will be required to support circular economy at national and local levels by introducing rightly chosen and designed policy measures that motivate or regulate resource efficiency, waste reduction, recycling, re-use and remanufacturing and create demand for sustainably designed products as well as resource saving services.

Emerging trends and business models

New technologies, design concepts, services, and innovative forms of co-operation are already contributing to the circular economy across the EU today. However, a fully-fledged circular economy will require radical and systemic eco-innovations in order to transform the linear patterns of production and consumption which have evolved over the last two centuries, creating wasteful regimes of over-consuming natural resources.

The circular economy involves eco-innovations in two very different fields that may be labelled as circular economy “hardware” and “software”: The technologies and technical infrastructures that would allow for turning waste into resources again (hardware) and the skills, expertise and business models which would turn this transformation processes into business opportunities (software).

Circular economy eco-innovations encounter great challenges in resource intensive sectors and value chains. But, there are viable eco-innovation activities in different fields and sectors that highlight the innovation potential of the circular economy framework. These concern, inter alia, plastics, bio-based products, food waste, critical raw materials, construction & demolition. A number of business cases in all EU Member States have already proved

successful in key areas and have the potential to be transferred to other countries, as the good practice examples demonstrate.

Circular economy and eco-innovation performance of countries

Eco-innovation plays a central role in transforming the traditional linear system of production and consumption into an economic system characterised by circular flows of raw materials. However, performance across the EU MS is very heterogeneous. Countries differ widely with regard to the share of material use being recycled as well as with regard to many other aspects, such as employment and turnover in sectors engaging in circular economy activities, waste generation and resource productivity. The **circularity performance of EU MS** shows a high variation in the recycled quantity of DMC (Domestic Material Consumption), ranging from 0.3% in Latvia to 36% in Luxembourg. Apart from deviations in the actual performance, this large variance can also be explained by data constraints and different accounting systems. The number of people employed in selected recycling, repair and reuse sectors is between 0.4 (Greece) and 3.2 (Latvia) per thousand inhabitants and the operating turnover per number of people employed shows that some countries generate significant revenues in these sectors.

In the 2015 version of the **Eco-innovation scoreboard**, Denmark scored by far highest of all EU countries, with an aggregate score of 167. Denmark was followed by Finland (score of 140), Ireland (134) and Germany (129). Also Sweden, Luxembourg and France have been grouped to the "eco-innovation leading" countries. Nine Member States obtained scores around the EU average of 100 and were therefore addressed as "average eco-innovation performers". The aggregated eco-innovation scores in this group range from 108 (Austria) to 96 (Slovenia). With the exception of Greece, all countries found in the group of "countries catching up in eco-innovation" were new Member States. Aggregated scores in this country group range from 82 in the case of Romania to 49 in the case of Bulgaria.

In order to put European eco-innovation performance in an international context, the Eco-Innovation Observatory started to develop a **Global Eco-Innovation Scoreboard** in 2013. The Global Scoreboard covers 126 countries. The group of the top-20 performers is dominated by European countries, with 13 EU countries plus Switzerland, Norway and Iceland being among the global eco-innovation leaders. Only Singapore (rank 5), Australia (rank 16) and Canada (rank 20) are also found among the top-performing countries.

Towards an eco-innovation policy for a resource-efficient circular economy

Every EU Member State has a set of policy measures related to elements of a circular economy, largely shaped under the waste and resource efficiency policies and widely focusing on aspects like addressing material resource losses via savings. A few countries have adopted or are close to adopting a dedicated strategy or action plan on the transition to a circular economy. There are also examples of circular economy focused strategies that have been taken up by regional governments. These show an increasing **prioritising of circular economy in national and local strategies**.

To promote initiatives of circular eco-innovations, routine practices need to be transformed into new practices based on sharing, reusing, repairing, as well as remanufacturing. In addition, in order to address barriers at the local level, the national and local governments can deploy a **range of policy measures**. These include, among others:

- Regulatory instruments, such as regulations on recycling, producer responsibilities, eco-design, mandatory targets, codes, standards, and certification for products;

- Economic instruments, including fiscal and financial incentives, direct funding, and public procurement;
- Research, development and deployment support measures, such as grants for R&D and piloting activities, R&D infrastructure, innovation vouchers, supporting innovation incubation, and R&D personnel;
- Information, education and networking support measures, for example, advising, training, offering direct support in activities to SMEs, customers, technology adopters, promotion of networking, providing information, and supporting public private partnerships, and
- Voluntary measures, such as performance labels and guarantees for products and services, or voluntary agreements and commitments.

However, the application of these measures in the context of circular economy development in Member States is rather selective and not very widespread, thus calling for expansion into ambitious mixes of circular economy instruments.

Key findings

- The term circular economy is currently penetrating the strategic national policy agendas of many EU Member States. A few countries address them in a more generic context of the resource efficiency strategies (with a narrow definition based on material efficiency, recycling and waste prevention or management); other examples show more ambition and developed comprehensive strategies (containing a more systemic approach tackling the products design, durability, reuse, reparability, etc. as well as promoting new business models).
- The eco-innovation performance, as measured with the Eco-Innovation Scoreboard (Eco-IS) varies widely across EU Member States. Northern and Western European countries (Denmark, Finland, Ireland and Germany) are generally characterised by high inputs into eco-innovation in terms of R&D spending and investments, high eco-innovation activity of companies as well as comparatively high eco-innovation outputs. New MS are mostly found in the group of "countries catching up in eco-innovation".
- The Global Eco-Innovation Scoreboard, which compares the eco-innovation performance of 126 countries worldwide, illustrates that many European countries, including non-EU countries such as Switzerland, Norway or Iceland, are found among the global eco-innovation leaders.
- Monitoring and assessing the performance of the circular economy is still a challenge due to insufficient presentation of the circular economy elements by existing indicators.
- Promising eco-innovations with the potential to be scaled-up can be seen across the EU, with many eco-innovations however concentrated in market niches. Bottom-up approaches like repair, reuse and sharing set powerful examples of change, but they have not, yet, reached the mainstream.

Main messages

- Activities at the Member States level are still overwhelmingly focused on waste management measures indicating **needs for support for a transformation from waste to a circular resource management** and the breaking of the "lock-in" in existing systems. This could be achieved by moving towards alternative systems for consumption (like

sharing, reuse), production (e.g. repair, remanufacturing) and eco-innovative product design and corresponding framework conditions as vital elements.

- Barriers to the transition towards a circular economy are, inter alia, falling commodity prices, insufficient investment, lack of skills and know-how, limited acceptance of alternative models of consumption and business, and lack of policy coherence. These have to be addressed in a comprehensive way by **favourable framework conditions** (e.g. embracing regulation, institutional settings, targets, instruments, curricula, infrastructures, networks, key actors, etc.).
- National and local governments can deploy a **large range of policy measures** (i.e. regulatory instruments, economic instruments, R&D support measures, infrastructure provision, information, education and networking support measures, and voluntary measures) to promote initiatives of circular eco-innovations. Governments can learn from existing policy good practices that have emerged in selected EU Member States.
- The circular economy will have **different meanings and different roles and responsibilities for different stakeholders**. Framework conditions should provide direct or indirect incentives to act, plan, consume, produce or engage in business contributing to the circular economy.
- **Different types of eco-innovations**, i.e. product, process, organisational, marketing, social, system eco-innovation, are instrumental in transforming a linear economy into a circular economy.

The circular economy will require **"hardware" and "software" eco-innovations**: technologies and technical infrastructures and skills, expertise and business models. Supporting the "hardware" may rely on the conventional innovation support instruments, but development of "software" requires innovative approaches in policy making in order to achieve changing mind-sets for sharing, remanufacturing, reuse and repair.

1 | Introduction

The pace of innovation and technological change is unprecedented today. While many innovations and technological achievements are expected to be helpful in order to strive for the reduction of environmental pressures and progress towards circularity, there is much uncertainty and risk, and many innovations doubtlessly still contribute to accelerating resource use and wastage due to rebound effects.

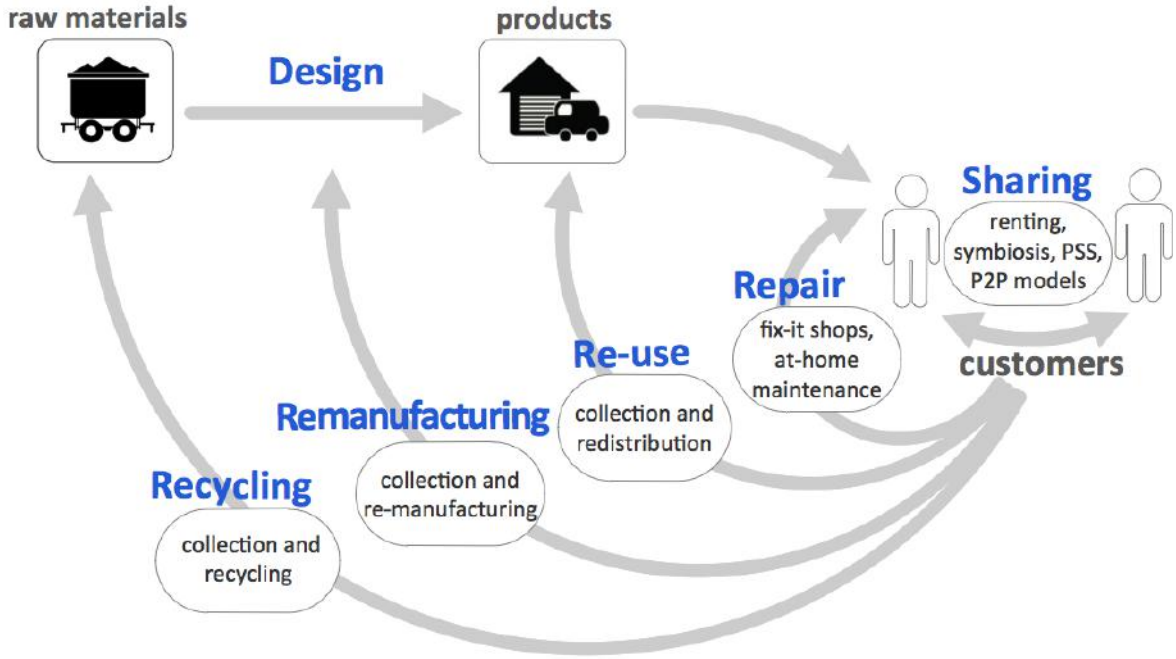
The current system of production and consumption can be characterised as a predominately linear system. Resources are extracted, processed, used and disposed as waste. At the end of a products' life cycle wastes are typically incinerated (thermal recovery) or landfilled. In both cases, materials are withdrawn from or eliminated within the economic system, even if some energy is regained through thermal utilisation. Such a linear economic model is able to persist as long as resources are abundant within a world of infinite needs. However, the global demand for resources is still increasing and both non-renewables and also renewables are limited. In the long term, a linear economic model must reach its limits (Wilts 2016).

However, there are a multitude of alternatives approaches to break up the linear path-dependent economy, reduce its resource use, increase its resource efficiency and minimise its generation of hazardous substances and wastes. These are known as the 3 R's: **reduce** (i.e., decrease the demand and the use of raw materials, intermediates and products); **reuse** (i.e., reutilisation of products or components of products); and **recycle** (i.e., feed back substances and materials into the system). All those approaches support a circular economy as a fundamental alternative to the linear economic model (EEA 2015, p. 9).

Besides the famous 3 R's, further essential elements of a circular economy have been brought onto the agenda. These include: **refurbish, sharing/leasing, remanufacture, recovery,** and **repair** while reduce (in the sense of waste prevention and minimisation of hazardous substances) plays also a prominent role (European Commission 2014).

The vision is to deploy eco-innovation as a means to reach a resource-efficient circular economy in Europe.

Figure 1-1 A simplified illustration of a circular economy



Source: Based on EIO 2014, p. 4.

The goal of a sustainable resource and waste management must be to ultimately achieve a transition to a fully fledged circular economy within this century (WBGU 2016, p. 85), i.e. to preserve the value of the resources and materials as long as possible, to reuse them as often as possible and, ideally, to generate no or as little as possible waste. The concept includes all sectors of the economy, from resource extraction over the production, storage and consumption, as well as the disposal or recycling. Through the closing of loops waste shall become a resource again (so-called "second-sourcing"). But to implement this idea as extensively as possible, the consideration of reuse, repair, remanufacturing, sharing and recycling is necessary as well as eco-innovation and circular economy aspects in the product design (Wilts 2016). Stronger eco-innovation efforts are needed for each option.

Eco-innovation is a vital element of all circular economy efforts. Within the Eco-innovation Observatory, eco-innovation is defined as any innovation that reduces the use of natural resources and decreases the release of harmful substances across the whole lifecycle (EIO 2010). Eco-innovations with the potential to enable the transition to a resource-efficient circular economy model span efforts to change dominant business models (from novel product and service design to reconfigured value chains), transform the way citizens interact with products and services (ownership, leasing, sharing, etc.) and develop improved systems for delivering value (sustainable cities, green mobility, smart energy systems, etc.) (EIO 2014, p.8).

Table 1.1 presents the scope of different types of eco-innovation related to the circular economy. It portrays the wide array of avenues to eco-innovation that may play a role in different aspects of the transformation: for example from changing behaviours to adapting technologies.

Table 1-1 Types of eco-innovation for a circular economy

Type	Brief descriptions, examples & keywords
Product design eco-innovation	**Overall impact on the environment and material input is minimised over the whole product's life cycle** Allowing for recovery options like repairing, maintenance, remanufacturing, recycling and cascading use of components and materials (e.g. Fairphone)
Process eco-innovation	**Material use, emissions and hazardous substances are reduced, risks are lowered and costs are saved in production processes** Advancing remanufacturing, such as - Refurbishment by replacing or repairing components that are defective, including the update of products - Disassembly and recovery at the component, material and substance level - Upcycling, functional recycling, downcycling → Zero waste production, zero emissions, cleaner production
Organisational eco-innovation	**Methods and management systems reorganisation pushing for closing the loops and increasing resource efficiency** New business models e.g. industrial symbiosis, new collection and recovery schemes for valuable resources (incl. Extended Producer Responsibility/Individual Producer Responsibility), → From products to functional services (product-service systems)
Marketing eco-innovation	**Product and service design, placement, promotion, pricing** Promotion of the reuse for the same purpose (e.g. bottles, appliances), promotion of the reuse for different purposes (e.g. tyres as boat fenders, for play grounds) → Eco-labelling, green branding
Social eco-innovation	**Behavioural and lifestyle changes, user-led innovation** Sharing (e.g. domestic appliances, books, textiles), collaborative consumption (e.g. flats, garden tools) sufficiency (e.g. plastic bag bans) → Smart consumption, responsible shopping, use rather than own schemes
System eco-innovation	**Entirely new systems are created with completely new functions reducing the overall environmental impact** Leading to a substantial dematerialisation of the industrial society → New urban governance, smart cities, permaculture

Source: Adapted on the basis of EIO 2014.

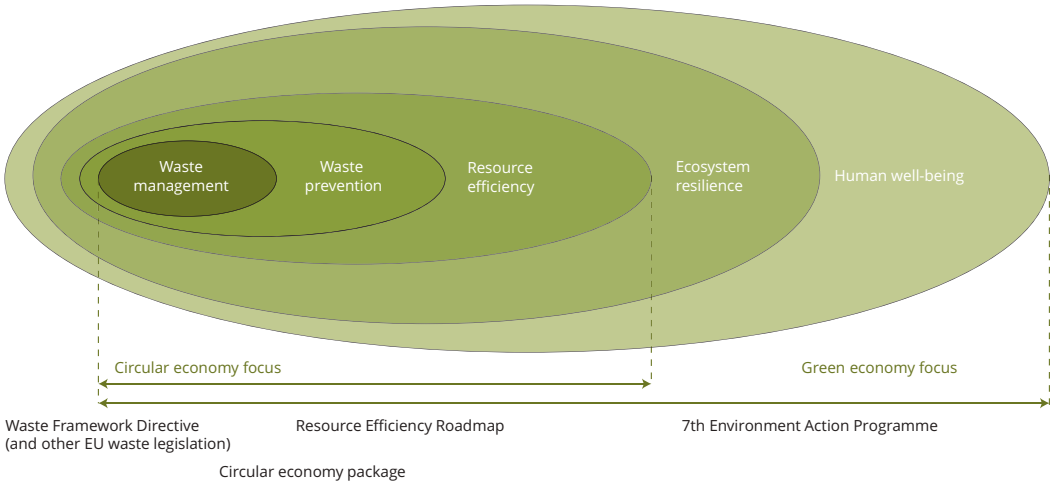
2 |The role of policy for eco-innovation in the circular economy transition: how change can be driven

2.1 |Creating framework conditions for fostering the Circular Economy

2.1.1 Circular economy in a wider policy context

The concept of a circular economy is relatively new at the European level, but the term has been in use for some years, e.g. in China, Japan, and Germany, notwithstanding that those countries have not implemented a fully-fledged circular economy already. In Europe, the circular economy concept has recently been embedded in a wider policy context referring to the green economy and the strive for a resource-efficient and low-carbon society (see figure below) (European Commission 2015). As yet, circular economy activities at the Member State level are still overwhelmingly regarded as waste management measures (EEA 2016b), which indicates a lack of knowledge and general uncertainty in the transformation to a circular resource management and neglects the eco-innovation efforts in the stage of product design.

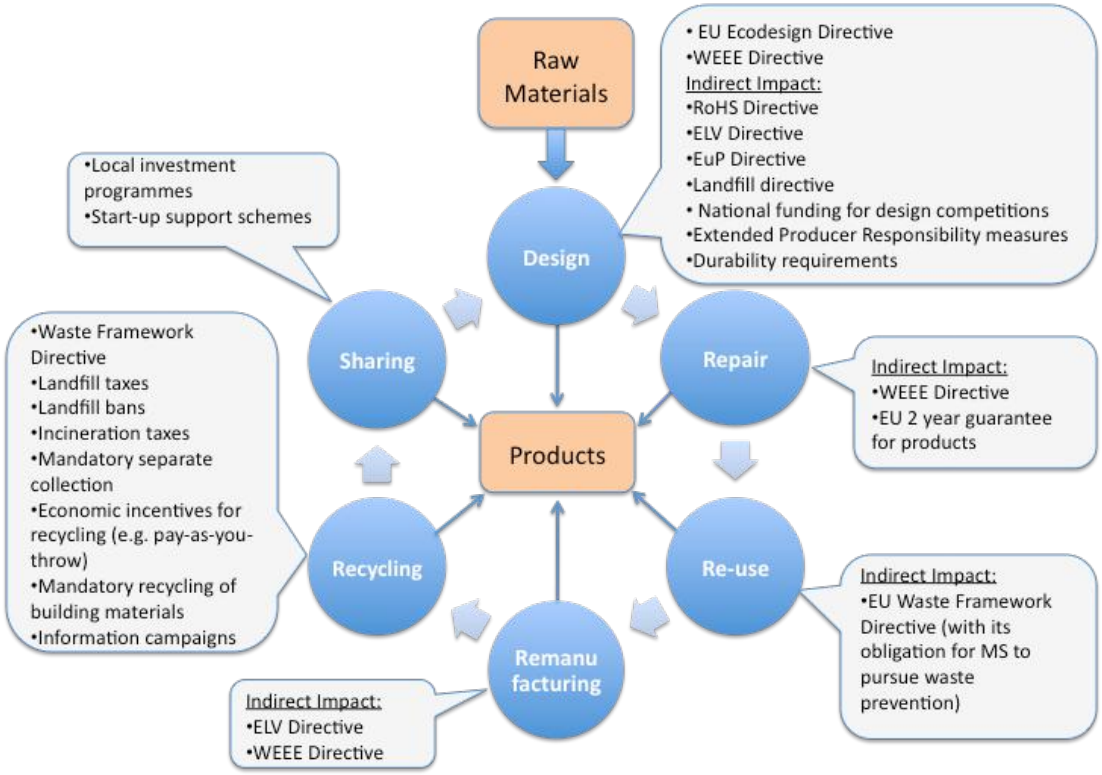
Figure 2-1 Circular economy in the wider policy context



Source: EEA 2016a, p. 31.

However, eco-innovation and circular economy concepts and activities need to be more closely linked. The Waste Framework Directive provides for technical requirements and regulations (e.g. mandatory recycling quota for several waste streams) but, as yet, the institutional settings and the country-specific planning for circular economy issues vary significantly from country to country with regard to contents, ambitions, targets and choice of policy instruments and it mainly focuses on waste management (Bahn-Walkowiak et al. 2014). The following figure shows where the current policy framework has direct and indirect impacts on the different options and phases of a circular economy.

Figure 2-2 Overview of existing instruments and approaches for a circular economy in EU*



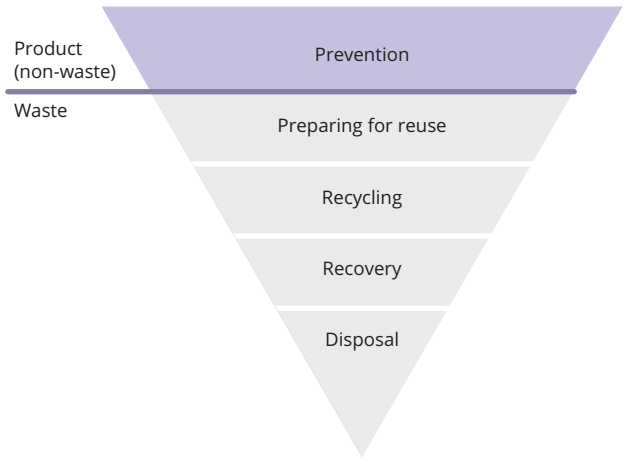
Source: Doranova and Gigli 2014.

The EU MS also often lack an integrated infrastructure planning for waste infrastructures, with corresponding counter and side effects on resource efficiency and circular economy. For example, regional waste incineration over-capacities act as an incentive to use those usually capital-intensive incineration plants at full capacity but they do not drive a circular economy. The current diverging country performances concerning waste recycling rates, infrastructures and waste prevention measures in place indicate that—as long as waste is still looked at as a cost factor instead of as a "resource"—regulatory instruments are often more effective than economic instruments (Bahn-Walkowiak et al. 2014).

Policy approaches are frequently not sufficiently considering the waste hierarchy and circular necessities and thus lead to unwanted effects. A policy for diverting waste from landfill without considering an alternative and eco-innovative treatment for a pathway further up the waste hierarchy, which might be environmentally and economically appropriate in the specific context, can lead to results, which:

- are ineffective (e.g. recycling focus on less resource-intensive waste fractions instead of the resource-intensive ones),
- induce unwanted pathways (e.g. investment in capital-intensive incineration capacities without taking account of future shifts such as recycling) or
- have a completely counterproductive effect (e.g. illegal dumping).

Figure 2-3 Waste hierarchy



Source: The European Parliament and the Council of the European Union 2008.

2.1.2 Barriers to a better circular performance

While the benefits are increasingly recognised there are many barriers to the transition to a circular economy indicating investment in a series of necessary measures at the same time:

- Insufficient **investment** in recycling and recovery infrastructure, and eco-innovation and eco-technologies for closing the loops;
- Insufficient **skills and investment** in circular product ecodesign and production which could facilitate greater re-use, remanufacture, repair and recycling;
- Challenges in obtaining **suitable finance** for eco-investment;
- Current levels of **resource pricing** create economic signals that do not encourage efficient resource use, pollution mitigation or innovation;
- Limited **consumer and business acceptance of potentially more efficient service oriented business models**, e.g. leasing rather than owning, performance-based payment models;
- Insufficient **waste separation at source** (e.g. for food waste, packaging);
- Lack of incentives due to the insufficient **internalisation of externalities** through policy or other measures;
- Limited **information, know-how and economic incentives for key elements in the supply and maintenance chain**, e.g. for repair and reuse, on chemical composition of certain products such as substances in electronic devices;
- Limited **sustainable public procurement** incentives in most public agencies (i.e. Green Public Procurement);
- Non-**alignment of power and incentives between actors within and across value chains** (e.g. between producers and recyclers) to improve cross-cycle and cross-sector performance;
- Shortfalls in **consumer awareness** (e.g. perishability of food products);

- Weaknesses in **policy coherence at different levels** (e.g. bioenergy and waste policies) (adapted from European Union 2014).

A circular economy will need to address all stakeholders for such fundamental transition: businesses, citizens, civil society, and governments (EEA 2016a) as well as take different action at the EU, national, regional and local levels.

2.1.3 Key actors in building a circular economy

Implementing policies towards building a circular economy model requires the participation of many different types of stakeholders. This is particularly true for implementing a coherent strategy, when a wide range of actors should be involved, including national/regional/local governments, local businesses, NGOs, social enterprises, consumers/citizens, academic and research centres. Diverse roles and potential inputs by diverse stakeholders are summarised below.

Table 2-1 Key actors to be involved and their role in promoting circular economy

National, regional, local authorities and agencies dealing with industrial development and waste • Ensuring policy, regulatory support, introduction of support measures, as well as technical and financial support • Facilitating the dialogue with, and between, research organisations, businesses and civil society organisations • Leading, or involvement in, project development, implementation, monitoring of project activities and the financial allocation • Supporting awareness raising and education amongst the population and promoting more sustainable lifestyle, sharing, re-use, recycling
Businesses and industries • Developing and investing in new sustainable businesses, business models, products and services based on circularity principles, symbiosis • Cooperating with authorities in implementing initiatives and helping to scope visions for the greening and circularity in regions, cities and communities • Cooperating with research organisations in developing new eco-innovative and circular solutions
National, regional or local innovation agencies and intermediaries • Advising SMEs and organisations on innovation measures • Advising or playing an active role in the development and implementation of projects and monitoring project activities, outcomes and impacts • Cooperating with authorities in implementing eco-innovation initiatives and scoping visions for the greening of regions, cities and communities • Promoting or lobbying for specific regulations or policy decisions
Research organisations, cluster organisations and universities • Cooperating with authorities in implementing sustainable initiatives and helping to scope visions for the greening and circularity of regions, cities and communities • Cooperating with SMEs and industries in developing new solutions • Facilitating or taking an active role in project development and implementation, and the monitoring of project activities, outcomes and impacts
• **NGOs, citizens, user groups** • Participating in priority setting for eco-innovation initiative planning • Educating and raising awareness amongst the population and promoting social innovations in areas such as lifestyle and mobility

- Supporting project planning, implementation and monitoring
- Creating networks and mobilising local efforts
- Lobbying for specific regulations or policy decisions
- Co-creating and co-testing of new eco-innovations by users, NGOs, citizens, user groups
- Supporting the dissemination of eco-innovations towards a circular economy
- Supporting eco-innovative or sustainable systems such as recycling, eco-mobility and sustainable lifestyle

Source: Based on Doranova and Gigli 2014.

For all those stakeholders, eco-innovation for a circular economy will have different meanings and involve different approaches and responsibilities. This requires a systemic approach that "makes use of a wide toolkit of policies and measures, across different points of value changes and affecting the full set of private and public stakeholders. Given the multi-level governance approach needed, options can be structured across different actors (e.g. EU, Member State, regional and local authorities, private sector, civil society, citizens), levels and timeframes, keeping in mind that in some areas circular economy benefits will materialise as a result of own initiatives by the private sector, while in other areas support (including public intervention) will be needed to encourage transitions" (European Union 2014, p. 54).

2.2 |Building a circular economy from the ground up

Grounded on the idea that the circular economy transition will be powered by a combination of bottom-up and top-down changes, eco-innovation can transform individual behaviour and also create new forms of interactions between people or change peoples' relationship with products.

The transformative potential of cities and urban regions, for example, is important at different levels by contributing to a sustainable development and in practice by a multitude of circular economy relevant approaches, like initiating and running repair cafés, sharing, reuse and refurbish initiatives, and promoting waste prevention approaches, etc. which are, first and foremost, implementable at local levels (Maschkowski and Wanner 2014). At present, this is a niche development mentioned here in order to illustrate the ideas of bottom-up initiatives. As an organisational innovation in businesses re-manufacturing, repair, maintenance, recycling and eco-design can however create business opportunities for SMEs and "have a great potential to become drivers of economic growth and job creation while, at the same time, making a significant contribution to addressing environmental challenges" (European Commission 2014).

This section briefly shows different types of eco-innovation that play a role within a circular economy for future citizens *and* businesses and provides good practice examples from the country reports. A social (and sometimes user-led niche innovation) can induce behavioural and lifestyle changes that are more sustainable than existing solutions and thus "reduce impacts on the environment, but also re-structure social relations in one form or the other" (EIO 2013).

2.2.1 Re-use, sharing and collaborative consumption

Re-use is a critical part of the 3R waste management strategy (reduce, reuse, recycle) and eco-innovation can play a central role in enabling re-use, sharing and collaborative consumption. From the product perspective, re-use relates to aspects like longevity, durability, and reparability, and thus closely links to product design. Social eco-innovation such as sharing and

collaborative consumption, often induced by user-led social eco-innovation and new business models, emerge as particularly relevant. Re-use is linked to social enterprises as well as citizen movements and relates to changes in consumption and disposal behaviour. This can play an important role notably in eco-innovative business models based on service provision and is instrumental in models based on sharing, leasing and product-service systems, which require extensive use of goods by multiple users and increase the need for regular maintenance and repair, be it commercial or non-commercial (see examples for business models in chapter 3).

Good practice 1 Vigga – circular subscription of baby clothes, Denmark

Vigga – circular subscription of baby clothes

One of the biggest issues for parents is that babies grow out of their cloths quickly. It's both expensive and a waste of resources. Vigga offers a circular subscription model for baby clothes. The baby clothes are made from organic fabrics and once the baby has grown out of the clothes they are returned to Vigga. There the clothes are dry cleaned in an environmentally friendly way and made ready for another baby.

Keywords: Baby clothes, circular subscription, reuse

Link: http://www.vigga.us/in-english/

Contact: kundeservice@vigga.us

Good practice 2 Free Trade Ireland

FreeTrade Ireland

Freetradeireland.ie is a free online reuse service funded by the EPA National Waste Prevention Programme that allows its users to pass on unwanted items for free, from furniture to electronic goods and garden equipment.

In 2014, FreeTrade Ireland diverted 18,220 items, amounting to more than 216 tonnes of materials, away from landfill. The use of the service resulted in CO_2 savings of approximately 1,944 tonnes. Using conservative estimates for item values, it is calculated that FreeTrade users saved €679,000 in 2014 in terms of avoided purchases. The service continues to prove an excellent value-for-money waste prevention initiative, with a €17 return on every €1 invested by the EPA in 2014.

FreeTrade Ireland has also developed a partner reuse exchange service for public sector organisations in order to maximise resource efficiency in the public sector.

Further information:

http://www.freetradeireland.ie/About.html

Environmental Protection Agency (EPA), 2014, Towards a Resource Efficient Ireland. A National Strategy to 2020 incorporating Ireland's National Waste Prevention Programme http://www.epa.ie/pubs/reports/waste/prevention/towardsaresourceefficientireland.html

Keywords: reuse; waste prevention; resource efficiency

2.2.2 Repair and maintenance

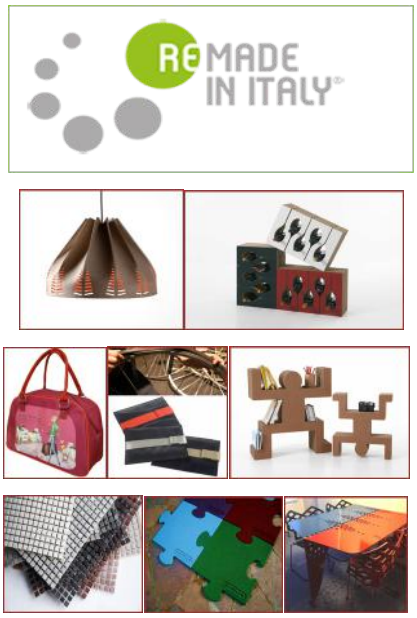
Repair[1], maintenance[2] and remanufacturing[3] can be characterised as service innovation activities prolonging the lifetime of products which allow avoiding buying new replacements, thus preventing pollution, dispensable material use and waste arising. There is significant potential to develop innovative approaches to providing maintenance and repair services in the EU. However, the role of repair and maintenance has not been explored sufficiently in relation to eco-innovation, nevertheless their role in service based eco-innovative business models (based on sharing, rental, product-service systems) can be significant.

Integrating repair services in the product can provide a competitive advantage for a company and repair based business models can offer extended business opportunities for product suppliers. There are also some practices where producers provide lifetime guarantees and repair services for their product, which can be seen as a part of the business model. These products are normally "high end" products, however there are also examples relevant to "average consumers". There is a close link to eco-design that has to allow for repair and maintenance.

Good practice 3 Remade in Italy

REMADE IN ITALY

Remade in Italy is a non-profit organization founded in 2009 by the Lombardy Region, CONAI (the Italian Union for packaging material), the Chamber of Commerce of Milan and CONAI for the promotion, at the national and international level, of products "made in Italy" arising from recycling.



In 2014, Remade in Italy was recognized by ACCREDIA (the Italian body for certification), becoming the first certification scheme accredited in Italy for the verification of recycled content in a product. The certification Remade in Italy certifies traceability of production within the same production chain, from the verification of the origins of incoming raw materials to the output of the certified products, making it a tool specifically recognised in green public procurement as a model for the verification of the quality and sustainability of recycling.

Remade in Italy® products are identified by a label that contains information about the sustainability characteristics of the product, in terms of raw material savings, reduction of energy consumption and reduced CO_2 emissions.

Source and further information:

http://www.remadeinitaly.it/

[1] Repair (refurbish, reconditioning) is defined as a correction of a specified fault in a product/component and returning it to satisfactory working condition (Charter and Gray 2007).

[2] Maintenance has a wider scope than 'repair' and it is defined as a critical activity carried out in the use phase of the product life cycle to prolong system availability. Maintenance offerings can include repairs, servicing, diagnostics (onsite and remote), technical support (documentation and personal), installation, warranty, courtesy replacement product whilst product is being repaired, cleaning/valeting (http://circulareconomytoolkit.org/about.html).

[3] refers to used product that after the remanufacturing process is as good as a new one; so includes even upgrading.

Good practice 4 Pilot operation of a furniture reuse centre in Prague, Czech Republic

The project was supported by the Ministry of Environment's programme to support NGO projects. The project aims to open the first centre for collecting and repairing furniture for reuse, and to pilot a service that would collect, repair and re-sell repaired furniture cheaply. This would provide solutions for prevention of furniture waste, as well as allowing (low-income) citizens to buy repaired furniture at low prices. The activities of the centre would include: regular collection of old furniture and household equipment in Prague and actively raising public awareness about this opportunity. It will also allow the pick-up of furniture during office hours. In addition, the centre will offer the opportunity of attending a series of workshops to repair the furniture under the guidance of experienced instructors. These workshops will be organised together with the project Zdrojovna, which organises workshops with the support of the Prague City authorities.

Keywords: reuse, repair of furniture, social inclusion, public awareness

Link: http://spojenehlavy.siknese.cz/

2.2.3 User-led eco-design

The concept of eco-design has a focus on the environmental impacts of products during their whole life cycle and aims to offer new solutions that are profitable and attractive but lead to an overall reduction in the consumption of materials and energy at the same time (EIO 2014). In addition to that, user-led eco-innovation is driven by customer demands for new goods and services or developed with stakeholders, thereby minimising the risk of superfluous product features or functionality.

The concept of eco-design has been evolving from a focus on single aspects of the product, like energy consumption, to a more holistic, life-cycle approach. This is a clear link to the circular economy model as it means that each phase of the product life cycle—including raw materials, production, distribution, use, re-use, re-manufacturing, recycling and disposal—is taken into consideration in the design of a product. In practice, however, the application of the concept is still rather narrow: while energy performance has become a standard element of a wide range of products (home appliances, vehicles, etc.), life-cycle thinking has only been applied to a limited number of examples and has not, yet, broken out of niche markets (EIO 2014).

Good practice 5 QUIB – the circular economy workspace, Romania

QUIB – the circular economy workspace - Romania

QUIB is the first circular economy workspace in Romania, promoting cradle-to-cradle design and circular economy production principles. All of the products developed here are made of reused materials without generating waste. The services offered include support to product design and prototyping, access to a full range of equipment for wood, metal and textiles processing, and several advanced technical tools such as a 3D printer, a CNC router and laser printer. It also offers various creativity and technical design classes. So far, since opening in 2015, the centre has supported 100 makers to develop 125 products out of 430 tonnes of reused materials.

The main drivers for opening the space were environmental, as well as the range of economic opportunities that the circular economy offers. Barriers to developing the business further include the scarcity of Romanian suppliers of organic raw materials. The company had to import the raw materials from Germany or Italy, because businesses are hard to convince to give up materials they do not use. Moreover, the workers are not accustomed to using as little material as possible, while the Romanian consumers place less value on the sustainability of products, but more on the design. This is why the products developed in QUIB are primarily meant for export.

The development of QUIB was funded with the help of the European Social Fund.

Keywords: Cradle-to-cradle; circular economy; eco-design; maker-spaces; reuse; sustainable production

Contact: QUIB centre, contact@quib.ro; adriana.cojocaru@quib.ro; bogdan.cojocaru@quib.ro

Links: quib.ro - Picture source: http://quib.ro/quib-start-up-ecosystem-and-services/

2.2.4 A mix of policy measures to support circular economy on national and local level

Introducing rightly chosen and designed policy measures can motivate or regulate resource efficiency, waste reduction, recycling, re-use, and remanufacturing, and create demand for sustainably designed products as well as resource saving services. There is a need to directly support resource saving and eco-innovation in SMEs, as underlined by the Green Action Plan for SMEs "thus supporting green business developments across all European regions, notably in view of the fact that, at this stage, significant differences in resource efficiency exist between sectors and Member States" (European Commission 2014).

The scope of policy measures to support eco-innovations for circular economy, resource saving, and sustainable design can be quite wide. Many traditional innovation support measures can be adapted to support eco-innovations based on circularity. The figure below presents policy measures that can be adopted to support circular economy objectives.

Table 2-2: Examples of national and local policy measures to support circular economy

Categories of policy measures	Examples of policy measures
Regulatory instruments	• Regulations (e.g. on waste recycling, extended producers responsibility, eco-design, take-back, transparency in material chain and responsibilities, etc.) • Quality and other mandatory targets (e.g. waste recycling, re-use) • Codes, standards, certification for products, recycled material content, packaging, emissions, as well as the ones triggering innovation prior to setting new minimum performance limits
Economic instruments	• Fiscal/financial instruments and incentives, including, charges and taxes for waste, incineration, landfill, subsidies and tax reliefs, pay as you throw • Direct investment/funding (e.g. infrastructure, programme, etc.) • Demand pull instruments, including public procurement • Market based instruments, etc.
Research, development and deployment	• Funding for R&D in CE related themes (e.g. direct or competitive grants) • Pre-commercial /R&D procurement for products and services with sustainable design • Providing R&D infrastructure • Innovation vouchers schemes for SME on CE related innovations • Support to innovation incubators focusing on CE related areas • Support programmes and incentives for R&D personnel
Information, capacity building and networking support	• Advisory services & information provision (to companies, start-ups, customers, technology adopters, etc.) • Professional training and qualification and skills enhancement courses, i.e. in material chain management • Support networking via matchmaking, technology platforms
Voluntary measures	• Performance label for products and services • Guarantee for product durability, repair, • Negotiated agreements (public-private sector) • Public or unilateral voluntary commitments (by private sector)

Source: Doranova and Gigli 2014.

3 |Toward the circular economy: eco-innovation on the ground

The circular economy aims to boost the EU's competitiveness by protecting businesses against scarcity of resources and volatile prices by helping to create new business opportunities and innovative more efficient ways of producing and consuming (European Commission 2015, p.2). Policy frameworks like the European Commission´s Circular Economy Action Plan or similar national initiatives aim to initiate eco-innovations that would enable fulfilling these ambitious objectives. For the circular economy to go from an attractive concept towards business reality, pioneers along the whole value chain are challenged to develop alternatives to the traditional "make-use-dispose" approach.

Already today new technologies, design concepts, services, and innovative forms of co-operation are contributing to the circular economy across the EU. This chapter aims to highlight the different types of eco-innovations and related challenges (Chapter 3.1), the priority fields of action (Chapter 3.2) and in a final step looks beyond the European border taking the example of China´s role in plastics recycling.

3.1 |Emerging trends and new business models

Becoming a circular economy will require radical eco-innovations that enable completely transforming the linear patterns of production and consumption that developed over the last two centuries and became an obviously wasteful but stable regime of over-consuming natural resources. The circular economy will thus require eco-innovations in two very different fields that could be labelled as circular economy "hardware" and "software": The technologies and technical infrastructures that would allow to turn waste (like glass, see the following good practice example) into resources (hardware) and at the same time the skills, expertise and business models that would turn this transformation into a business case (software).

Good practice 6 Greenblast

GREENBLAST

Due to the lack of demand there is an excess of green coloured glass, which must be stored or sent to a landfill. The Greenblast project aims to prevent this through an eco-innovative solution, which also offers two new business models: A "double recycling". During the first stage the waste glass can be used for a technique called blasting, which forms a large part of shipyard work. Through the use of glass the most commonly used blasting media copper slag or grit, which produces toxic dust and is not environmentally friendly, can be replaced. In addition Greenblast eliminates the need for landfilling the glass, which is reused for blasting, as it gets double recycled. During the **second stage** the waste glass can be used in the heavy clay industry, as it enables low temperature kiln firing and/or higher quality end products, which can reduce costs and the environmental impact.

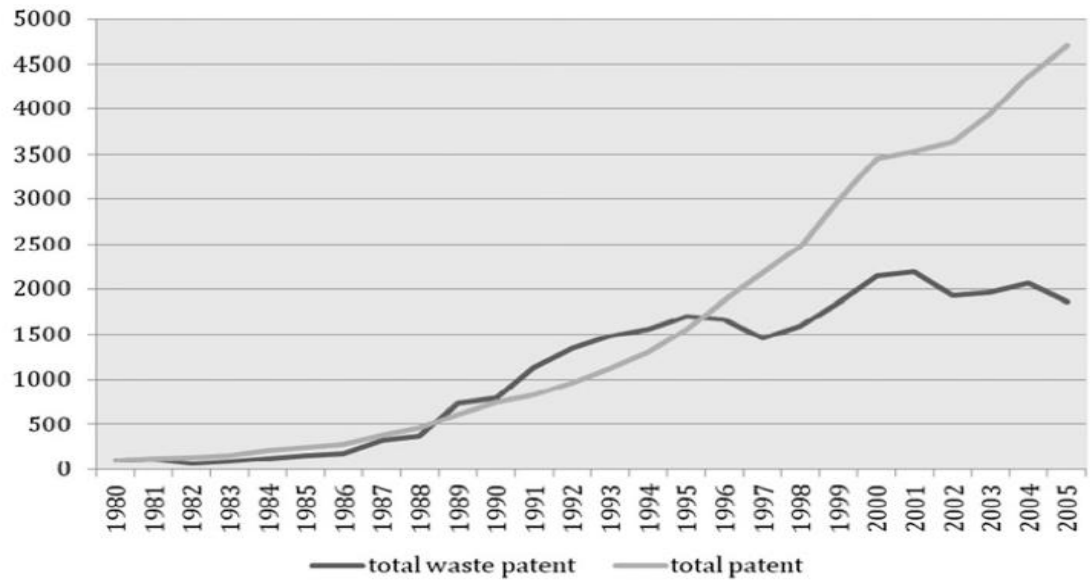
The project's planned results include: creating a new market for green coloured waste glass; decreasing hazardous waste and reducing waste stream processing costs; converting a waste stream to an income stream; lowering costs of raw materials; and testing new business models.

Source: www.greenblast.eu

The "hardware" perspective

The broad field of waste, waste collection and waste management forms a great part of the circular economy approach. With regard to the rising publicity of the concept of a circular economy as analogous to highly efficient waste treatment one might expect an increase of patents in the waste sector as an indication of technological innovation. However a study conducted by Francesco Nicolli in 2013 suggests otherwise. This study took into account 28 countries (including e.g. UK, US, Germany, Japan, New Zealand, Mexico) and all patents in the waste sector filed under the Patent Cooperation Treaty (PCT) for over 25 years. These numbers were then compared to the total patent applications. It shows, that unlike the total patent applications, the number of patent applications in the field of waste is stagnating and at times (e.g. 1997, 2002 and 2005) even decreased. If divided into five categories (waste management, material recycling, solid waste collection, incineration and recovery, fertilizers from waste) in order to gain better insights into this trend, the two most the most dynamic categories for a circular economy with the most patent applications (waste management and material recycling) follow this stagnating and at times decreasing trend.

Figure 3-1 Number of patent applications filed under the PTC (total patent and waste patent, 3-year moving average)



Source: Nicolli 2013, p. 189.

Delving further into the question of why the numbers of waste patents are stagnating brings further insight. In many countries environmental problems associated with the existence and treatment of waste have been substantially reduced, and "security of disposal" has been broadly established as the objective of the waste management. Waste is in principle comprehensively collected and could be returned to the materials cycles. In fact, many actors now regard waste as a problem that has been "technically solved" (Wilts, von Gries, and Bahn-Walkowiak 2016)—although of course new challenges emerge from new products like for example wind turbines.

The DreamWind project – How to recycle glass fibre from used wind turbine blades

Old or broken wind turbine blades are currently mostly crushed and put on landfill. The objective of the DreamWind project is to develop a chemical substance, with which composite materials can be separated from each other. After the glass has been cleaned it shall possibly be reused in new fibreglass components and structures, e.g. wind turbines, aircraft or cars.

This new technology offers economic benefits and can also reduce carbon dioxide emission by lessen the need for producing new fiberglass.

Sources: www.innovationsfonden.dk/en/node/789 and www.stateofgreen.com/en/profiles/state-of-green/news/recyclable-wind-turbine-blades

The "software" perspective

Completely different kinds of eco-innovations can be found on what could be described as the software of the circular economy: Innovative forms of business models and consumption patterns that enable maintaining the value of products and raw materials as long as possible.

Not all business models in a circular economy need to be highly innovative or be completely new compared to the business models in place today, but some business models will be. Ideally they will all support the circular economy and form a part of it—either because the business model itself is completely focussed on the circular economy or because it is at least partly using the provided infrastructures, products or services enabling the circular economy.

Some businesses' business models will focus on providing these infrastructures, products and services. Other businesses will use them either to build their business model based on this provision or they will make use of it in order to round out their business model or to fulfil legal or other requirements. As such most of the following concepts can be seen as either the core part of business models providing the infrastructure or as a part of other businesses' business model.

The basic infrastructures to a circular economy are collection systems or platforms linking the demand and supply side in order to enable **waste-as-a-resource** procedures or the distribution and use of **secondary raw materials**. These systems will most likely benefit from a cross-border, cross-industry and cross-sector reach and from global supply chains, which will form a major part of reverse cycle networks and the distribution of (used) products, components and materials (Ellen MacArthur Foundation 2014). Businesses are needed which offer the facilities or services to treat products and materials in order to reuse, repair, remanufacture or recycle them. Many businesses will incorporate this waste-as-a-resource, either directly through using bought or self-produced waste, by-products or end-of-life products or components or indirectly through selling them.

But sometimes it might not be so easy to determine whether reusing, repairing, remanufacturing, recycling or selling would be the right treatment for a product, component or material. The businesses in a circular economy will therefore need support in this decision-making process, for example through tools that take into account various factors like for example the product's condition, the market situation, environmental effects and economic factors and so on. The provision of such tools could be another business model (Ellen

MacArthur Foundation 2016). Strongly linked to the ability of making these decisions is the idea of **eco-design**. Already in the design stage of developing new materials, components or products, businesses in a circular economy need to think about the after-use-span and how the product can be treated and ideally enter another cascade step or life-cycle. Eco-design has to deal with the question of how the design enables easy reuse, repair, recycling etc., how disassembling (manually, technically, chemically, biologically etc.) without any losses in terms of quality or quantity can be facilitated and what materials should be used (e.g. composition, hazardous material content, pure material content). Through these considerations the durability should be enhanced, so that the materials, components or products can either enter more cascade steps or life-cycles or spend more time within one cycle. The benefits of eco-design would be energy and material savings and the chance to **design out waste** (EEA 2015, Ellen MacArthur Foundation 2013).

Today most business models, regarding the provision of products, are based on selling items and generating one-time earnings. The enhanced durability of products might therefore seem contra productive—but **service- and function-based business models** (where **product-as-a-service** forms one part often referred to) will benefit from this[4]. Leasing, renting, sharing, and pooling and the so called **collaborative consumption**, performance contracts, predictive maintenance, and remanufacturing will form typical parts of the new service- and function-based business models (EEA 2016a, p. 15). As the earnings generated within these business models are rather performance-based and are reoccurring, instead of one-time earnings, the financial structure of such businesses will change compared to the financial structure of businesses with traditional concepts. As large scale payments at the start of the products' life-cycle are not generated, but reoccurring payments, these business models might even require new financial models (EEA 2016a).

Some new business models will again deal with the provision of the necessary infrastructure like market places in order to match the offers and the demand side, some businesses will incorporate the services related to for example leasing, others will offer to provide these services for other businesses and within the organisation, and some will focus on the provision of completing services like insurances, which will be especially interesting for business models focussing on product-as-a-service options or sharing.

Generally more connections between players of the economy will exist in a circular economy, either directly between for example businesses or indirectly through infrastructure and/or global supply chains. Another option could be through some kind of market space, which aims to match existing offers and demand in terms of products, components, materials and services in order to enable cascade usage, and longer or more cycles. And more business models than today will rely on the Internet of Things or Industry 4.0, as it will help to run business models containing for example product-as-a-service offerings, which require (real-time) information about the usage of a product or component as well as its condition[5]. Feedback from products could also be used for product enhancements (Ellen MacArthur Foundation 2016).

[4] Of course enhancing the durability of materials and leading them into cascaded usage, reusing them or recycling them is also a crucial benefit.

[5] Example could be Philips – Lighting as a service.

Good practice 8 Competition-based Events for Start-Ups, Estonia

Competition-based events for start-ups

The best chance for eco-innovative entrepreneurs to find funding for their idea is to participate in one of Estonia's many entrepreneurship competitions aimed at selecting the best ideas and teams for start-ups. In addition to monetary support, the winners often get much-needed know-how and advice on running a business and are widely promoted in Estonia as well as abroad.

Over the years many ideas were generated, also covering the areas of eco-invention, eco-innovations, circular economy and green technology.

The biggest entrepreneurship competition **Ajujaht** for example challenges its participants to present their ideas in a live TV-show. The best eco-innovations receive a special award.

Sources: www.prototron.ee, www.ajujaht.ee/en, www.negavatt.ee, www.garage48.org, www.rakett69.ee

Good practice 9 Successful cases of industrial symbiosis in IT, Italy

Successful cases of industrial symbiosis in IT:

Industrial Symbiosis pilot projects were developed, both with network and ecoindustrial park approaches:

- Networking approach:

o Industrial Symbiosis in Sicily (IT). Results: more than 600 potential synergies; focus for industrial symbiosis pathways on agroindustry, construction and plastics residues;

o "Green Economy and Sustainable Development". Results: 90 potential synergies within and outside the network; focus on residues from agroindustry sector (main synergies for energy, bio plastics and nutraceutical substances production).

- Industrial Area approach: green development with focus on WEEE, plastics, agrifood, and construction residues. Main results: 25 companies involved, more than 140 resources shared, approximately 110 potential matches and 30 technically verified matches.

Source: www.industrialsymbiosis.it

But also eco-innovations in the field of consumption will be necessary to support the development of the circular economy, e.g. sharing products or infrastructures (collaborative economy), consuming services rather than products, or using IT or digital platforms (Fischer et al. 2015; Leismann et al. 2013). And especially such "Industry 4.0" approaches or web-based applications could become powerful enablers of a circular economy, especially in the field of collaborative consumption based on sharing, swapping, bartering, trading or leasing products and other assets such as land or time (Botsman and Rogers 2010). While such peer-to-peer interactions have long been practised on a local scale, they have developed into a different dimension through the use of online sharing marketplaces, through which the demand for certain assets, products or services is matched with their supply, usually through consumer-to-consumer (C2C) channels. A key challenge will be to set the right policy and incentives frameworks that ensures that the transition from consumers to "prosumers" actually boosts eco-innovations and does not simply lead to rebounds regarding traditional or even more resource intensive consumption patterns, e.g. spending vacation money saved by AirBnB for buying more long-distance flights.

3.2 |Sectors: changing value chains and material flows

Circular economy eco-innovations in the European Union are clearly linked to challenges in specific sectors and value chain that are often characterised by particular resource intensity. Within its Circular Economy Action Plan the European Commission identified so called priority waste streams as starting points for targeted measures that address the various phases of the cycle along the whole value chain. Despite these relevant challenges, there are already viable eco-innovation activities in these different fields that highlight the innovation potential of the circular economy framework.

3.2.1 Plastics

The CE Action Plan has clearly stated that especially increasing plastic recycling will be essential for the transition to a circular economy. The use of plastics has grown steadily. The global production increased from 1.7 million tons in 1950 to 288 million tons in 2012 of which around 20% were produced in Europe. This has led to a generation of plastic waste of about 25 million tons; less than 25% of collected plastic waste is recycled and about 50% goes to landfill or even worse ends up in the oceans as marine litter (Plastics Europe 2013). The presence of hazardous chemical additives can pose technical difficulties and the emergence of innovative types of plastics raises new questions, e.g. as regards plastics biodegradability.

However, our current consumption patterns would not be imaginable without the use of plastics. The innovation in plastics can contribute to lowering environmental impacts and developing the circular economy by better preserving food, improving the recyclability of plastics or reducing the weight of materials used in vehicles—leading to significantly reduced fuel consumption and CO_2 emissions. On-going eco-innovations in this field also include more integrated packaging concepts that aim to minimise the use of unnecessary plastics or plastics of environmental concern and in this way support the prevention of plastics waste. Concepts like the Holis market in Austria also offer consumers the possibility to purchase only the exact amount of food that they want instead of being limited to specific packaging sizes.

Good practice 10 Holis market - zero waste food packaging, Austria

Holis market

holis market

© holis-market.at

Holis is derived from “holistic” and is an innovative concept for a new generation of food retail markets, combining a radical zero-waste food packaging philosophy with initiatives to raise public awareness and information with regard to diet change. All products in the Holis market are sold without packaging.

Holis market received the 2015 Austrian National Clean Technology Award in the category of start-ups focusing on resource efficiency.

Source: www.holis-market.at

3.2.2 Bio-based products

Bio-based products made out of renewable biological resources (such as wood, crops or fibres) will have to play a crucial role in a circular economy. Bio-based materials can present advantages linked to their renewability and biodegradability; such elements of a bio-economy provide alternatives to fossil-based products and energy, e.g. in the fields of construction, furniture, paper, food, textile, chemicals as well as energy uses like biofuels (European Commission 2015). The drive to shift the material composition of consumables from technical towards biological nutrients and to have those cascade through different applications before extracting valuable feedstock and finally re-introducing their nutrients into the biosphere, rounds out the core principles of a restorative circular economy (Ellen MacArthur Foundation 2014, p. 23).

At the same time, the objective of replacing non-renewable with renewable resources may increase competition for land in a circular economy and thereby increase pressures on natural capital. Bio-based materials compete with production of both food and biomass for energy generation, as well as with land use for other purposes (including e.g. conservation of biodiversity). In general, biomass is best used in a cascade in which energy generation is the last step rather than the first. But even if biomass is primarily used for durable products, environmental impacts are not straightforward. A key example is wood as a construction material. The benefits of this renewable resource should be offset against the biodiversity impacts of increased wood harvest, with current harvesting rates in Europe already reaching 65 % of the annual increment and imports on the rise in many European countries, in particular to meet renewable energy targets. Analogous to the debate on bio-energy, the potential for uptake of bio-based materials should be critically analysed in view of overall biomass production and ecosystem resilience (EEA 2015).

Nevertheless, the European Commission has highlighted that eco-innovations in the bio-based sector have already shown their potential for innovation in new materials, chemicals and processes, which can be an integral part of the circular economy. Researchers are working to develop novel applications and processes that could potentially generate a higher added value than existing uses, such as biorefining, insect breeding, the production of C_5 and C_6 sugars, solid state fermentation, and more efficient biogas production processes (Bastein et al. 2013). The Bio Base Europe Pilot Plant is an excellent example for infrastructures to test these innovations for market readiness and to upscale their implementation and contributions to a circular economy.

Good practice 11 Bio Base Europe Pilot Plant

Bio Base Europe Pilot Plant: Speeding up bio based innovation

Bio Base Europe Pilot Plant is an independent, state-of-the-art facility that operates from a laboratory level to a multi-level scale. It is a service provider for **process development**, **scale-up** and **custom manufacturing of bio-based products and processes**.

Bio Base Europe Pilot Plant enables the conversion of biomass into biochemical, biomaterials, biofuels and other bio-products. Its expertise covers the **whole value chain** from **biomass** to **refined products**.

One example of the different consortium-based projects initiated in 2015 is CARBOSURF (2015-2018): The project aims to develop new bio based processes as well as products and solves bottlenecks in the fermentative production of bio based bio surfactants and specialty carbohydrates.

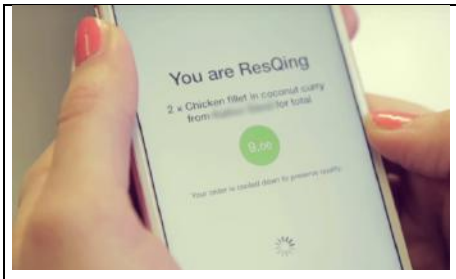
Source: www.bbeu.org/pilotplant

3.2.3 Food waste

The European Commission has identified food waste as an increasing concern in Europe. Across the globe, nearly 30% of food is wasted throughout the agrifood supply chain. Around 100 million tons of food is wasted annually in the EU (estimate for 2012). Modelling suggests—if nothing is done—food waste could rise to over 120 million tons by 2020. The food resources being lost and wasted in Europe would be enough to feed all the hungry people in the world two times over. In September 2015, as part of the 2030 Sustainable Development Goals, the United Nations General Assembly adopted a target of halving per capita food waste at the retail and consumer level, and reducing food losses along production and supply chains. The EU and its Member States are committed to meeting this target.

Together with shifting to more sustainable diets, reducing food waste both in and out of the home is the most significant demand-side measure for reducing the carbon impact of the food system. But also supply-side eco-innovations will be able to contribute to the prevention of food becoming waste: It will require to design and develop technological innovations to improve valorisation of food waste, e.g. from food processing, and ICT-based platforms and tools to support new and existing solutions to reduce food waste[6]. The ResQ Club in Finland can be considered as one of the most promising eco-innovations in this specific area of a circular economy.

Good practice 12 ResQ Club - rescue quality food



ResQ Club

ResQ Club is a start-up with a mission to help people rescue quality food from going to waste.

Users receive notifications directly from local restaurants (via the ResQ-App) that have food that is about to go to waste. They can buy selected food directly in the app and pick it up at a chosen time – with an affordable price tag.

ResQ is a great example of small-scale eco-innovation based on ICT, intuition and the emerging environmental conscience among the general public.

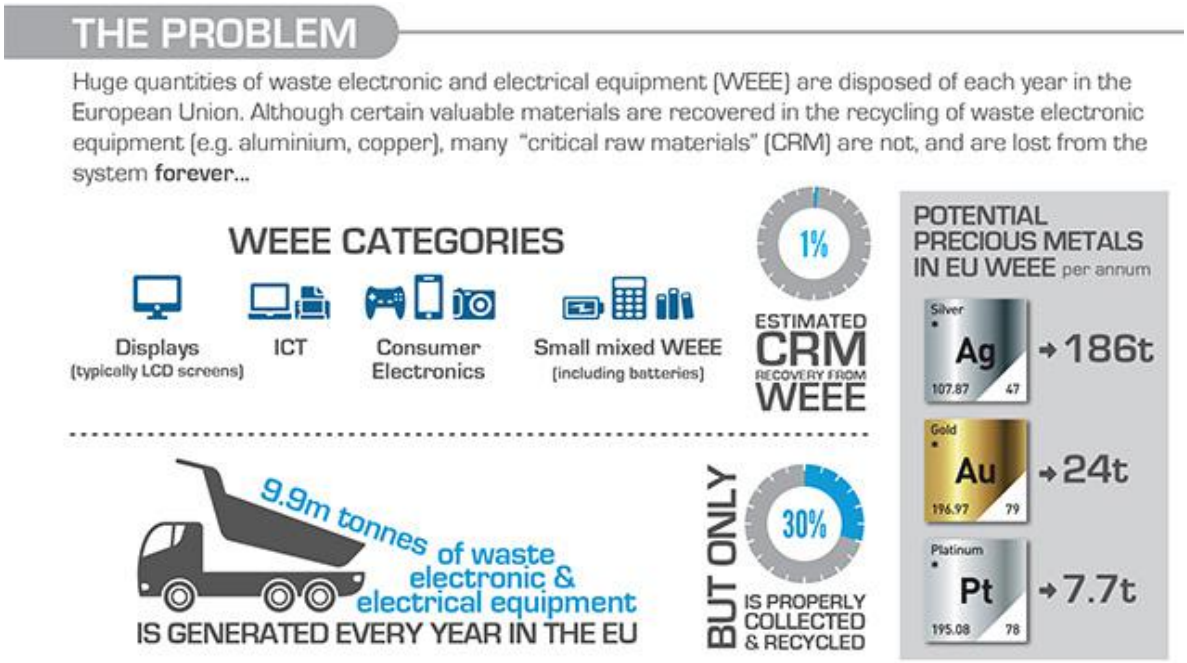
Source: www.resq.club

3.2.4 Critical raw materials

An increasing number of raw materials can be classified as “critical” because they are both of high economic importance for the EU and vulnerable to supply disruption. The European Commission has published a list of such critical raw materials that includes, for example, rare earth elements and other precious metals, but also phosphorus. The following figure illustrates the specific challenge of so far disappointingly low recovery rates and missed economic opportunities. The European Commission states that increasing the recovery of critical raw materials is one of the challenges that must be addressed in the move to a circular economy.

[6] http://eu-refresh.org/about-refresh#background

Figure 3-2 Recovery rates and material leakages

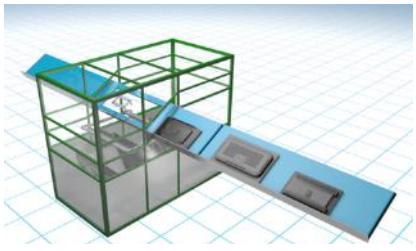


Source: http://www.criticalrawmaterialrecovery.eu/project-summary.

Key barriers include insufficient information exchange between manufacturers and recyclers of electronic products, the absence of recycling standards, and a lack of data for economic operators on the potential for recycled critical raw materials. Against this background, technical and organisational eco-innovations will have to play a crucial role in order to secure the supply of critical raw materials—that are to relevant amounts used for green technologies like fuel cells or photovoltaic panels. Projects like ReVolv aim to develop product-specific technologies that would allow in this case indium from LCD displays.

Good practice 13 ReVolv - recycling of LCD visual displays,

ReVolv: Recycling of LCD Visual displays



Votechnik LCD Recycling Machine

The majority of recyclers of LCD Visual Displays use a slow and labour-intensive manual disassembly process. The difficulty of LCD disassembly combined with the high costs has led to a situation of stockpiling of LCDs at recycling facilities across Europe.

An EPA-funded project analysed LCDs in order to identify traits which may make treatment less of a challenge. The project culminated in an automated technology (Trumaster-ALRTM) for the safe removal of the hazardous materials found in LCDs. This led to the establishment of a start-up company, Votechnik, at the University of Limerick and a follow-up EU-funded project aimed at upscaling and commercialisation of the technology.

Source: www.revolvproject.eu

3.2.5 Construction and demolition

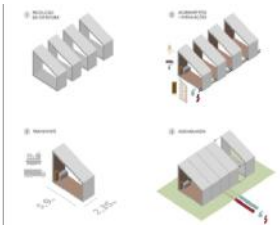
The final, and in volume terms most relevant waste stream stems from construction and demolition activities: It accounts for approximately 25% - 30% of all waste generated in the EU and consists of numerous materials, including concrete, bricks, gypsum, wood, glass, metals, plastic, solvents, asbestos and excavated soil. Many of the materials are recyclable or can be reused, but reuse and recycling rates vary widely across the EU.

The recycling of construction and demolition waste is encouraged by a EU-wide mandatory target, but challenges on the ground still have to be addressed if waste management in this sector is to improve. For example, valuable materials are not always identified, collected separately, or adequately recovered. Given the long lifetime of buildings, it is essential to encourage design improvements that will reduce their environmental impacts and increase the durability and recyclability of their components. The GOMOS system is an excellent example for necessary eco-innovations that bridge the design phase with the end-of-life phase of buildings.

Good practice 14 GOMOS - modular systems of reinforced concrete

GOMOS

www.p3.publico.pt



The Gomos system results from a collaborative R&D project between architects and engineering companies (18 companies). It is a modular system of reinforced concrete that simplifies and speeds up the construction process. It is scalable, in which each module, or 'bud' (*gomo* in Portuguese), comes out of the factory completely ready, including all needed parts. The assembly takes place in a few days, simply adding these modules.

The construction is flexible enough to be reused, expanded or disassembled for recycling, and its design and materials allow for it to be a low energy-consumption building.

Source: www.inhabitat.com/new-gomos-system-allows-tiny-homes-in-portugal-to-be-built-in-mere-days and www.farcimar.ptamuel

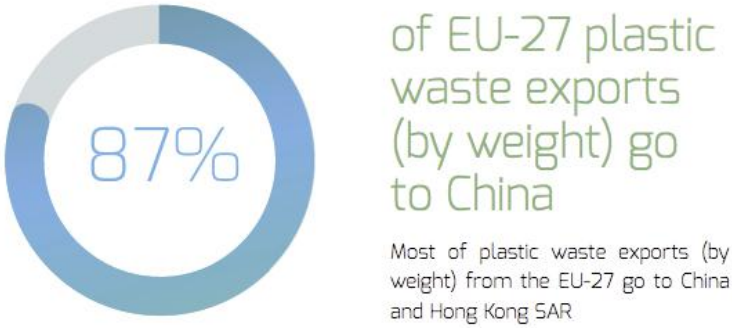
3.3 |Beyond the EU: competition and co-operation

Looking at waste as a potential resource also leads to the situation that more and more waste streams are increasingly traded as commodities on a global scale. Against this background, one of the key challenges for Europe as a circular economy will be to develop better coordination schemes of waste policies that so far are mainly dominated by national perspectives. Especially China can be seen as an example of how strategic and forward-looking approaches can lead to eco-innovations as a prerequisite for increasing market shares and economic growth.

This can be especially illustrated taking the example of plastic waste: The annual volume of globally traded waste plastics in 2012 was around 15 Mt. Plastic scrap flows from Western countries with established collection systems mainly to China, which dominates the international market, receiving around 56% wt. of global imports. Europe collectively is the major exporter: The European Union (EU 27) collectively exports almost half of the plastics collected for recycling (3.4 Mt, worth of €1.7B), corresponding to 12% of the entire post-

consumer plastic waste arising. Europe depends entirely on China to absorb its exports as illustrated in the figure below.

Figure 3-3 Final fate of plastic waste exports of EU-27



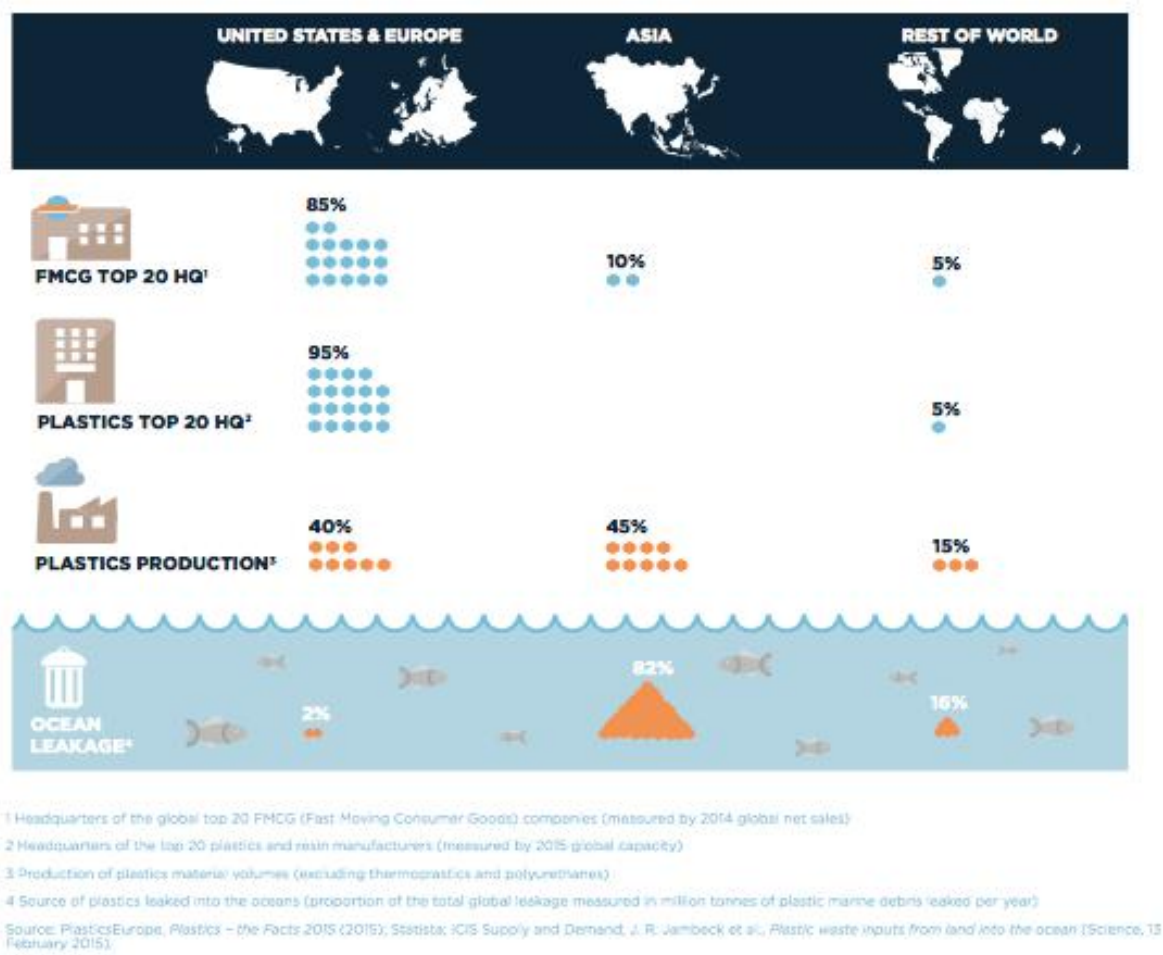
Source: Velis 2014.

Due to its size and rapid financial development China has become a dominant player in the global recycling market for paper and metals, but particularly for plastics (Velis 2014). Economic considerations have been the key driver for this development, especially the scarcity of plastic raw material has been a continuing problem in China and recycled plastics are valuable sources to cover this need: The long term demand for waste plastics in China is closely related to the gap between the supply and demand of primary plastics. The circular economy is thus a necessity for China that dominates the global plastic production with more than 40% of all plastic produced in China.

In the past (and in many regions still today) plastic recycling in China has been dominated by thousands of small manufacturers/re-processors using low-tech equipment and pollution practices, often family-run, without any environmental protection controls. Following the objectives of the Chinese government to become more independent from importing high quality virgin plastics for its manufacturing industry, it has strategically invested in modern centralized manufacturing and reprocessing facilities: China's Ministry of Environment reportedly estimates that up to US$2.6 trillion could be allocated to environmental protection projects in the 13th Five Year Plan, up from EUR 689 billion in the previous five-year plan (Chipman Koty 2016). These efforts could potentially benefit several recycling-related industries that are already encouraged for investment according to the "Catalogue for the Guidance of Foreign Investment Industries (2015)", specifically mentioning the recycling of plastics.

The following figure illustrates the overall dynamic of this development: Asia and specifically China already dominate the production of plastics and are eager to expand their role in the value chain as the main value added is still concentrated in the US and Europe while most of the plastic leakage that causes marine littering with all its negative impacts on the environment, health and well being is concentrated in Asia. As such, from an environmental point of view it seems rational to focus investments in recycling technologies in China.

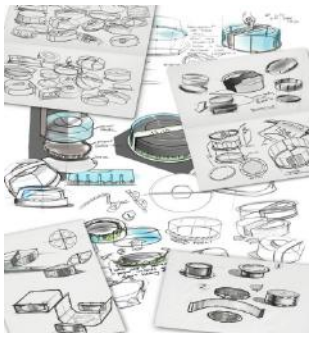
Figure 3-4 Distribution of plastics headquarters, production and leakage



Source: Ellen MacArthur Foundation, World Economic Forum, and McKinsey Center for Business and Environment 2016, p. 38.

On the other hand, this development might influence the future level of eco-innovations especially in European SMEs. The EU plastics recycling market is dominated by small SMEs that might lack the financial resources for necessary investments in high quality technologies; especially compared to the now emerging state-funded companies in China. A logical pathway for European companies could be to go beyond end-of-pipe technologies and to focus on integrated circular concepts as for example illustrated by KTZ Centre of Packing Innovations and Research in Lithuania.

Good practice 15 KTU Centre of Packing Innovations and Research



KTU Centre of Packing Innovations and Research

The Centre of Packing Innovations and Research at Kaunas University of Technology (KTU) offers services related to the life-cycle of packaging: from selection of environmentally friendly raw materials, package design, preparation for press and press processes, engineering of packing processes, to management of safe packages which become waste and recycling solutions. The centre also consults businesses and policy makers on these issues.

Source: www.ktu.edu/en/faculty-mechanical-engineering-and-design/packaging-innovations-and-research-centre

4 | Eco-innovation and circular economy performance of countries

As chapters 2 and 3 above argued, eco-innovation plays a central role in transforming the traditional linear system of production and consumption into an economic system characterised by circular flows of raw materials. A large number of business cases in all EU Member States (MS) have already proved successful in key areas such as bio-based products and construction (see chapter 3).

This chapter expands the analysis from the company and sector to the national level. First, the focus is set on the eco-innovation performance across EU countries, featuring key results from the latest versions of the EU and global Eco-Innovation Scoreboards (Eco-IS) (section 4.1). Subsequently, the chapter assesses the circular economy performance of EU MS as well as turnover and employment in key circular economy sectors (section 4.2). The chapter closes with some concluding remarks.

4.1 | EU Eco-Innovation Scoreboard

With regard to circular economy aspects, performance across the EU MS is very heterogeneous. Countries differ widely with regard to the share of material use being recycled as well as with regard to many other aspects, such as employment and turnover in sectors engaging in circular economy activities, waste generation and resource productivity. We now turn to the eco-innovation performance across the EU, in order to analyse, which countries have high versus low eco-innovation performance.

In order to evaluate this specific performance across EU countries, a composite index has been developed by the Eco-Innovation Observatory: the Eco-Innovation Scoreboard (Eco-IS; see Box 4-1 for more details). Regarding its structure and the underlying calculation procedures, this index is oriented at other scoreboards in similar thematic fields, most notably the Innovation Union Scoreboard (European Commission 2015b).

Box 4-1 The structure of the Eco-Innovation Scoreboard

The Eco-Innovation Scoreboard (Eco-IS) illustrates eco-innovation performance across the EU Member States. The scoreboard aims at capturing the different aspects of eco-innovation by applying 16 indicators grouped into five thematic areas. The full list of indicators included in the Eco-IS can be found in Annex 2.

(1) *Eco-innovation inputs* comprising investments (financial or human resources), which aim at triggering eco-innovation activities,

(2) *Eco-innovation activities*, illustrating to what extent companies in a specific country are active in eco-innovation,

(3) *Eco-innovation outputs*, quantifying the outputs of eco-innovation activities in terms of patents, academic literature and media contributions,

(4) *Resource efficiency outcomes*, putting eco-innovation performance in the context of a country's resource (material, energy, water) efficiency and GHG emission intensity,

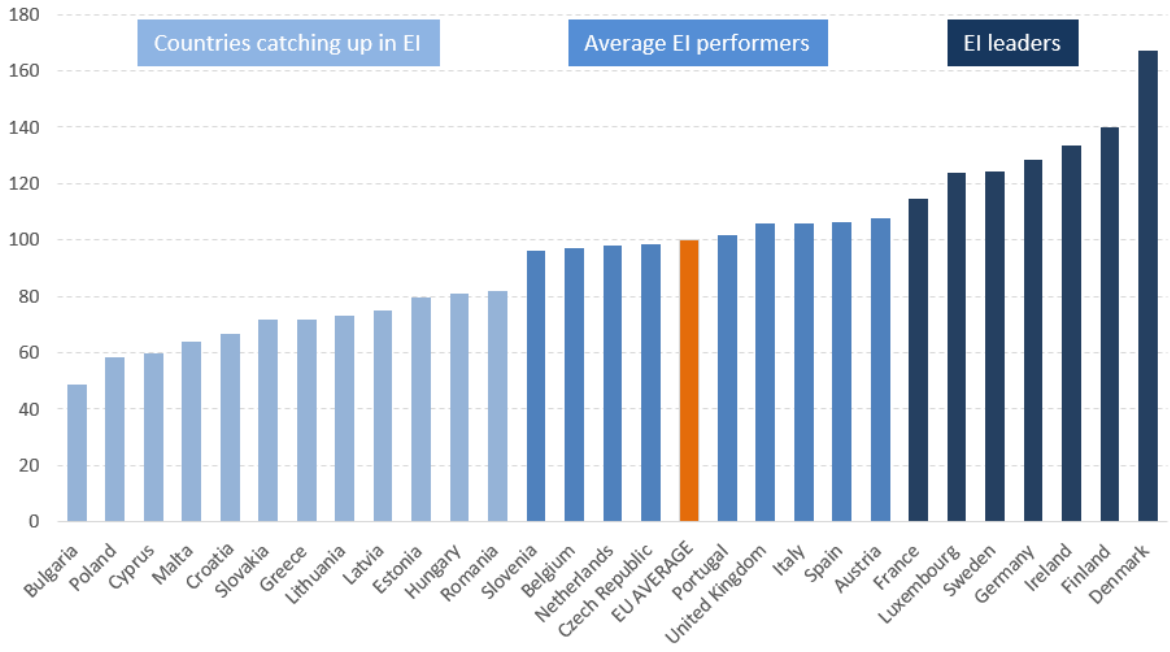
(5) *Socio-economic outcomes*, illustrating to what extent eco-innovation performance generates positive outcomes for social aspects (employment) and economic aspects (turnover, exports).

The Eco-IS thus shows how well individual Member States perform in different dimensions of eco-innovation compared to the EU average and presents their strengths and weaknesses. Details about the calculation procedures and the meta information on the single indicators can be found in the technical note accompanying the scoreboard (Giljum et al. 2016).

Figure 4-1 shows the results from the aggregated Eco-IS in its 2015 version. For illustrative purposes, countries have been clustered into three groups:

1. Eco-innovation leaders, scoring significantly higher than the EU average;
2. Average eco-innovation performers with scores around the EU average; and
3. Countries catching up in eco-innovation, with around 80% or less performance compared to the EU average.

Figure 4-1 Eco-Innovation Scoreboard 2015



In the 2015 version of the Eco-IS, Denmark scored by far highest of all EU countries, with an aggregate score of 167. Denmark was followed by Finland (score of 140), Ireland (134) and Germany (129). Also Sweden, Luxembourg and France have been grouped to the "eco-innovation leading" countries. Nine Member States obtained scores around the EU average of 100 and were therefore addressed as "average eco-innovation performers". The aggregated eco-innovation scores in this group range from 108 (Austria) to 96 (Slovenia). With the exception of Greece, all countries found in the group of "countries catching up in eco-innovation" were new Member States. Aggregated scores in this country group range from 82 in the case of Romania to 49 in the case of Bulgaria.

While this aggregated index provides an overview of the geographical structure of country performances across the EU, it does not allow identifying strong or weak areas for the various Member States. Therefore, Figure 4-2 illustrates the single scores of the five components. Green colour illustrates higher scores, red colour lower scores. To illustrate the diversity across the EU countries, the minimum and maximum scores, the overall score range as well as the standard deviation is illustrated for each of the five components, as well as the aggregated Eco-IS.

Figure 4-2 Scores in the five components of the Eco-Innovation Scoreboard 2015, by country

		Eco-innovation inputs	Eco-innovation activities	Eco-innovation outputs	Resource efficiency outcomes	Socio-economic outcomes	Eco-IS
EI leaders	Denmark	368	71	157	108	86	167
	Finland	182	152	190	77	120	140
	Ireland	310	135	65	104	63	134
	Germany	154	162	140	107	87	129
	Sweden	121	154	160	102	93	124
	Luxembourg	106	115	205	131	60	124
	France	111	110	108	108	138	115
Average EI performers	Austria	98	126	136	107	73	108
	Spain	94	134	102	112	105	106
	Italy	75	118	117	116	101	106
	United Kingdom	126	116	74	126	87	106
	Portugal	79	167	83	86	99	102
	Czech Republic	63	181	47	66	147	99
	Netherlands	66	77	106	124	108	98
	Belgium	89	116	111	98	71	97
	Slovenia	74	92	98	78	142	96
Countries catching up in EI	Romania	39	138	53	64	120	82
	Hungary	72	98	27	81	126	81
	Estonia	78	129	53	48	100	80
	Latvia	43	60	95	70	109	75
	Lithuania	43	94	59	81	87	73
	Greece	57	37	101	78	61	72
	Slovakia	38	101	52	78	87	72
	Croatia	21	100	89	80	49	67
	Malta	25	72	55	104	46	64
	Cyprus	14	54	132	77	17	60
	Poland	40	54	58	62	77	59
	Bulgaria	19	71	27	46	81	49
Minimum		*14*	*37*	*27*	*46*	*17*	*49*
Maximum		*368*	*181*	*205*	*131*	*147*	*167*
Range		*354*	*144*	*178*	*86*	*131*	*118*

The performance regarding ***eco-innovation inputs*** was generally above the EU average for all top-performing countries. Denmark and Ireland were outstanding cases, where the performance in this component of the scoreboard was far beyond all other member states. For these two countries, the indicator of "green early stage investments, 2012-2015" was the main determining factor, where Denmark and Ireland had exceptionally high numbers. In the case of Denmark, investments of more than 1,200 US$ per capita were reported by the primary data source (Cleantech). For Ireland, the respective number was more than 900 US$. This compares to the EU average of around 90 US$ and values as low as 4 US$ for Portugal and 2 US$ for Poland. Regarding "eco-innovation inputs", countries at the lower end of the performance spectrum all had scores far below the EU average. Due to the outstanding performance of Denmark and Ireland, this component is also the one with by far the highest range of scores (difference of 354 points between the highest and the lowest score) and the highest standard deviation across the set of results.

In the second component of ***eco-innovation activities***, the overall top-performing country Denmark had a remarkably low value (score of 71). This is a result of the fact that data for Denmark were missing in Eurostat's Community Innovation Survey (CIS) and thus were only available for one of the three indicators in this component. Consequently, the overall score was determined by the indicator of "ISO 14001 registered organisations", were Denmark had a comparably low performance. Less than 900 companies in Denmark are currently certified following the ISO 14001 standards. The Czech Republic leads the score list for the second

scoreboard component, with high scores in the CIS-based indicators of innovation activities in companies aiming at a reduction of material as well as energy input per unit output, as well as regarding ISO 14001 certifications. Portugal, Germany, Sweden and Finland followed. All these countries had a relatively high share of companies indicating to be active in eco-innovation. For example, in Germany in 2008, more than 37% of all companies included in Eurostat's CIS indicated that they had implemented innovations that led to a reduction of energy inputs per unit of output. In Portugal, this share was 24%, in Sweden 15%. In the group of countries catching up in eco-innovation, Romania and Estonia performed remarkably well, mainly due to a high share of companies with ISO 14001 certifications. With an overall range of 144 points between the minimum and maximum scores, EU countries showed a more homogeneous performance compared to the eco-innovation inputs.

High performance regarding ***eco-innovation outputs*** was also found in the group of eco-innovation leaders. With a component score of 205, Luxembourg led the ranking, mainly determined by a very high performance regarding eco-innovation related publications (almost 50 publications per one million inhabitants) and eco-innovation related media coverage (on average, each electronic media source published one story on eco-innovation in 2015). Ireland's low score of 65 stands out in the group of top-performing countries, which is due to low performances regarding eco-innovation related patents (only 5 patents per one million inhabitants) as well as a low performance regarding media coverage. On the other side of the spectrum, Cyprus in the group of catching up countries had a comparatively high performance, mainly determined by the eco-innovation publication record.

In the component of ***resource efficiency outcomes***, scores across all EU countries were most similar, ranging from a score of 36 in the case of Bulgaria up to a score of 136 for Luxembourg (standard deviation of 22.7). This relates to a fact already addressed in evaluations of earlier versions of the scoreboard, i.e. that top-performing eco-innovation countries in general are characterised by comparatively high values of per capita material, energy and water use as well as high GHG emissions. Although levels of GDP are significantly higher compared to the third group of countries catching up in eco-innovation, the high absolute environmental pressures translate in only modest advancements in resource productivity. For example, Finland, among the eco-innovation leaders, has a remarkably low score of 77. This results from its high material and energy consumption levels, caused by the comparatively high importance of primary industries (such as wood and paper industries).

Performance is very mixed across the three country groups with regard to the fifth component of ***socio-economic outcomes***. Both high and low performing countries are found in each of the groups. For example, with scores of 126 and 120, respectively, Hungary and Romania had a better performance than many of the eco-innovation leaders. In both countries, employment in eco-industries as a share of total employment was one of the highest in the EU. On the other hand, Ireland and Luxembourg received scores significantly below the EU average. While Ireland had a particularly low performance regarding exports of products from eco-industries, Luxembourg had a low share of eco-industries with regard to both employment and turnover.

Box 4-2 Beyond EU borders: the Global Eco-Innovation Scoreboard

Chapter 3 above highlighted the importance of looking beyond European borders when evaluating current trends in the transition towards a circular economy. As the example of the rapid transformation of the Chinese recycling sectors illustrated, key players in other world regions have increasing impact also on European industries.

In order to put European eco-innovation performance in an international context, the Eco-Innovation Observatory started to develop a Global Eco-Innovation Scoreboard (Global Eco-IS) in 2013. The Global Eco-IS is structured in the same five thematic components as the EU Eco-IS (see Box 4-1 above) and consists of 14 indicators. In the 2015 version of the Global Eco-IS, most of the indicators have their most recent data available for the years 2012 to 2014 (see Annex 2 for the full list of indicators). The Global Eco-IS covers 126 countries with the minimum criterion that data are available at least for 50% of the indicators. However, 114 of these 126 had data coverage above 75%.

Figure 4-3 illustrates the aggregated result for the Global Eco-IS in the form of a map. Countries with dark colour have high eco-innovation performance, while lighter colours illustrate lower performance. As in the EU Eco-IS, the average performance across all 126 countries was set at a score of 100.

Figure 4-3: Overall score from the Global Eco-Innovation Scoreboard, 2015

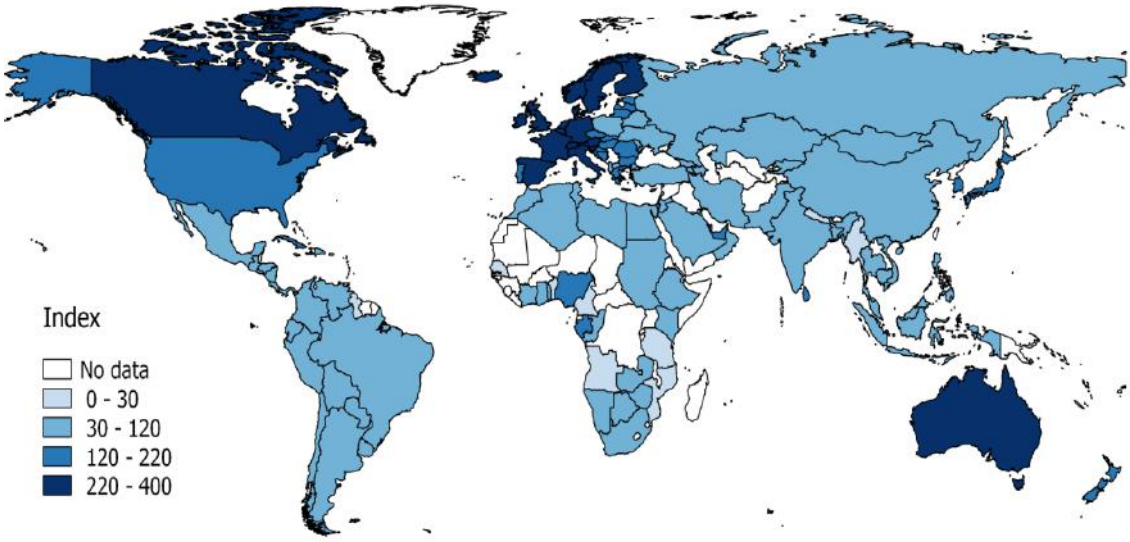
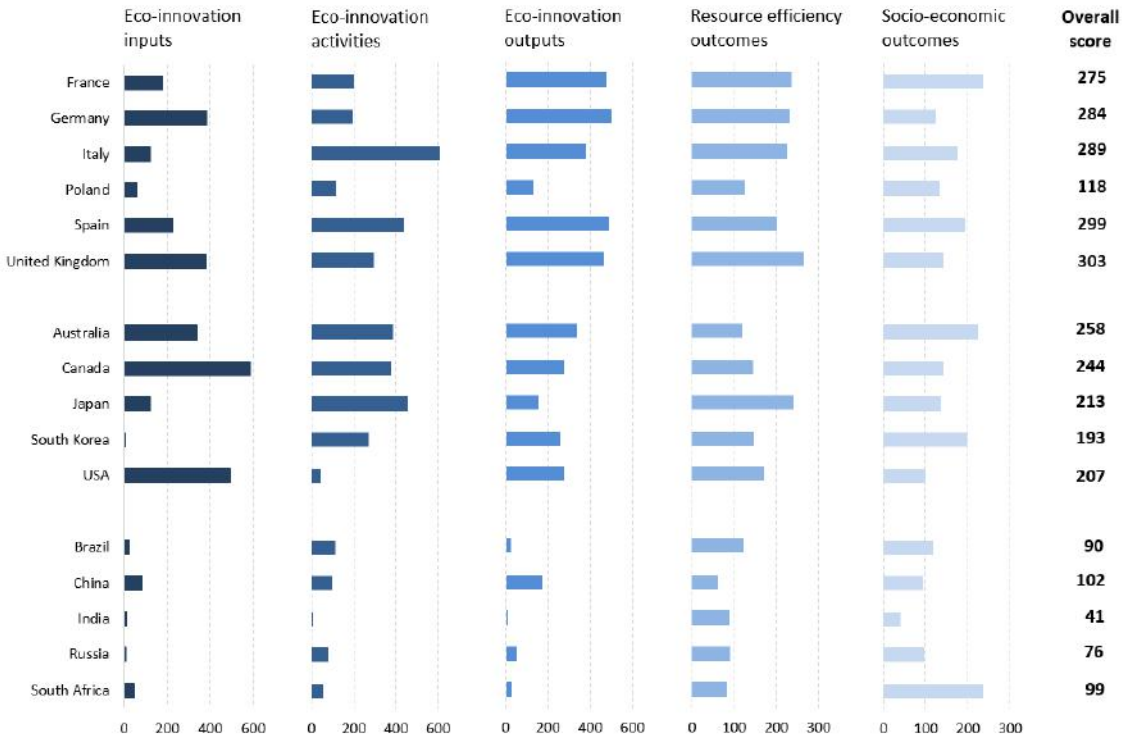


Figure 4-3 illustrates that the overall range of the index scores is much larger in the Global Eco-IS compared to the EU Eco-IS, ranging from an index score of almost 400 for some European countries down to a score of around 20 for some developing countries, such as Nepal, Mozambique or Guyana. This wider range is a result of the significantly higher variability of data across countries for each of the indicators in the Global Eco-IS.

The group of the top-20 performers is dominated by European countries, with 13 EU countries plus Switzerland, Norway and Iceland being among the global eco-innovation leaders. Only Singapore (rank 5), Australia (rank 16) and Canada (rank 20) are also found among the top-performing countries. Other major economic competitors of the EU have lower ranks, among them Japan (rank 23), the United States (rank 25), South Korea (30), China (52), South Africa (54), Brazil (60), Russia (75), Argentina (93) and India (115).

Figure 4-4 illustrates the performance profiles of selected EU countries, other industrialised countries and the BRICS countries, indicating the scores of each component in the Global Eco-IS.

Figure 4-4: Scores by component in selected countries of the Global Eco-IS



In a comparative assessment with the main competitors, the performance of EU countries with regard to *eco-innovation inputs* reveals mixed results. Some countries, notably the US and Canada, have higher scores in this component, mainly due to significantly larger amounts of green investments per capita, while the R&D expenditures on environmental and energy topics are equal or below the EU level. Scores for BRICS countries are much lower, mainly due to lower green investment efforts.

Compared to the selected EU countries, other industrialised countries also partly have a better performance regarding *eco-innovation activities*. For example, Japan scores particularly high regarding the share of companies engaged in eco-industry, but also regarding the number of companies with ISO 14001 certifications. In contrast, the US performs very low regarding both indicators in this component.

It can be seen from Figure 4-4 that – apart from Poland – the selected major EU countries have a comparatively high performance in the area of *eco-innovation outputs*. Compared with Japan or the USA, European countries deliver a comparable amount of eco-innovation related patents per capita, however, produce a larger number of scientific outputs related to eco-innovation and have also a higher media presence of eco-innovation topics.

Also *resource efficiency outcomes* are a component of the Global Eco-IS where EU countries generally receive higher scores compared both to other industrialised and the BRICS countries. EU countries perform comparatively better with regard to all four indicators in this component, i.e. material, water and energy productivity as well as greenhouse gas emission intensity. Only Japan has a performance comparable to that of EU countries.

The group of BRICS countries score comparatively best in the fifth component of *socio-economic outcomes*. Most notably, South Africa performs better than many industrialised countries regarding the revenues generated with eco-innovation and circular economy-related company activities. In addition, employment in these companies is comparatively high. Also the performance of Australia and South Korea results in high scores for these two indicators.

4.2 |Circular economy performance across the EU

Under a circular economy, materials from products at the end of their lifecycle are recovered through dismantling and recycling and consequently re-injected into the beginning of the product lifecycle, thereby reducing environmental impacts and production costs. Recycling is therefore a necessary precondition for a circular economy – resources and materials are recycled, returned back to the economy and used again. However, to maximise the effectiveness of recycling and the economic potential of secondary raw materials, eco-innovation is key. Eco-innovation allows for the possibility to transform waste into a valuable resource through the development of new technologies, processes, services and business models. SMEs, including a qualified workforce working in eco-industry sectors related to recycling, repair, and reuse are therefore a necessary contribution to the circular economy and act as vectors for boosting the recycling and reuse market.

In order to assess circular economy performance across the EU, it is important to apply a set of reliable indicators. Data from Eurostat, the Resource Efficiency Scoreboard and the Raw Materials Scoreboard all contain relevant indicators and analysis, which are useful for tracking progress. For the purposes of this exercise, we have selected one main indicator related to recycling (Total waste recycled/Domestic Material Consumption (DMC)) to provide some insight on MS performance in terms of the circularity of their economies. Following the analysis of the circularity performance, we provide a comparative assessment of EU countries with regard to employment and turnover in key circular economy sectors.

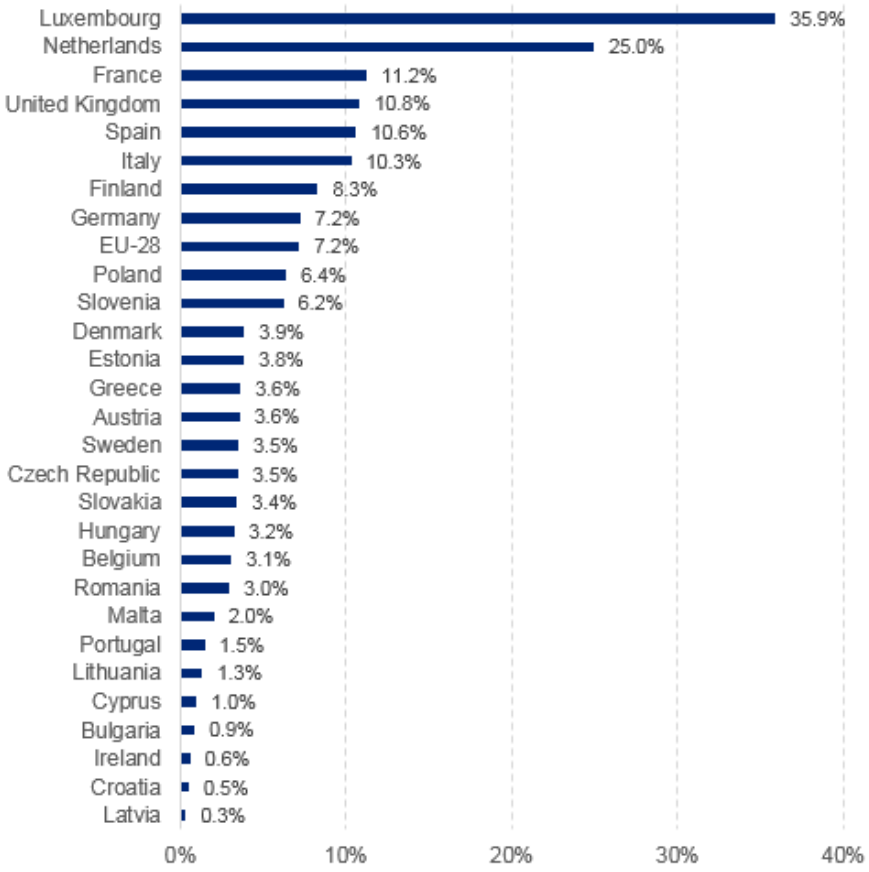
4.2.1 The circularity performance of EU MS

The following figure shows the relation of the total amounts of recycled waste to the indicator Domestic Material Consumption (DMC) per MS for all EU-28 countries and the EU-28 average. DMC measures the total amount of materials used by an economy. It is defined as the quantity of raw materials extracted from the domestic territory, plus all physical imports minus all physical exports.[7] In order to refine the results to the extent possible, DMC data extracted from Eurostat was further disaggregated to exclude materials that may be involved in activities such as energy production and recovery in order to avoid "double-counting" the quantity of DMC that is recycled. DMC includes all material types with the exception of mainly energy-related ones.[8] Estimations of recycled quantities include all types of recovery except for energy recovery and back filling. The ranking of MS in Figure 4-5 is based on the share of DMC recycled in 2012.

[7] See http://ec.europa.eu/eurostat/statistics-explained/index.php/Glossary:Material_flow_indicators

[8] The sectors exempted from the DMC include: Biomass, Fossil energy materials/carriers, Coal and other solid energy materials/carriers, Lignite (brown coal), Hard coal, Oil shale and tar sands, Peat, Liquid and gaseous energy materials/carriers, Crude oil, condensate and natural gas liquids, Natural gas, Fuels bunkered, Fuel for land, water or air transport, Products mainly from fossil energy products, Other products, Waste for final treatment and disposal, Stage of Manufacturing – Finished, semi-finished and raw products.

Figure 4-3 Share of DMC recycled in 2012 per MS (in %)



Source: own calculation based on data from Eurostat.

Figure 4-5 indicates that the highest performers in 2012 were Luxembourg (35.9%), the Netherlands (25%) and France (11.2%), while Ireland (0.6%), Croatia (0.5%) and Latvia (0.3%) ranked lowest. The EU average was 7.2%.

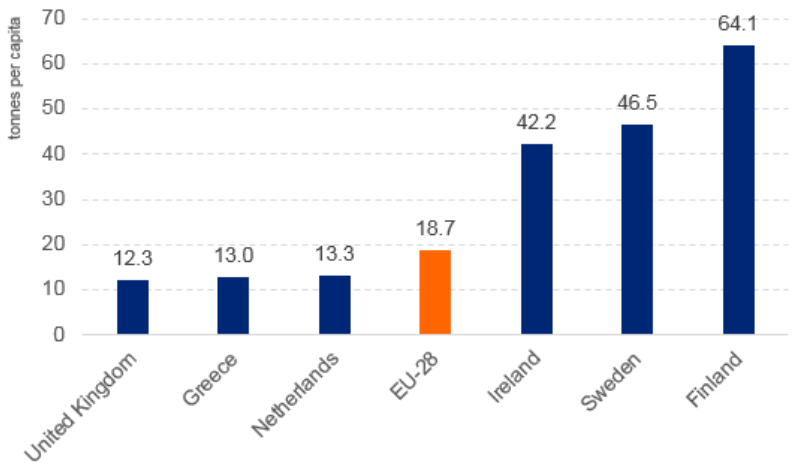
Results from the figure above indicate high variation in the recycled quantity of DMC across the MS. Several possible reasons can explain this. Firstly, MS do not always report their data in a harmonised manner. For example, MS can have different interpretations on the type of data to report (e.g. definitions on different waste streams, distinguishing the waste treatment techniques that can be defined as recovery, the parameters of data reporting, etc.). Eurostat points out that one important factor that can influence the high variety between countries in relation to the figures reported for waste treatment may be the 'other treatment' category, which is calculated as the difference between the sum of the amounts of waste treated and the amounts of waste generated. This difference arises in countries that have to estimate waste generation in areas not covered by a municipal waste collection scheme and thus report more waste generated than treated. In addition, the 'other treatment' category reflects the effects of import and export, weight losses, double-counting of secondary waste (e.g. landfilling and recycling of residues from incineration), differences due to time lags, temporary storage and, increasingly, the use of pre-treatment, such as mechanical biological treatment (MBT)." [9]

In order to put the results from Figure 4-5 into a larger context, Figure 4-6 shows DMC in tonnes per capita for the top and bottom three EU MS plus the EU-28 average. Finland (64.1 tonnes per capita), Sweden (46.5) and Ireland (42.2) showed the highest DMC per capita values of all EU-28 countries. Luxembourg followed closely behind with 31.8 DMC tonnes per

[9] http://ec.europa.eu/eurostat/statistics-explained/index.php/Municipal_waste_statistics#Database

capita. The Netherlands (13.3), Greece (13) and the UK (12.3) had the lowest DMC tonnes per capita out of the EU-28.

Figure 4-4 DMC per capita of top and bottom three MS and EU-28 average, 2012



Source: Eurostat.

Considering both of the above indicators, we clearly see that the Netherlands had the second highest DMC recycling rate (25%), coupled with a low DMC consumption value (13.3 tonnes/capita). This is also the case for the UK which ranked 4th for the amount of DMC recycled (10.8%) and a low DMC value (12.3 tonnes/per capita). The inverse is true for Ireland, which had a DMC recycled rate of only 0.6%, while ranking third in terms DMC consumption (42.2 tonnes/capita). Sweden followed a similar pattern with a high DMC tonnes/per capita value and relatively low DMC recycling rate (3.5%). These results indicate that for some MS, the DMC per capita is correlated with the DMC recycled rate: low DMC per capita = high DMC recycled rate.

However, compared to the findings above, results for Luxembourg and to some extent Finland and Greece stand out. Luxembourg had the highest DMC recycled rate at 35.9% out of the EU-28 as well as a relatively high DMC per capita rate (31.8 tonnes). This is in contrast to other high DMC recycled performers – the Netherlands and the UK who had low DMC per capita. Results for Finland also follow a similar logic with the highest DMC value (64.1 tonnes/per capita) and an above EU-average recycling rate at 8.3%. Greece, on the other hand not only had a relatively low DMC recycled rate at 3.6 % but also a very low DMC per capita value at 13 tonnes.

Analysis on how DMC is calculated can provide some additional insights into the results. The scope of DMC is limited to the amount of materials directly used by an economy (raw materials extracted from the domestic territory plus all physical imports minus all physical exports). It does not, however, include the materials indirectly consumed through imported products and materials indirectly required for export production. Therefore, DMC data could be underestimating the amount of raw materials consumed in MS with material-intensive industries and overestimate raw material consumption in MS with less material-intensive industries that export heavily, e.g. which may be the case for Luxembourg, as it is characterised by more services-intensive industries.

4.2.2 Turnover and employment in circular economy sectors

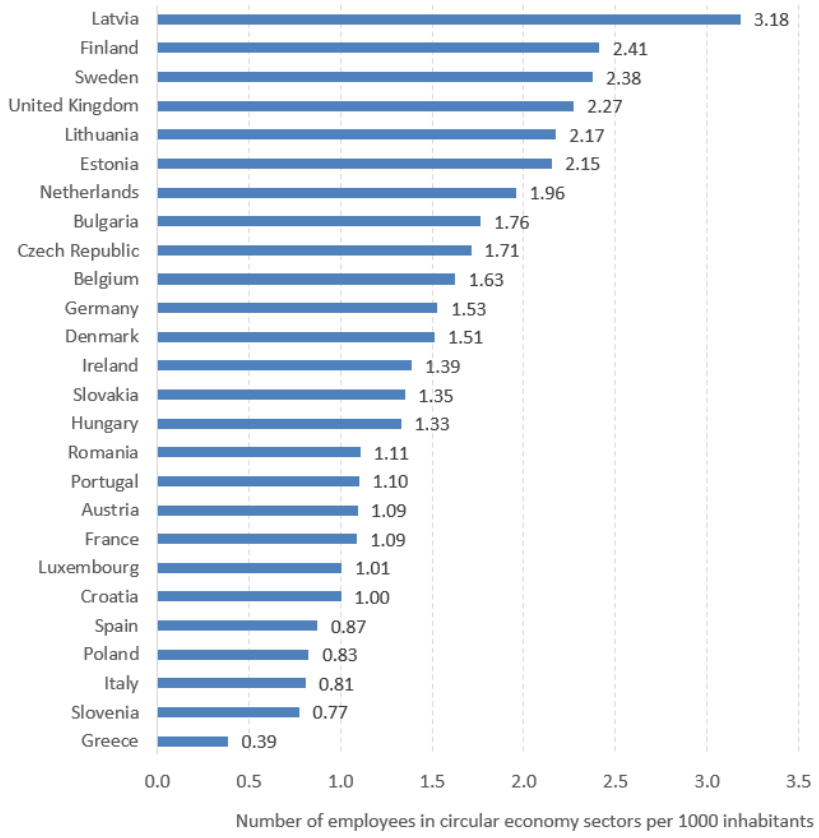
Indicators related to revenues and employment generated in eco-industries provide further insight on MS performance in areas such as recycling, repair and reuse, which are fundamental sectors for a circular economy.

Data on eco-industry activity in the EU was extracted from the Orbis database[10], a comprehensive database covering around 80 million companies in Europe. The extracted data is based on 1,260,000 records from the Orbis database, which correspond to 24 selected sectors in which companies are active in the areas of eco-industry and circular economy, e.g. activities related to recycling, reuse and repair.[11] After formatting and refining the data, it comprised about 290,000 company records.

Results of the data extraction indicate that in 2014, the UK (146,247), Germany (123,632) and France (71,803) had the highest number of people employed in the recycling, repair and reuse sectors in terms of absolute values. Luxembourg (553) and Slovenia (1,596) and Estonia (2,832) had the lowest number of employees in these sectors. These results correspond to earlier findings for MS such as Luxembourg, which is characterised by services-intensive industries, therefore low employment in recycling, repair and reuse sectors is not surprising if we assume that the majority of the country's industries are services-related, rather than material-intensive.

The following figure below provides another angle of analysis concerning the employment data. The data shows the number of employees in selected recycling, repair and reuse sectors per 1000 inhabitants.

Figure 4-5 Number of people employed in selected recycling, repair and reuse sectors, per 1000 inhabitants, 2014



Source: Orbis database.

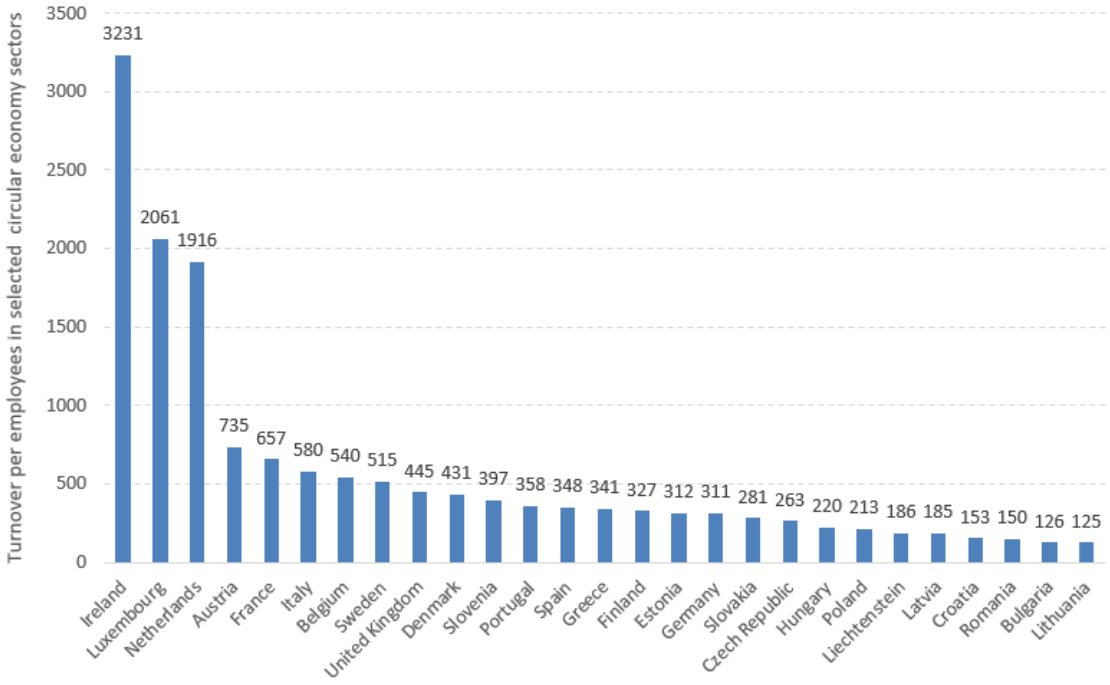
[10] See http://www.bvdinfo.com/en-gb/our-products/company-information/international-products/orbis

[11] The 24 selected sectors are: Recycling dry cleaning fluids; Tire Retreading; Motor Vehicle Parts (Used) Merchant Wholesalers; Recyclable Material Merchant Wholesalers; Used Merchandise Stores; Passenger Car Rental; Passenger Car Leasing; Truck, Utility Trailer, and RV (Recreational Vehicle) Rental and Leasing; Consumer Electronics and Appliances Rental; Formal Wear and Costume Rental; Video Tape and Disc Rental; Recreational Goods Rental; All Other Consumer Goods Rental; General Rental Centers; Commercial Air, Rail, and Water Transportation Equipment Rental and Leasing; Construction, Mining, and Forestry Machinery and Equipment Rental and Leasing; Office Machinery and Equipment Rental and Leasing; Other Commercial and Industrial Machinery and Equipment Rental and Leasing; Materials Recovery Facilities; General Automotive Repair; Automotive Exhaust System Repair; Automotive Transmission Repair; Other Automotive Mechanical and Electrical Repair and maintenance; Automotive Body, Paint, and Interior Repair and Maintenance.

Based on this formula, Latvia, Finland and Sweden had the highest proportion of employees in the selected eco-industry sectors compared to their populations. The UK came in 4th for the highest proportion (number of eco-industry jobs/1000 inhabitants).

The following figure provides results on an additional indicator comparing the selected sectors' combined operating turnover for 2014 with the number of employees.

Figure 4-6 Operating turnover per number of people employed in selected recycling, repair and reuse sectors, 2014



Source: Orbis database.

Findings show that Ireland, Luxembourg and the Netherlands had the highest operating turnover per number of employees in 2014. A key observation based on these findings is that MS such as Ireland and especially Luxembourg have significant revenue generated in these sectors compared to the relatively low number of employees. This could be explained by comparatively higher costs for the services provided in these MS or other factors such as higher salaries.

Additional analyses based on other key circular economy indicators, such as waste intensity, resource productivity, as well as specific policy measures such as Extended Producer Responsibility (EPR) schemes and deposit schemes can be found in Annex 1 to this report.

4.3 Concluding remarks

The objective of the analyses on circular economy and eco-innovation across the EU was to identify patterns of high versus low performance across the EU and to specify areas of strong versus weak performance in each of the EU MS.

The analysis provided a preliminary outlook on progress towards circular economy across the EU. However, it did not provide a detailed picture of the current situation in each country, which would require more in-depth analysis taking into account a larger set of indicators and factors. For example, to investigate the degree of circularity, focus was set on the DMC indicator, which only accounts for material directly consumed and not indirectly consumed through imported products. The use of other indicators that also reflect materials embodied in

trade, such as Raw Material Consumption (RMC), could provide an important additional perspective. Other relevant indicators to help measure circular economy progress include green investments, recycling rates of specific waste streams, e.g. packaging waste and data on landfill rates.

Further, both the analysis of the circular economy as well as the eco-innovation performance focused on the latest available year only. It would be important to also investigate trends in progress made over a period of several years, in order to obtain a more comprehensive picture of current development trends. This would allow identifying significant events that occurred in specific years that affected observed trends, such as the impact of the economic crisis or the implementation of certain policies and initiatives.

Reliable and relevant data is essential in order to monitor progress towards a circular economy and to analyse the role of eco-innovation in this process. This allows MS and policy makers to identify areas of improvement as well as high performing countries, who could participate in knowledge exchange on best practices and guidance. In the recent EC Communication on an EU action plan for the circular economy (European Commission, 2015a), the Commissions states its intention to work closely with the European Environment Agency (EEA) and Member States to propose a simple and effective monitoring framework for the circular economy. This will be a very important initiative towards monitoring circular economy progress. In addition, it is also important that circular economy indicators are also more closely linked to eco-innovation and eco-industries as well as take into account material consumption related to international trade.

5 | Eco-Innovation policies towards a circular economy

5.1 | Policy trends in the EU and EU Member States

Every EU member state has a set of policy measures that can be related to some elements of circular economy. They have been largely shaped under the waste and resource efficiency policies, mainly focusing on aspects like addressing material resource losses via savings, implementing waste and packaging recycling schemes. The recent European Environmental Agency (EEA 2016b) survey of the Members States showed that also waste prevention plans and initiatives on the use of secondary raw materials featured prominently.

The circular economy concept is penetrating the policy discourse in the Members States, largely due to given political priority to it at the EU level in last years and introduction of the European Action Plan for Circular Economy in December 2015. The Circular Economy Package, does not envisage work on a target for resource productivity, either for the EU as a bloc or for Member States individually.[12] However, nine EU Member States have adopted their own targets for improving resource productivity (EEA 2016b). These are in addition to the waste and energy target that are defined by the EU legislations.

EEA study: Circular Economy related consideration for policy

- The majority of reported initiatives on the circular economy in European countries are targeted at waste and secondary raw materials and at the abiotic part of the economy. Only two countries explicitly commented that the circular economy requires going beyond increasing recycling rates and a higher use of secondary raw materials. It might therefore be worth reflecting on how policies on the transition to a circular economy could encourage initiatives beyond waste and recycling.
- Approaches to closing material loops in a circular economy are still developing, and different stakeholders and countries interpret the topic differently. It would be useful to disseminate information on successful initiatives in which the circular economy helps achieve other key policy objectives, such as those related to the climate, competitiveness or employment agendas.
- For the majority of countries, compliance with existing legislation is the main driver of any action taken at the national level. Targets seem particularly effective in energising policy development and guiding policy implementation.
- Regional (subnational) initiatives can take advantage of physical proximity, reduced distances and a strong incentive on the part of local stakeholders. When expanding the knowledge base for the circular economy, it is worth keeping an eye on emerging regional and local initiatives.

Source: EEA 2016b, More from less — material resource efficiency in Europe 2015 overview of policies, instruments and targets in 32 countries, http://www.eea.europa.eu/publications/more-from-less/

Most countries incorporate material use and resource efficiency in a wide variety of other strategies and policies, including on waste and energy, industrial development and reform programmes, or in national environmental strategies. It is therefore most important to clearly link the new circular economy policy with the resource efficiency agenda (European

[12] As EEA was invited to develop an indicator framework for the CE, there might be options for broader targets to be re-introduced.

Commission 2011a) and with the Eco-Innovation Action Plan (European Commission 2011b), in order to strengthen the activities of the Member States that are partly very progressive and innovative. The new policy should not produce any shift of focus that would compete with resource efficiency and other eco-innovation policies but rather integrate the strategies for policy coherence and better coordination, unlocking of potentials and use of synergies (Bilsen et al. 2015).

EEA (2016b) survey of Member States found the economic considerations to be the most important factors driving their efforts in resource efficiency policies in most countries. This indicates that material use and resource efficiency are now core economic and strategic issues, and that the logic of doing more with less has been widely embraced. Among other drivers for policies were the desire to increase competitiveness and to secure the supply of raw materials and energy as well as to reduce dependence on imports on the one hand, and the need to reduce pressures on the environment on the other. Other frequently mentioned incentives were the need to improve production efficiency and the performance of the energy sector, the creation of new green-sector jobs or job creation in general, and the need to improve waste management and the use of secondary raw materials.

5.2 | Prioritising circular economy in national strategies

A few countries having adopted or being close to adopting a dedicated strategy or action plan on the transition to a circular economy. These include Belgium and the roadmap "Vers une Belgique Pionnière de l'Economie Circulaire" ("Towards a circular economy pioneering Belgium") developed by the federal government, the Netherlands with the "From Waste to Resource programme", Ireland with its strategy "Towards a resource efficient Ireland", Austria with its "Resource efficiency action plan", Finland with the National Material Efficiency Programme — Sustainable Growth through Material Efficiency as well as the upcoming in 2016 national Action Plan towards circular economy, and Germany with its Resource Efficiency Programme (ProgRess) and its Closed Cycle Management Act.

There are also examples of circular economy focused strategies that have been uptaken by the regional governments too. These include Scotland which in early 2016 launched its Circular economy strategy "Making things last", the 2012 Flemish region's Sustainable Materials Management Programme, including an Action Plan, the Catalonia's Strategy to promote the green and circular economy. More details of these strategies are presented below.

A few other countries in the EEA survey reported plans to adopt a dedicated strategy in the near future. In some countries, e.g. Sweden circular economy concept is referred to and envisaged to be addressed in several national strategies in the frontier areas of waste management and waste prevention.

However, there are countries such as Denmark, where there is a perceived reversal of policies from investing in circular economy and sustainability. This is felt at the level of the funding allocations for these priorities, as major cuts in funding have been introduced for the environment and climate initiatives (amounting to DKK 340m), including the Fund for Green Business Development that was investing in resource efficient activities and industrial symbiosis (see EIO 2015 Report for Denmark).

Austrian Resource Efficiency Action Plan

While there is no dedicated Circular economy strategy in Austria, the national Resource Efficiency Action Plan (REAP), published in 2012 identifies **resource efficient production**, **public procurement**, **the circular economy** and **awareness raising** as its major fields of action (EEA 2016 report on Austria).

REAP's 2012–2013 action programme includes measures on the recycling of materials which are critical for the Austrian economy. Target areas for the specified measures are the production industry as a whole, the construction industry, wood industry, industries that use critical materials (mainly the high-value metal industry, car industry, renewable energy industry and electronics industry) and the repair/reuse sector.

Current focus areas and measures for further improvements as defined by REAP comprise:

- a pilot project to investigate which materials are of high criticality for the Austrian economy, which will provide the basis for developing a corresponding strategy;
- the ordinance on recycling of construction materials (Recyclingbaustoffverordnung), under preparation, which will specify end-of-waste criteria for different materials as a precondition for their recycling;
- the ordinance on recycling wood (Recyclingholzverordnung BGBl. II Nr. 160/2012), which became effective in 2012, defining quality criteria for recycling wood.

Towards a circular economy pioneering, Belgium

In 2014, federal administrations prepared a roadmap proposal entitled "**Vers une Belgique Pionnière de l'Economie Circulaire**" ("Towards a circular economy pioneering Belgium") that laid out proposals for action to transition towards a more circular economy (EIO 2015 report on Belgium). Although not formally adopted, several of those proposals for action are already being implemented. In addition, upon request of the Federal minister of Environment and minister of Economy, a new roadmap version is under preparation, taking into consideration the circular economy package of the European Commission and expected to be released in 2016.

Potential actions under consideration in Belgium:

- Inclusion of the federal strategy for the efficient use of resources the efficient use of resources into the Belgium National Reform Programme
- The creation of a platform gathering industries, regional and federal administrations and ministries to share information and best practices, the identification of federal legislative and legal barriers in order to remove them
- Several other actions also refer to the contribution of the establishment of a new European product policy: study on recycled content in plastics in products (the output could be the development of a recycled content certification for producers who would like to mention it), information on dismantling and repair of end-of-life products, etc. On the regional level of Flanders, the "Plan C" should also be mentioned (http://www.plan-c.eu/en) The federal level also supports some Belgian SMEs for taking part in PEF/OEF (Product Environmental Footprint and Organisation Environmental Footprint) pilot projects launched in 2014 by the European Commission and aiming at developing environmental impacts calculation methodologies for different products and sectors

Finland: from material efficiency to circular economy

Since 2013, Finland has been pursuing its **National Material Efficiency Programme**, which has a goal to stimulate the development of the European Union's (EU) material resource efficiency policy instruments (EEA 2016 report on Finland). The main implementation components have been a research and innovation programme supporting developing new technologies and business development areas, and fixed-term material review project focusing on supporting businesses in clarifying the flow of materials and recognise possibilities for greater efficiency.

Furthermore, following the experience of the Netherlands "green deals" between the Government and companies has been suggested as a method of encouraging greater material efficiency

Since early 2016, Finland has been facilitation a discussion that aim to create a **circular economy Action plan and a roadmap for Finland**.[13] A group of high-ranking Finnish officials and industry representatives gathered in April and May to discuss how to make Finland a circular economy forerunner by 2025. The Finnish Innovation Fund, Sitra is in charge of development of the circular economy roadmap. Despite all the interest in circular economy, translating the interest into actual results is still a challenge. One of the most pressing issues is getting the Finnish SMEs on board the transition, considering that only 25% surveyed companies saw business potential in circular economy. The roadmap combined with the roundtable discussions will help tackle these issues and gather momentum. A draft of the action plan is already available on Sitra's website and stakeholders' consultation is on-going. The final version of the action plan will be released in September 2016.

Germany's Resource Efficiency Programme (ProgRess)

The circular economy concept increasingly seeps into other political programmes and objectives in Germany. In 2002, the Federal Government had already embedded the goal to double the German resource productivity by 2020 compared to 1994 in its sustainable development strategy, inter alia, through the closing of material cycles. The **German Resource Efficiency Programme (ProgRess I and II)** now aims to decisively contribute to this end (EIO 2015 report on Germany).

The new programme 2016-2019 encompasses in total 116 different proposals for resource efficiency measures. The waste and circular economy policy realm in the programme was fundamentally and strongly expanded and gained the rank of a focus area besides raw material supply, production, consumption, and overarching instruments. Overall, the programme provides some crucial contents for the (further) development of the circular economy.

The programme has four guiding principles (EEA 2016b):

- joining ecological necessities with economic opportunities, supporting innovation and social responsibility;
- viewing global responsibility as a key focus of German national resource policy;
- gradually making economic and production practices in Germany less dependent on primary resources, and developing and expanding closed-cycle management;
- securing sustainable resource use in the long term by guiding society towards quality growth.

ProgRess covers the entire value chain. It is about securing a sustainable supply of raw materials, raising resource efficiency in production, making consumption more resource efficient, enhancing resource-efficient closed-cycle management and using overarching instruments. A total of 20 strategic approaches are identified together with implementing measures. ProgRess attaches particular importance to market incentives, information, expert advice, education, research and innovation, and to strengthening voluntary measures and initiatives taken by industry and society. Since movement towards resource efficiency objectives will be reported every four years, the programme marks the beginning of a long-term process in policymaking, science and society (EEA 2016b).

[13] http://circulatenews.org/2016/06/finlands-action-plan-that-will-make-it-a-circular-economy-forerunner-by-2025/

'Towards a resource efficient Ireland'

In Ireland, an important policy development related to the circular economy is the adoption of a national strategy on resource efficiency in 2014 (EPA 2014). The strategy **'Towards a resource efficient Ireland'** incorporates the **fourth National Waste Prevention Programme** and sets out a framework for delivering the vision of 'living better, using less'. The specific objectives set out include:

- reducing wasteful consumption of material, water and energy resources by changing behaviours in businesses, households and the public sector;
- enhancing competiveness and reducing business costs by delivering programmes that stimulate resource efficiency and the circular economy;
- supporting sustainable growth and employment in the green economy – including re-use enterprises;
- minimising generation of hazardous wastes through efficient practices and use of safer alternatives;
- managing hazardous substances in products through efficient regulation;
- informing and influencing evidence-based decision-making by compiling and publishing high-quality data on waste.

The strategy lists 'stimulating innovation for efficiency' among the priority strands of the EPA's resource efficiency and waste prevention programme. Activities foreseen under this heading include, among others: providing expertise and financial backing for existing successful initiatives to support resource efficiency and waste prevention in businesses and in public sector organisations (including *Green Business;* the *Local Authority Prevention Network;* and the *Stop Food Waste* programme);[14] developing projects to engage priority sectors, building on successful activities such as *Green Healthcare; Green Hospitality;* and *Smart Farming*; horizon scanning to identify novel approaches, including a focus on efficient production processes to prevent loss of raw materials in processing through the *Green Enterprise* programme; formulating new business models and protocols for social enterprises and SMEs undertaking re-use operations. In terms of knowledge-building, the strategy also foresees the development of indicators for waste prevention and resource efficiency and of metrics for re-use and industrial symbiosis activities, as well as the establishment of a research fellowship dealing with challenges and solutions for achieving the behaviour changes associated with sustainable consumption and production choices.

Netherlands: From waste to resource

All policy efforts in the Netherlands related to the circular economy are captured in the action plan **'From waste to resource'** ("Van Afval Naar Grondstof- VANG) (EIO 2016 Netherlands report). Although VANG is a government programme, it includes activities in cooperation with enterprises from various industry sectors, as well as civilians and consumers, civil society, financial and legal service providers, and scientists.

The VANG-programme has nine overall operational goals and, at present, 54 actions in total. It is also flexible to introducing new goals if need emerges. Examples of actions undertaken include: a Digital Atlas Natural Capital that shows the availability of 'green zones' in the Netherlands at a high level of detail in order to better manage the use of this natural capital; the programme Creating business through Circular Design (CIRCO), with the aim to diminish material losses by 50%, to 5 million tonnes, within 10 years; an educational programme –

[14] See http://www.epa.ie/begreen/

Practice Research From Waste to Resource (PRO CATCH) was introduced at technical colleges to **integrate circular economy in the curricula of relevant educational courses and** work in partnership with business students on specific technical solutions that fit into the circular economy.

Furthermore, within the VANG-programme the Dutch National government has taken the initiative to cooperate with societal leaders to accelerate the transition towards a circular economy. Thus, the RACE-coalition (Realisation Acceleration Circular Economy) was set up to coordinate acceleration of the circular economy.

In addition, in order to **promote resource-independent entrepreneurship,** companies are supported in assessing their risks in relation to resources. This included research on the resource situation for 64 possibly critical materials (and activities to translate the findings to useful information for entrepreneurs), two activities on promoting the role of harbours in the circular economy, and support for the Dutch participation in the Knowledge and Innovation Community (KIC) for Raw Materials. It is the government's ambition to work towards closing at least 10 material chains. Green Deals, (which are non-financial support actions to create conditions for innovation) and other agreements have already been concluded for the material/product chains of concrete, food, packaging, phosphate, wood, textiles, plastics and biotic chains.

Financial and other market incentives have been developed to promote circular entrepreneurship. Since 1 January 2015, the waste tax is extended from waste deposit to waste incineration. Work is in progress on adapting other taxes for waste. **Circular Procurement** is promoted as well as **circular consumption patterns**. Various experiments have been set up, including reuse of ICT equipment that is discarded by the government. A specific project is set-up to **remove regulatory barriers for the circular economy** and increase waste separation by household to at least 75% in 2020 (or max. 100 kg of residual household waste per inhabitant per year). Finally, **indicators and statistics are developed** to increase insight in developments that may promote the circular economy.

Denmark: circular economy strategies

Together with the Danish EPA (Environmental Agency), the Danish Business Authority operates a **Task Force for Resource Efficiency**. The Task Force was set up with aim of increasing the competitiveness of the Danish economy and was part of the national growth strategy of the Danish Government, published by the Ministry of Finance in 2014. Its aim is to review existing regulations affecting resource productivity and circular economy practices, identify barriers and work to find solutions. It will use explorative studies of the experiences and daily work of companies to understand how barriers appear and affect the behaviour of the companies, covering the rules themselves, how they are administered and the help businesses receive to navigate them. In 2015 the taskforce will identify barriers blocking potential increases in resource efficiency. In its second and third years (2016–2017) the task force will work on selected barriers to find the most effective way to overcome them.

Italy: Bill "Collegato ambientale" / "Environmental Annex"[15]

The "Collegato Ambiente" (Environmental Annex) to the Financial-Stability Law can be considered a strategic tool to support at national level the transition towards circular economy. It entered into force on 2nd February 2016 under the name of Measures for green economy and resource efficiency. It contains several measures for improving the sustainable

[15] http://www.techitaly.eu/circular-economy-in-italy/

use of resources through bioenergy, green public procurement, environmental footprint, sustainable consumption and production, market for recycled products, circular waste management, soil protection and water management, natural capital and ecosystem services accounting system.

Concerning in particular the market for recycled products, Italy is identifying incentives for enterprises, local authorities and NGOs to support the purchase of products made with secondary raw materials, but also specific measures to increase waste prevention, separate collection and recycling, bio-waste composting, take-back mechanisms for reuse. In the field of GPP (Green Public Procurement), the use of the "minimum environmental criteria" for electronic devices, lighting, supply of paper, cleaning products, catering, sustainable construction materials has become mandatory. Furthermore, on the basis of the successful experience of the Italian Environmental Footprint Program launched in 2011, a national voluntary scheme (so called Made Green in Italy) in line with EC Recommendation 2013/179/EU (PEF) will be set up through a national regulation to increase the competitiveness of the Italian eco-products on national and international markets. EUR 35 million has been dedicated for an experimental program at national level for sustainable mobility (e.g. car-pooling, bike sharing), home-schooling and home-working.

France: "Act on the energy transition for green growth".

In July 2015, France adopted its "Act to the energy transition for green growth" (Loi relative à la transition énergétique pour une croissance verte), which significantly increased the France's commitments to sustainability and made it a reference. Among many objectives, it sets the national objectives and strategy to move towards a circular economy and zero waste.

The main dispositions of the Act aim to promote the circular economy through several aspects. Notably they aim to implement deposits on several packaging, encourage functional economy practices, fight against planned obsolescence of manufactured products, foster re-use and waste subject to preparation for re-use, improve material recovery, extend selective collection of waste to bio-waste and implement incentive taxation, promote industrial ecology. They also set quantitative targets for some specific sectors or waste categories and identify general objectives.

Circular Economy Objectives in Numbers

- 10% reduction in municipal household and assimilated waste;
- Increase the quantity of waste that are subject to material recovery by 55% in 2020 and 65% by 2025 (in weight);
- Material recovery of 70% of construction waste;
- 30% reduction in landfilling of non-hazardous non-inert waste by 2020 (50% by 2025);
- 50% reduction of the quantity of non-recyclable manufacture products by 2020;
- 30% increase between 2010 and 2030 of the ratio between GDP and its internal consumption of primary resources.

Making things last – A Circular economy strategy for Scotland

Scotland's vision of becoming Europe's first zero waste economy took a step forward in early 2016 with the publication of a new circular economy strategy that promises to slash food waste levels, nurture the country's remanufacturing sector, and promote eco-design principles.

This strategy builds on the progress that has been made on the zero waste and resource efficiency agenda, but scopes out ambition and action into a much broader set of business and

industry opportunities. The key elements of the Zero Waste Plan (2010) and Safeguarding Scotland's Resources (2013) were integrated into the new strategy (Scottish Government, 2016)

The strategy, identifies four main areas where circular economy models can be embraced**: food and drink and the wider bio-economy**, **remanufacturing**, **construction and the built environment**; and **energy infrastructure**.

The strategy also includes a new Scottish food waste reduction target, which is the first of its kind in Europe. This target, to cut food waste by a third by 2025, is expected to put Scotland at the front of global action to tackle food waste, achieve hundreds of million euro savings annually and to increase competitiveness of the focal food and drinks sector.

Under the plan, the government will provide further support to a remanufacturing sector that is already worth £1.1bn a year to the Scottish economy and is tipped to grow by a further £620m a year by 2020, introduce initiatives to encourage more efficient use of construction materials, and exploit considerable opportunities in the energy industry to reuse equipment from wind turbines and decommissioned oil and gas platforms.

The strategy will promote a new approach to producer responsibility, through a single framework for all product types that drives choices for reuse, repair and remanufacture, while more fully exposing and addressing the costs of recycling and disposal. In addition to existing producer responsibility schemes for batteries, electronic equipment, end of life vehicles and packaging, Scotland will also prioritise schemes for tyres, furniture and mattresses.

The strategy recognises the potential for public procurement to support the development of a more circular economy building on the statutory guidance on the sustainable procurement duty under the Procurement Reform (Scotland) Act 2014 and the extensive training on circular economy principles of the procurement professionals.

All in all, the strategy sets the well-defined ambitions, priority actions in such areas as **waste prevention, design, reuse, repair, remanufacture, recycling, producer responsibility for reuse and recycling, recovering value from biological resources, energy recovery, landfill**. It also defines as cope of action for **communications and engagement** of wide groups of actors, building **skills for a circular economy**, and **measuring progress** in achieving circular economy targets and activities (Scottish Goverment 2016).

Catalonia: Shifting from waste management to circular economy

The region of Catalonia is at the vanguard in the shift from traditional waste management schemes towards a model based on the principles of the circular economy (EIO 2015 report for Spain). The Strategy for Smart Specialization of Catalonia (RIS3CAT) from 2014 guarantees the promotion of circular economy through four main lines of action: a) the integration of circular economy into seven leading sectors, with specific initiatives driven by a private public steering committee that enables their efficient implementation, b) to support emerging activities related to circular economy, c) to develop opportunities arising from cross-cutting enabling technologies, d) to boost an innovation ecosystem that prioritises eco-innovation[16].

In 2015 the region launched a strategic plan to increase the region's effort and improve the consistency of regional programmes in favour of a greener and more circular economy. The

[16] https://www.ellenmacarthurfoundation.org/ce100/directory/catalonia-accio

strategic plan supports cross-sectorial integration of circular economy and coordination between related regional programmes, such as the Catalan general waste and resource management and prevention program 2013-2020, the Catalan Eco design strategy and the Industrial Strategy for Catalonia. The plan defines key strategic axes, in particular the generation of demand and creation of new markets, the improvement of access to funding, the promotion of R&D, support to internationalisation and promotion of entrepreneurship.

The Catalan Ecodesign Strategy seeks to promote design of eco-products and eco-services and encourage sustainable production and consumption patterns, establish synergies among stakeholders (companies, research organisations, designers, consultants, consumers, etc.), establish the necessary organisations, and adapting to EU regulatory requirements[17]. It also aims to advance green procurement for products and services with low ecological impact across life cycle and develop initiatives that will increase the range of more sustainable products and services as well as boost demand.

Circular economy priority area in Slovenia's Smart Specialisation Strategy

The circular economy is also one of the nine priorities of the Slovenia's Smart Strategy Specialisation. The first objective in this priority area is to connect stakeholders – business entities, educational and research system, non-governmental organisations, the state and individuals – into value chains according to the principle "economy of closed material cycles" to develop new business models for the transition towards a circular economy. Slovenia has relatively well-preserved natural resources, but better and more efficient preservation and management of natural resources is needed. "Consequently, economic systems of linear economies have to transform to circular ones by eliminating the concept of waste, and thus provide conditions for long circulation period of products in use, their cascading use and the provision of clean and unpolluted materials which can be reused. For establishing such a system innovation at the level of business models and the establishment of adequate systems of the so-called reverse logistics are essential." The focus will be on technologies for sustainable biomass transformation and new bio-based materials; technologies for use of secondary and raw materials and reuse of waste; and production of energy based on alternative resources. In this regard the 2023 objectives are to (i) raise the material efficiency index (of 1.07 in 2011 to 1.50 in 2020) and to (ii) establish five new value chains with closed material cycles.

5.3 | Specific policy measures for circular economy

To promote initiatives of circular eco-innovations, initiate changes from routine practices to the practices based on sharing, reusing, repairing, remanufacturing, as well as to address barriers on a local level, the national and local government can deploy a range of policy measures. These can be:

- **Regulatory instruments** including the regulations on recycling, producers responsibilities, eco-design, mandatory targets, codes, standards, certification for products
- **Economic instruments**, such as fiscal and financial incentives (taxes, fees), direct funding, demand pull instruments (e.g. procurement)
- **Research, development and deployment support measures**, such as grants for R&D and piloting activities, R&D infrastructure, innovation vouchers, supporting innovation incubation, and R&D personnel

[17] http://mediambient.gencat.cat/web/.content/home/actualitat/2015/docs/4_Presentacio_conferencia_ecodisseny.pdf and http://afersexteriors.gencat.cat/en/detalls/noticia/20150612_estrategiaecodisseny

- **Information, education and networking support measures**, which focus on advising, training, offering direct support in activities to SMEs, customers, technology adopters, promotion of networking, providing information, and supporting public private partnerships
- **Voluntary measures**, including performance labels and guarantees for products and services, voluntary agreements and commitments

Application of these measures in the context of circular economy development in Member states is not very wide. Although some new practices on national and municipal levels have been emerging. Sections below provide overview of such examples.

5.3.1 |Regulatory instruments

Regulatory measures at MS level are to a large extent driven by the EU-legislation, which so far has been pushing MS to upgrade their national frameworks towards better environmental and waste management (including general waste legislation, end-of-waste, waste treatment and recovery, legislation on specific types of wastes, products and activities, waste shipments etc.). Further legislation that is common across MS is related to environmental management standards (e.g. ISO 14001), as well as to the EMAS scheme. Austria has, for instance had its own ecological certification scheme that has been similar to the EMAS one. A new development is in Estonia, where a certification centre was established to provide certification for goods that have been made using recycled materials, for example, compost produced from production waste (see good practice example below).

There are few examples where the Member States use regulatory instruments systematically to promote the circular economy or where they are going beyond the measures needed for compliance with EU legislation. Several pieces of the EU legislation provide requirements to use circular economy policy approaches in implementing environmental regulation. For instance, the End-of-life vehicles Directive (2000/53/EC), the WEEE Directive 2012/19/EU and the Batteries Directive 2006/66/EC use Extended producers' responsibility (EPR) as an approach.

An example is in Sweden, where the adopted legislation on a European Insurance Solution SCC made it mandatory to have a specific insurance for all electronic products on the Swedish market that covers future collection and recycling costs. Restoration of new wind turbines is also covered through this scheme[18]. A Further example is described below from France, where extended producer responsibility schemes have been running since 1992. A recent one was introduced for furniture waste in order to help furniture reuse and recycling.

However, a study by Zero Waste Europe highlights that current EPR schemes are not designed for the circular economy and do not cover product waste, do not include incentives to re-design systems to drive product waste prevention and re-use and have been ineffective in driving eco-design[19]. The Germany's Waste Prevention Programme (2013) also confirms this and proposes to enhance knowledge and investigate whether "producer responsibility could focus more strongly on waste prevention, by requiring products to be designed in a way that minimises the incidence of waste during their manufacture and use".[20]

[18] See EIS PCC, 2015: http://www.govsgocircular.com/cases/european-insurance-solution-pcc/

[19] See Zero Waste Europe, 2015: Redesigning Producer Responsibility: A new EPR is needed for a circular economy, https://www.zerowasteeurope.eu/downloads/redesigning-producer-responsibility-a-new-epr-is-needed-for-a-circular-economy/

[20] German Federal Ministry for Environment, Nature Conservation and Nuclear Safety, 2013: Waste Prevention Programme, http://www.bmub.bund.de/fileadmin/Daten_BMU/Pools/Broschueren/abfallvermeidungsprogramm_en_bf.pdf

Good practice 16 Extended producer responsibility for furniture waste in France

The furniture scheme is one of the more recent (2012) French EPR schemes. Covering both household and professional furniture waste, it is expected to generate over EUR 300 million a year to help develop furniture reuse and recycling, and help create jobs and structure industrial activities around furniture waste management – leading to the creation of many new companies, including in relation to mattress and wood recycling, which were not profitable enough to generate sustainable activities prior to the establishment of the scheme. The scheme also strongly promotes furniture reuse, closely involving social economy structures in its organisation model and having a goal of doubling reuse activities at the end of the first approval period (2017).

The main objectives are:

- reuse and recycling of 45 % of household furniture by end of 2015;
- reuse and recycling of 75 % of professional furniture by end of 2015;
- recovery (including reuse, recycling and other forms of recovery) of 80 % of furniture by end of 2015

source: EEA, Country profile FRANCE 2015 review of material resource efficiency policies in Europe, http://www.eea.europa.eu/publications/more-from-less

Good practice 17 Estonian certification centre for quality standards of recyclable goods

Certification Centre for Recyclable Goods

(Source: http://www.recycling.ee/)

The creation of the centre is one of the first initiatives in Estonia clearly targeted at improvements in circular economy. The centre received its operating permit in spring 2016, starting its activities soon after. The centre will be providing certification for goods that have been made using recycled materials, for example, compost produced from production waste.

The initiative aims to reassure consumers that the goods bought are of good quality and meet specific standards. The long-term perspective of the centre is to become an autonomous conformity assessment unit for different types of products made of recycled waste, including fermentation waste from biogas production, sewage sludge compost and goods produced from construction and demolition waste

Source: http://www.recycling.ee/

A more hands-on approach to tackling regulatory challenges for the circular economy has been pioneered by the Netherlands (see good practice example in section 5.3.5), though the "Green Deals" approach. This involves the government working together with businesses and business associations and offering non-financial support. A specific project is set-up to remove regulatory barriers for the circular economy and increase waste separation by household to at least 75% in 2020 (or max. 100 kg of residual household waste per inhabitant per year).

In terms of setting ambitious targets for the circular economy, Spain's newly published Waste Management Plan for 2016-22 can be a good example of using targets to shift the system away from landfilling and incineration, towards more circular models. In particular, Spain is the first country to set targets for different categories of waste to be prepared for re-use, which can provide interesting learning experience for other Member States to follow (see good practice example below).

Regions have also played a role in promoting the circular economy through specific soft regulatory instruments. The Italian region of Lazio promotes the development of industrial symbiosis through a set of guidelines (the "APEAs Guidelines") for the development of Ecologically Equipped Productive Areas in Lazio.

Flanders also has a legal framework to ensure the quality of recycled aggregates – "Eenheidsreglement" since 2011. To implement this regulation, there are two certification institutions that base certification procedures on this common regulation.

Good practice 18 Spain's new Waste Management Plan 2016-2022

Spain's newly published Waste Management Plan for 2016-22 (*Plan Estatal Marco de Gestión de Residuos (PEMAR) 2016-2022)* can be a good example for regulation setting a roadmap and strategic guidelines for substituting linear economic models by circular models, and re-integrating waste materials into production cycles.

One important instrument is the target setting for waste recycling and re-use. In particular, the plan it sets overall targets of 50% of municipal waste to be prepared for re-use or recycled, or which 2% must be prepared for re-use including textiles, WEEE, furniture and "other suitable waste streams". This is considered the first time that such a target covers preparation for re-use of many waste categories in a national waste management plan.

Municipal waste authorities are mandated to work with social enterprises and other social economy actors to implement the plan. According to RREUSE estimates, this can lead to having over 200,000 tonnes of goods re-entering the second-hand market.[21]

More information: EIO 2015 Country Report on Spain, and RREUSE (http://www.rreuse.org/wp-content/uploads/2016-04-11-Expert-workshop-Reuse-Margarita-Ruiz-1.pdf)

5.3.2 | Economic Instruments

Environmental fiscal instruments and incentives, including charges and taxes for waste, incineration, landfill, subsidies and tax reliefs, or pay as you throw are common measures in EU Member States, but mostly belong to a linear thinking of the economy. On the other hand, there are specific tax rebates, or premiums that aim to incentivise consumption of specific ecological products. For instance, Belgium has tax cuts for passive houses, as well as "low energy" and "zero energy" houses. The Brussels Capital Region also has an incineration tax since 2013. A Green Tax Reform introduced in Portugal in 2014 included the €0.10 levy on light plastic bags, the increase of landfill taxes to €11 per tonne in 2020, carbon tax on economic sectors outside the scope of the EU Emissions Trading System and several incentives for electric vehicles and LPG- and LNG-based vehicles (see EIO 2015 country report on Portugal). In Austria, tax reductions are being granted for some environmental friendly products such as electric vehicles. In this case, the car purchase tax (NOVA) is not charged for electric vehicles,

[21] See RREUSE, 2016: Government experts share best practice on re-use, http://www.rreuse.org/government-experts-share-best-practice-on-re-use/

resulting in an around 16% reduction of the overall price (see EIO 2015 country report on Austria).

In Finland, environmental taxation is an important revenue, covering 2.9% of GDP, above the EU average of 2.5% (EIO 2015 country report on Finland). The good practice example below details the large variety in Finland's environmental taxes, including the recent changes that are introduced to the tax system that refund the mining industry and the reduction in car taxation. This also goes back to the core issues related to taxation policies, which are a politically sensitive instrument. This is why environmental taxes require wide societal debates and consensus.

Good practice 19 Environmental taxation in Finland

Environmental taxation is one of the more important parts of the related policy landscape. In 2014, Finland's revenue from environmental taxation, 2.9% of gross domestic product, was above the EU average of 2.5%. The share of environmental taxes in tax revenues has also gradually increased, while the composition has changed: taxes on carbon dioxide from heating, power plants and machinery as well as the waste tax have all been gradually increased. Such changes may reflect marginal improvements in incentives for eco-innovation in the country.

Some environmental taxes are being reduced. As an important example, effective as of 2017, Finland will reintroduce tax refunds for the mining industry. While the annual vehicle tax has been increased, car taxation is currently being reduced. According to some estimates, in order to meet environmental targets, a further review of environmentally harmful subsidies may be needed: the reduced rates on specific industrial activities and fuels amounted to €3 billion in 2014 (EC, 2016a).

Finland also experimented with a temporary R&D tax relief in 2013–15, offering an additional 100% deduction for R&D personnel wages, set against corporate tax. The eligible R&D was defined as basic, industrial and experimental research activities. According to the Research Institute of the Finnish Economy (ETLA, 2016), the tax break did not achieve its goals, especially since the companies that benefitted from the policy were on average older, more profitable and larger than those who did not rely on or benefit from it.

More information: EIO 2015 country report on Finland

The programmes offering direct investment or funding to resource efficiency activities or to infrastructure, etc. are very diverse across the Member States. There is a rising trend of direct support for SMEs developing circular economy solutions.

Demand-pull instruments, including green public procurement (GPP) are beginning to spread in the EU. There are only five EU countries where there are no Action Plans for GPP (Estonia, Greece, Hungary, Luxembourg and Romania) at the time of writing this report (June 2016). There is EU-wide GPP resources available including GPP criteria for 21 product and service groups; the European Commission Helpdesk for GPP offers direct support including regular webinars and information. However, in spite of the adoption of guidelines or action plans for GPP, this practice is not widely common especially in countries from Central and Eastern Europe (EIO 2015 country report on Lithuania).

At the same time, it is interesting to note that there are countries where sustainable procurement guidelines go beyond the common practice and also include circular economy principles. For example, in Austria, in 2016, a focal area is being set on "circular procurement", i.e. purchase of products with a high degree of circularity of the involved raw materials (EIO

2015 country report on Austria).[22] Circular Procurement is promoted as well as circular consumption patterns in the Netherlands. Here, various experiments have been set up, including reuse of ICT equipment that is discarded by the government (EIO 2015 country report on Netherlands).

Furthermore, countries have various support measures in place that favour the consumption of sustainable goods. For instance, Belgium has a wide array, including: subsidies for the construction of a single family passive house in Wallonia amounting to € 6,500 for the construction of a passive single family home; the EcoPack – a loan to households wishing to renovating and improving energy performance at 0% interest rate; eco-vouchers are provided by the employers as supplement "green" bonus to the salaries, which allow buying sustainable products and services). Enterprise Flanders provided subsidies for sustainable site management in business parks, including for sustainable group purchases and infrastructure needed to reach 'CO2 neutrality'. However, it is not widely seen that countries offer subsidies specifically targeted at purchases of technologies or products bought on second-hand markets or for re-manufactured or re-used goods.

Ireland has been making use of direct funding programmes to support green businesses and waste prevention. The Irish Green Enterprise programme has supported the formulation of new business models and protocols for social enterprises involved in re-use operations, offering incentives for companies to use cleaner production methods and provide services in an environmentally friendlier way[23].

Some Central and Eastern European Member States are also prioritising the use of EU Structural Funds support to enterprises developing „green economy" solutions. For instance, the Romanian government is expected to announce a public support scheme to fund eco-innovative SMEs in 2016. However, it is not a common practice among the latter states to fund circular economy solutions directly.

Good practice 20 Tendering and procurement rules, Berlin, Germany

With an annual volume of approx. 260 billion euros, of which about EUR 50 billion relate to environmental future markets, the public sector in Germany has large market potential. In Berlin only, the market volume of the public sector covers around 4-5 billion EUR per year.

Since 2013, public institutions and companies of the Federal State of Berlin are obliged to define ecological requirements for delivery services, construction and other services, as well as to take account of life-cycle costs within the scope of their procurement activities. Results from an investigation of the environmental impacts of 15 products groups that have been purchased under these specific conditions reveal a potential CO_2eq reduction of 355,000 tonnes per annum. In addition, the environmentally sound public procurement led to a reduction in costs of public budgets of EUR 38 million per year (minus 3.8%). Although some products are associated with additional costs, the sum of environmentally friendly purchased products are economically more advantageous than the procurement of conventional products over their lifetime. The product groups with the largest potential for greenhouse gas reduction are green energy, the renovation of buildings to passive house standard, the recycling of industrial waste, as well as the renovation of the street lighting through high-efficiency LED lights.

Source: http://www.oeko.de/oekodoc/2379/2015-541-de.pdf

[22] See Austrian Sustainable Public Procurement website, http://www.nachhaltigebeschaffung.at

[23] See http://www.epa.ie/researchandeducation/research/epafunding/greenenterprise/

5.3.3 |Research, development and deployment support measures

Funding for RDI in the circular economy is linked to the eco-innovation support measures, but also includes measures such as:

- Funding for R&D in CE related themes (e.g. direct or competitive grants)
- Pre-commercial /R&D procurement for products and services with sustainable design
- Providing R&D infrastructure
- Innovation vouchers schemes for SME on CE related innovations
- Support to innovation incubators focusing on CE related areas
- Support programmes and incentives for R&D personnel

There has been increasing use of such instruments for eco-innovation and development of environmental technologies along the innovation cycle in EU. EIO 2015 country reports provide a good overview of such instruments in EU. EU15 Member States have more mature RDI policies and have a more advanced policy mix targeting "green" and eco-innovation and have started to introduce support for circular economy RDI and demonstration. Central and Eastern European countries also started to converge to adopting traditional eco-innovation support priorities into their smart specialisation strategies and into national or regional structural funds operational programmes. The latter Member States are, however, overall not active in adopting circular economy support approaches into RDI policies.

- There are several examples where mostly the EU15 Member States' RDI policies target specifically the circular economy. An example is Luxembourg, which introduced a scheme to support SMEs develop products according to circular economy principles. In France, ADEME – the Agency supporting the entrepreneurial environment launched a call for SME projects developing technological or organisational innovations dealing with circular economy challenges (see good practice examples below). France also funds Eco-tech competitiveness clusters network, where member clusters support private-public innovation partnerships and aim to develop common solutions across sectors, i.e. on eco-efficient cities, environmental impacts, sustainable mining, secondary raw materials and the circular economy, eco-efficient industry and metrology (see EIO 2015 country report on France).
- In the Netherlands, the VANG programme ('From waste to resource') includes funding on the theme of Product design for circularity the aim is to diminish material losses by 50%, to 5 million tonnes, within 10 years. In the past period a programme, Creating business through Circular Design (CIRCO), was launched and input was provided for the European policy process to integrate EU product legislation with the EU Eco-design Directive (see EIO 2015 country report on Netherlands).

In Austria, the biggest programme supporting eco-innovation is the Programme on Technologies for Sustainable Development, managed by the Ministry of Transport, Innovation and Technology. It aims at supporting the economy with future-oriented innovations, initiates and supports trendsetting research and development projects and the implementation of exemplary pilot projects. It consists of the four sub-programmes "Building of Tomorrow", "City of the Future", "Factory of Tomorrow", "Energy systems of Tomorrow". A significant share of Austria's passive house and ecological construction knowledge stems from this programme (EIO 2015 country report on Austria).

In Finland, Green Net is a cleantech business network that brings together the expertise and resources of Finnish cleantech companies, scientific and educational institutions and public authorities. The thematic focus in cleantech is urban cleantech, comprising: smart and energy efficient construction and living, and circular economy in the urban environment. Several

business parks and clusters accommodate companies focusing on eco-innovations and the circular economy, including the Lahti Region Development LADEC Ltd (previously Lahti Science and Business Park) and Smart Chemistry Park in Turku.

In Belgium – the region of Brussels, there are several examples of measure, which offer innovative businesses the initial funding or coaching to develop projects in circular economy areas (see good practice example below).

Good practice 21 Brussels region mix of support measures for resource efficiency and circular economy

The region of Brussels of Belgium has implemented a number of measures to boost the eco-innovation capabilities of businesses. They include the **BSE Academy**, renamed **Greenlab.brussels** in 2016, a 6-month programme aimed at accelerating the development of innovative start-ups dealing with circular economy projects, renewable energy or environmental protection[24]; **ResilieNtWeb,** a strategic pilot project helping SMEs become more resilient to economic, social and environmental challenges[25]; or **Irisphere**, an industrial ecology pilot project on two economic activities and parks encouraging synergies (water, equipment, waste collection, etc.) between businesses[26].

Access for SMEs to research centres and expertise is also facilitated through the **"Boost" innovation checks.** A business incubator – **Greenbizz.brussels**[27] – has also been set up to develop the green economy and environmental entrepreneurship.

The region also supports research and innovation with the **"co-create" programme** that brings together citizens, researchers and businesses to encourage co-creation in living labs. For 2014-2015, the focus was on the development of sustainable food systems.[28]

The region of Brussels Capital, together with the City of Brussels and the FEDER European fund for regional development also fund the **Mad Brussels** eco-design platform that promotes innovation in the design and fashion sector[29].

[24] For further information, please visit: http://www.greentechbrussels.be/en/component/k2/item/227/227

[25] ResilieNtWEB website: http://resilientweb.eu/en/

[26] Irisphere website: http://irisphere.be/fr#synergy

[27] Greenbizz website: http://www.greenbizz.be/en/

[28] See Innoviris, http://www.innoviris.be/fr/documents/synthese-projets-co-create-2015.pdf

[29] Mad Brussels website: http://mad.brussels/en

Good practice 22 France: Call for projects – circular economy, recycling and waste transformation

As part of the "Investments for the Future" Programme, ADEME launched in September 2015 a call for projects dedicated to circular economy, recycling and waste transformation. The objective is to support technology and/or organisational innovations, as well as innovative industrial solutions related to these issues, especially in relation to the following topics: eco-design, re-use, recycling, transformation of recycled materials, recycling centres, recycling of plastic and composites, and waste from construction work.

This call for projects targets projects with a budget of at least €2 million, from individual companies or from consortia (with a company as a leader).

Support from ADEME comes as grants and repayable advances – in case of success of the project.

Source: https://appelsaprojets.ademe.fr/aap/DECHETS2015-95?ref=DECHETS2015-95 ; http://www.ademe.fr/recherche-et-innovation

Good practice 23 The Scottish Institute for Remanufacture (SIR)

SIR was launched on 21st January 2015 by Richard Lochhead, Scotland's Environment Secretary. Hosted at the University of Strathclyde, it is **one of only four centres of excellence for remanufacturing in the world**. Its assigned objectives are threefold:

1. **Increase innovation** through stimulating and co-funding collaborative projects bridging the gap between academic experts and the industry;
2. **Increase activity and engagement** from the academic community to build capacity;
3. Establish the Scottish **remanufacturing community** and provide **networking opportunities**

According to SIR, remanufacture "returns a used product to at least as new performance specification and gives the resultant product a warranty that is at least equal to that of a newly manufactured equivalent."

Remanufacturing projects nurtured by SIR entail **economic, social and environmental benefits** for the industry and Scotland: Reduction in raw materials, waste, energy usage and carbon footprint, improved design for products, closer customer relationship and increased creation of skilled jobs.

Source: http://www.scot-reman.ac.uk/

Good practice 24 Fit 4 Circularity Luxembourg

Fit4Circularity is a new support scheme created in 2015 by LuxInnovation and targeting SMEs, following the Fit4Digital and Fit4Innovation initiatives.

Fit4Circularity is dedicated to helping SMEs that are willing to make a more substantial commitment to sustainable development practices and to implement a circular economy approach. The objectives are to limit the use of raw materials, maximise the use of renewable sources, develop innovative products and services for sustainable growth, reduce energy consumption and increase recyclability.

LuxInnovation, the Innovation Agency of Luxembourg, along with external consultants, will help SMEs apply for the scheme and implement their projects. Expected results of the Fit4Circularity scheme are improved competitiveness and increased revenues for SMEs. Different kinds of projects can be eligible for support: technological innovation, organisational innovation and investment.

Source: http ://en.luxinnovation.lu/News/Archives/Renforcer-sa-compétitivité-grâce-à-l'économie-circulaire

5.3.4 |Information, capacity building and networking support measures

Soft measures targeting advisory services and information provision for CE and eco-innovation offered to companies, customers, or technology adopters have become more widespread. There is also an increasing trend towards establishing networking and collaboration platforms to strengthen the ties in a crosscutting field such as the circular economy. See for instance boxes below for good practice examples of specific networking initiatives and platforms in Belgium and Germany, and for advisory services to businesses wanting to develop industrial symbiosis, circular economy products or reduce waste in Belgium and Ireland.

Support measures for professional training or skills enhancement are, on the other hand, less mentioned as initiatives in the EIO country reports. In the Netherlands, there are efforts made to also integrate the circular economy in the curricula of relevant educational courses. This is the purpose of the Practice Research from Waste to Resource (PRO CATCH) programme, which has been set up so that technical colleges can work in partnership with business students on specific technical solutions that fit into the circular economy. Results are used in the development of training programmes. Furthermore, within this activity the RACE-coalition (Realisation Acceleration Circular Economy, see below good practice example) was set up to coordinate acceleration of the circular economy.

An innovative model of a public private partnership is promoted under an instrument called "Green deals", which has been pioneered by the Netherlands, and now being picked up by other member states, as well as by the international organisation[30]. Green Deals is an accessible way for companies, other stakeholder organisations, local and regional government and interest groups to work with Central Government on green growth and social issues. The aim is to remove barriers in order to help sustainable initiatives get off the ground and to accelerate this process where possible. Central Government plays a key role in this area. Initiatives often start from the bottom up, in response to societal dynamics. The Green Deal approach has gained international interest from the governments of France, the United Kingdom, Germany, Belgium, Sweden and Finland, from the European Commission, from OECD and from UNEP.[31]

[30] http://www.greendeals.nl/english/

[31] http://www.greendeals.nl/english/going-international/

Good practice 25 Collaboration and networking platforms for the circular economy in Belgium

Brussels Waste Network, founded by a public-private partnership and BECI (Chamber of Commerce and Union of Brussels Enterprises) to reduce the amount of waste generated by businesses and enhance waste sorting[32]

Wallonia: **The NEXT-platform- Circular Economy platform**: It is a programme designed to promote projects of industrial symbiosis and circular economy in order to minimize the loss of resources (energy, materials, and water). The overall objective of the program is to support the sustainable competitiveness of companies through actions involving awareness raising, specialist support, detection of potential synergies and mutualisation.

The Short Cycles Reference Centre[33] was launched in 2013. It is the contact point for any accompanying structure regarding "short cycles". It has established a catalogue of direct and indirect actors in Wallonia, connects and strengthens actors and fosters the emergence of innovative sustainable "short cycles" projects. This objective is to highlight local producers and to bring them into relationship with consumers to help them develop.

The Circular Economy Reference Centre was created in 2014 and focuses on raising Walloon businesses' awareness about the challenges and opportunities of the circular economy and resource management, coordinates field players on this topic and manages the circular economy fund for the Walloon SMEs to help projects materialize.

Good practice 26 RACE Coalition Netherlands

Within the VANG-programme, the Dutch National government has taken the initiative to cooperate with societal leaders to accelerate the transition towards a circular economy. In the RACE-coalition (Realisation Acceleration Circular Economy), the cooperative company Circle Economy (with members including companies, researchers and public bodies, Click NL, De Groene Zaak, Het Groene Brein and MVO Nederland) is supported by RVO Netherlands and the Ministries of Economic Affairs, and Infrastructure and Environment, to realise the advantages of a circular economy.

RACE goals include:

1 Define and stimulate circular design
2 Stimulate high-quality reuse of products
3 Analyse the barriers to the circular economy
4 Create a portfolio of circular projects that will serve as examples
5 Raise public awareness about the circular economy
6 Involve young people in the transition to a circular economy.

RACE is a young initiative but it has already created a set of guiding principles for circular design and started to test them. These, according to RACE, "challenge designers to first make a statement about the need they are going to fulfil with their design, rather than directly focusing on a physical product."

Source: http://ec.europa.eu/environment/ecoap/about-eco-innovation/policies-matters/netherlands/netherlands-pulls-ahead-in-circular-economy-race_en

More: http://www.circle-economy.com/projects/regional/netherland-circular-hotspot/

[32] Brussels Waste Network website: http://www.brusselswastenetwork.eu/

[33] Agence de stimulation économique (Economic stimulation agency): http://as-e.be/outil/le-centre-de-reference-des-circuits-courts

Good practice 27 RETech - an export network for the German recycling and waste management industry

German RETech Partnership
Recycling & Waste Management
Made in Germany

The German Recycling Technologies and Waste Management Partnership e.V. was established in 2011 as a result of the Recycling and Efficiency Technology initiative of the Federal Ministry of the Environment. RETech activities are focused on the promotion of applying sustainable environmental technology of the German recycling abroad. RETech is the contact for all public and private organisations and/or institutions domestic and abroad, taking an interest in the German resource and efficiency technology. RETech offers a neutral platform for companies interested in innovative technologies for recycling and waste management issues and their export. Within this platform members may exchange information on technical issues such as the financing or the hedging of foreign business. Due to this network the RETech platform provides a unique opportunity for supporting the establishment of a well-ordered waste management industry, improving the requirements significantly for the export of German waste management and recycling technology.

Source: http://www.retech-germany.net

Good practice 28 Green Business Programme Ireland

Green Business

epa GreenBusiness

The Green Business programme is an EPA-funded initiative that provides free resource efficiency audits and recommendations to SMEs. By the end of 2014, 180 companies participated in the programme, with identified savings totalling €6.7 million. A number of participating companies have already acted upon Green Business advice and have achieved significant cost savings and reduced their environmental impacts.

Green Business also holds regional workshops to introduce the concept of waste prevention and discuss resource efficiency issues with businesses. A number of guidance documents in the area of resource efficiency and environmental management have also been developed.

Source: Green Business website http://greenbusiness.ie/

EPA (2015) National Waste Prevention Programme Annual report 2014, https://www.epa.ie/waste/nwpp/reports/NWPP%202014%20Report.pdf

Good practice 29 Netherlands: Green Deals for Circular Economy

Green Deals (introduced in 2011) are non-financial support actions to create conditions for innovation and new sustainable entrepreneurial activities. In the period 2011-2014, 176 Green Deals were closed in the Netherlands, involving a total of 1,090 participants. Within the Waste to Resource programme Green Deals are now used to systematically address major issues for a broad range of policies, with the Circular economy being the key.

As part of the Dutch EU Presidency, a first international Green Deal was closed in March 2016, in the field of circular economy, with participation from the Netherlands, France, the UK, Flanders, businesses and environmental NGOs. With the North Sea Resources Roundabout (NSRR) the parties involved want to streamline the regulation for recovering resources from waste and facilitate responsible international trade in waste streams such as aluminium and lead.

This year the Netherlands Ministry of Infrastructure and the Environment and the Ministry of Economic Affairs will explore the possible contributions of transnational or international Green Deals to the transition towards a circular economy.

Sources: I&M, 2015; https://www.europadecentraal.nl/eerste-internationale-green-deal-gesloten-ter-bevordering-van-circulaire-economie/

More: http://www.greendeals.nl/english/

5.3.5 |Voluntary measures

The voluntary policy measures can also be used to encourage innovations for circular economy. Such measures can include performance labels for products and services, guarantees for product durability and repair, as well as negotiated agreements between public and private sector, with the public or unilateral voluntary commitments by private sector.

International voluntary environmental instruments are well established throughout Member states. These include the EU Eco-Management and Audit Scheme (EMAS) and Environmental Management System under ISO 14001 (EMS); environmental labelling of products, implemented through the European and national eco-labelling schemes, such as EU Ecolabel and Environmentally Friendly Products. Many member states have introduced national schemes for communication of ecological footprint of the products and services that are voluntary. For example, a national voluntary scheme in Italy, defined as “made green in Italy” has been introduced in 2015 with the overall objective to sustain the competitiveness of the Italian economy in light of the increasing demand for green products (EIO 2015 report on Italy). The Germany’s Waste Prevention Programme (2013) recommends to extend the Blue Angel eco-label scheme to further selected product groups in order to recognise and award waste-minimising manufacturing techniques[34]

Over the years the voluntary environmental management certification tools have shown to be supportive in summoning eco-efficiency and environmental management practices in industries, as well as in public organisation and service-oriented companies. The application of various type of sustainable product labelling has grown massively in the EU and globally, which help consumer to make more informed choices in the consumption. However, the contribution of these instruments to circular economy practices and business model is rather limited to the material efficiency optimisation, better waste management practices and recycling, while reuse, remanufacturing, repair and circular design still need to find their way for systematic

[34] German Federal Ministry for Environment, Nature Conservation and Nuclear Safety, 2013: Waste Prevention Programme, http://www.bmub.bund.de/fileadmin/Daten_BMU/Pools/Broschueren/abfallvermeidungsprogramm_en_bf.pdf

integration into these instruments. A flagship example is demonstrated in France. Its 2015 Act on energy transition for green growth is launching experimentation with voluntary display of the lifespan of several consumer products with possible repairs criteria including reparability (meaning a network of service stations), possibility to disassemble, availability of spare parts at a given cost and with a given duration after the end of production line.

A promising trend has been emerging in application of another soft instrument—a voluntary agreement between industries and public authorities on sustainable practices. The observed examples show that such agreements are considered useful for promoting circular economies on local and national levels. Examples from selected Members States are presented below. Interestingly, such voluntary agreements can have rather divers focus: some targeting specific products and closing the loop in the life cycle of products (see example of beverage packaging in Austria below), others have more horizontal outreach addressing, e.g. reuse and recycle practices across industries (see below the case from Italy and Ireland). Discussed in section 5.3.4 "Green deals" instrument can also be seen as a voluntary negotiated agreement between government and business companies, where companies must make substantial contribution to environmental goals via, for example, circular economy practices, in return to the government's assurance of removing specific, often regulatory barrier. All in all, the voluntary agreements are not yet a widely diffused practice, however there is clearly a growing interest to them.

Good practice 30 Voluntary agreements for consumption of reused and recycled products in Italy

Voluntary agreements and incentives to support the consumption of products made from waste (post consumption materials), recovered materials, and parts of dismantled products have been established (Article 23 of Bill 28 December 2015 – 221). The Ministry of Economic development can set agreements with public bodies, economic associations, private firms, etc. and provide financial incentives to support business activities that produce goods made from reused and recycled materials and dismantled materials. Incentives are provided to commercial activities that sell recycled products defined under these rules: UNI EN 13242: 2013, UNI EN 12620:2013, and UNI 10667-13:2013. Funding resources for the (fiscal) incentives are defined, as are the recycling standards under which the funding is provided.

Source: EIO 2015 report on Italy

Good practice 31 Sustainability agenda for beverage packaging - Austria

Already more than 1,000 Austrian companies are involved in the initiative "Sustainability agenda for beverage packaging", which was initiated by the Austrian Chamber of Commerce. With this voluntary agreement between beverage producers, all major food and beverage retailers and recycling companies in Austria, the target was defined to reduce greenhouse gas emissions by at least 10% in absolute terms between 2008 and 2017. The strategies to achieve this overarching target are on the one hand oriented towards stabilising the share of reusable packaging through investigating in technical improvements and raise awareness. On the other hand, the material efficiency of disposable packaging, particularly plastics and metal packaging, is being increased through further raising recycling ratios and investing in recycling technologies, such as PET-to-PET recycling.

© www.nachhaltigkeitsagenda.at

Source : www.nachhaltigkeitsagenda.at

Good practice 32 Prosperity agreement - Ireland

Northern Ireland Environment Agency (NIEA) introduced the **Prosperity Agreements** a new approach to help meet strategic goals on resource efficiency and environmental impact. Through the Agreements NIEA supports responsible businesses to move beyond minimum compliance and towards harnessing value from innovation particularly in energy use and resource management. The Prosperity Agreements are voluntary partnerships that seek to improve the relationship between Northern Ireland's environmental regulator and key stakeholders whilst facilitating mutual gains in economic and environmental performance

Source: Department of the Environment, Prosperity Agreements: https://www.doeni.gov.uk/articles/prosperity-agreements

6 | Key findings and main messages

Circular economy increasingly represented in the strategic national policy agendas of the EU Member States

- Evidence of the benefits of a transition towards a circular economy has increased over recent years. This has led to the increased embracement of the circular economy concept in society. Circular economy is currently penetrating the strategic national policy agendas of the EU Member States. A few countries address circular economy in the more generic context of their resource efficiency strategies, where it is addressed in a somewhat narrow definition based on material efficiency, recycling and waste prevention or management. However, there are examples of more ambitious and more comprehensive strategies, such as the recent circular economy strategy of Scotland that has a more systemic approach tackling the products design, durability, reuse, reparability, etc. as well as promoting new business models that can be at the core of the circular economy.

Promising eco-innovations across the EU but gaps between good intentions and changed behaviours

- Promising eco-innovations can be seen across the EU with the potential to be scaled-up. This includes in particular eco-innovations at the design phase. However, most efforts seem to be concentrated in individual markets or market niches instead of bridging the full circular model from design to disposal. Citizens seem willing to embrace environmental products through their purchasing decisions, but confusion exists as regards what is "green" and there seems to be a gap between good intentions and changed behaviours. Bottom-up approaches such as repair, reuse and sharing initiatives set powerful examples of how change may be implemented, but seem to remain in certain social niches instead of penetrating the mainstream.

Lack of knowledge and uncertainty in the transformation from waste to a circular resource management

- Despite the increased presence of the circular economy in the policy discourse, the majority of activities at the Member States level is still overwhelmingly regarded as waste management measures, which indicates a lack of knowledge and general uncertainty in the transformation from waste to a circular resource management. Existing regulatory framework conditions are not favourable for engaging in circular economy activities. On the one hand, there is a need to break the “lock-in” in existing systems for waste management. On the other hand, there is a need to move towards alternative systems for consumption (e.g. sharing, reuse) and production (e.g. repair, remanufacturing). Product design is an important element in shifting to these alternative systems, therefore creating framework conditions for promoting the alternative design of products should be one of the main emphases of the circular economy policies.

Barriers to the transition towards a circular economy

- There are also a number of barriers to the transition towards a circular economy, including the falling commodity prices since mid 2014, insufficient investment, lack of skills and know-how, limited acceptance of alternative models of consumption and business, and lack of policy coherence. In shifting to circular economy, there should be a systemic approach that addresses many barriers in a comprehensive way and creates favourable framework conditions (e.g. embracing regulation, institutional settings, targets, instruments, curricula, infrastructures, networks, key actors, etc.). Policies will play a key role in this.

Eco-innovation: Hardware and software solutions

- Eco-innovation is an important element of all circular economy efforts. Different types of eco-innovations, i.e. product, process, organisational, marketing, social, system eco-innovation, are instrumental in transforming a linear economy into a circular economy. Building a circular economy will require boosting and creating favourable conditions for all types of eco-innovation.
- The circular economy will require eco-innovations in two different fields that could be labelled as the circular economy "hardware" and "software": first being technologies and technical infrastructures and second being skills, expertise and business models that would turn this transformation into a business case.
    - The patents statistics shows that whilst the growth rate of overall technological inventions is constantly growing, inventions focused on waste management and recycling has not been developing to the same extent over the last decade. This was due to limited focus on waste disposal, which has been seen as a "technically solved" problem. There is a strong need to promote R&D addressing wider concepts of circular economy, including circular design of products (e.g. durable, repairable, remanufacturable, etc.), as well as recycling, urban mining, and valorisation of waste as resources.
    - The "Software" of circular economy is another highly important element that needs a strong support and framework conditions in order to develop. Business models based on the new consumption patterns and offering functionalities of products rather than the products themselves will need to gain bigger diffusion.
- Creating favourable conditions for both the "hardware" and the "software" for the circular economy should become a part of a holistic policy support strategy. While supporting the "hardware" is something where policy makers can rely on the traditional innovation support instruments, development of "software" requires innovative approaches in policymaking. Much of the efforts should be focused on changing the mind-sets of consumers and creating an environment where companies can find economic prospects in business models based on sharing, remanufacturing, reuse and repair.

Stakeholders, policies and responsibilities

- For different stakeholders, circular economy will have different meanings and involve different roles and responsibilities. For each of them, framework conditions should provide direct or indirect incentives to act, plan, consume, produce or engage in business in a manner that contributes to circular economy.
- To promote initiatives of circular eco-innovations the national and local governments can deploy a range of policy measures. These can be regulatory instruments, economic instruments, such as fiscal and financial incentives (taxes, fees), direct funding, demand pull instruments (e.g. procurement), R&D support measures, such as grants, infrastructure provision, supporting R&D personnel, information, education and networking support measures, and voluntary measures including performance labels and guarantees for products, voluntary agreements and commitments. Application of these measures in the context of circular economy development in Member States is not yet very wide. However, there is an opportunity to learn from selected policy initiatives and new practices on national and municipal levels that have been emerging.

Monitoring and eco-innovation performance

- Monitoring and assessing the performance of the circular economy is still a challenge due to insufficient presentation of the circular economy elements by the existing indicators. This study focused on analysis of specific indicators such as DMC, which accounts for material directly consumed (excluding accounting of imported products), and employment and turnover in selected recycling, repair and reuse sectors. Latvia, Finland, Sweden and the UK had the highest proportion of employees in the selected eco-industry sectors compared to their populations (N of jobs per 1000 inhabitants). At the same time MS such as Ireland, Luxembourg and the Netherland have significant revenue generated in these sectors compared to a relatively low number of employees. These countries had the highest operating turnover per number of employees in 2014.
- The eco-innovation performance, as measured with the Eco-Innovation Scoreboard (Eco-IS) varies widely across EU Member States. Northern and Central European countries, such as Denmark, Finland, Ireland and Germany lead the eco-innovation ranking in the EU. These countries are generally characterised by high inputs into eco-innovation in terms of R&D spending and investments, high eco-innovation activity of companies as well as comparatively high eco-innovation outputs, for example regarding patents. Most new MS are found in the group of "countries catching up in eco-innovation". While these countries perform worse regarding eco-innovation inputs, activities and outputs, in some categories they have a similar or even better performance than eco-innovation leaders. For example, countries such Hungary, Romania or Latvia, reach comparatively high scores regarding socio-economic outcomes, as they have relatively high exports from and employment in eco-industry sectors.
- Applying international datasets allows expanding the analysis beyond the European borders. The Global Eco-Innovation Scoreboard, which compares the eco-innovation performance of 126 countries worldwide, illustrates that many European countries, including non-EU countries such as Switzerland, Norway or Iceland, are found among the global eco-innovation leaders. Among the top-20 countries, only Singapore, Australia and Canada are top-performers beyond Europe. The comparatively low ranking of many Asian, African and Latin American countries illustrates the need these economies face to further expand their eco-innovation and circular economy activities.

ANNEX 1

Complementary analyses of EU circular economy performance

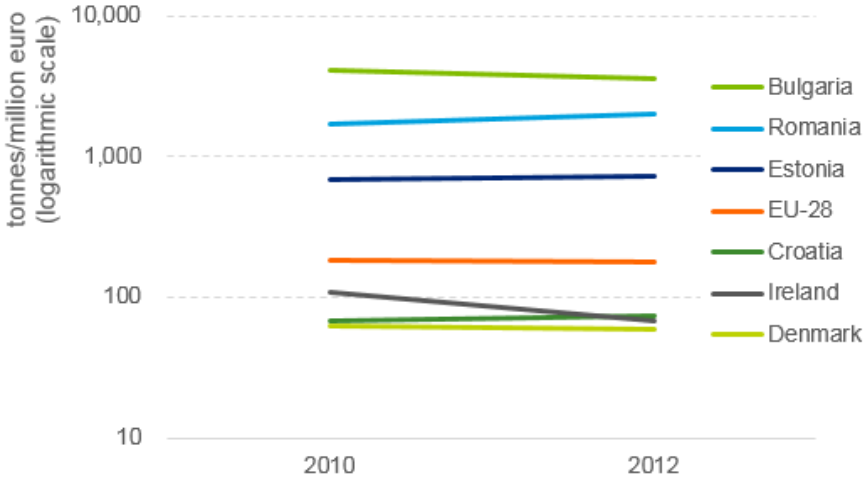
In this Annex, we present the analysis based on additional complementary indicators and data relating to waste generation, recycling and eco-innovation activities. Analyses are presented for the following indicators:

a. Waste intensity (waste generation/GDP/capita)
b. Resource productivity (GDP/DMC)
c. Municipal recycling rate (municipal waste recycled/municipal waste generated)
d. Existence of EPR schemes, deposit refund schemes and repair cafes

A1 Waste intensity

Measuring the waste intensity of a MS provides insights on the magnitude of waste generated compared to the country's GDP and population. For this, the following calculation was performed: waste intensity equals waste generated (in tonnes) per GDP (in million euro) using data from 2012. Based on data extracted from Eurostat, results were most pronounced in Romania (3,546 t/M€), Bulgaria (1,995 t/M€) and Estonia (728 t/M€) meaning that a large amount of waste was generated with respect to GDP, as shown in Figure A1-1.

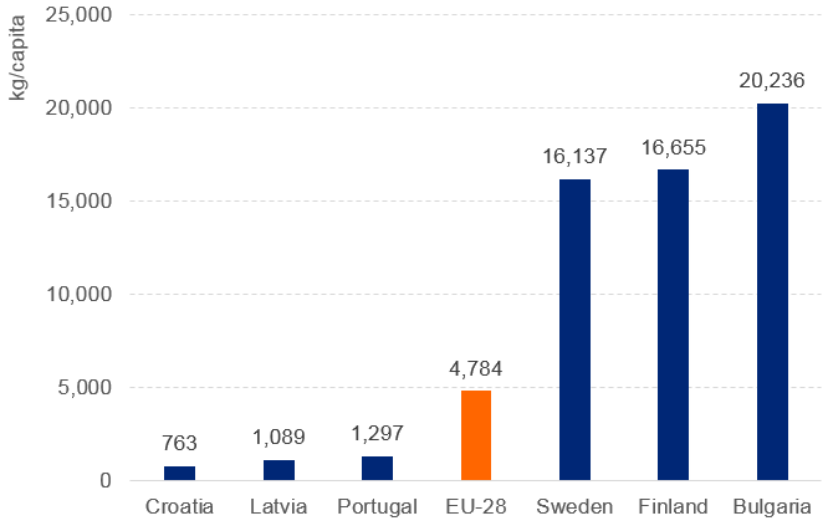
Figure A-1 Total waste generated/GDP from 2010 - 2012 (in tonnes/million euro)



Source: Eurostat.

All three highly waste-intensive countries ranked relatively low in terms of GDP for 2012 compared to EU-28. Romania ranked 17th, Bulgaria 22nd and Estonia 27th. In terms of waste generation, Bulgaria generated the most waste per capita in 2012 with 20,236 kilograms. Romania and Estonia ranked 5th and 6th respectively with 13,277 kilograms and 9,702 kilograms of generated waste (see Figure A1-2).

Figure A-2 Waste generation of top three and bottom three countries and EU-28 average, 2012 (in kg per capita)



Source: Eurostat.

Results indicate that the bottom three least waste intensive countries are Denmark (60 t/M€), Ireland (69 t/M€) and Croatia (74 t/M€). In terms of GDP in the same year they ranked 11th, 14th and 20th respectively. As for waste generated per capita, Denmark came 17th (2,708 kg/capita), Ireland 18th (2,624 kg/capita) and Croatia 28th (763 kg/capita).

This indicator highlights in particular the waste intensity performance of MS such as Croatia, which has both low waste generated per capita and per GDP. For MS such as Romania and Bulgaria, the high amount of waste generated per GDP and per capita could indicate that further measures are needed to reduce household consumption and reduce waste generated from industry.

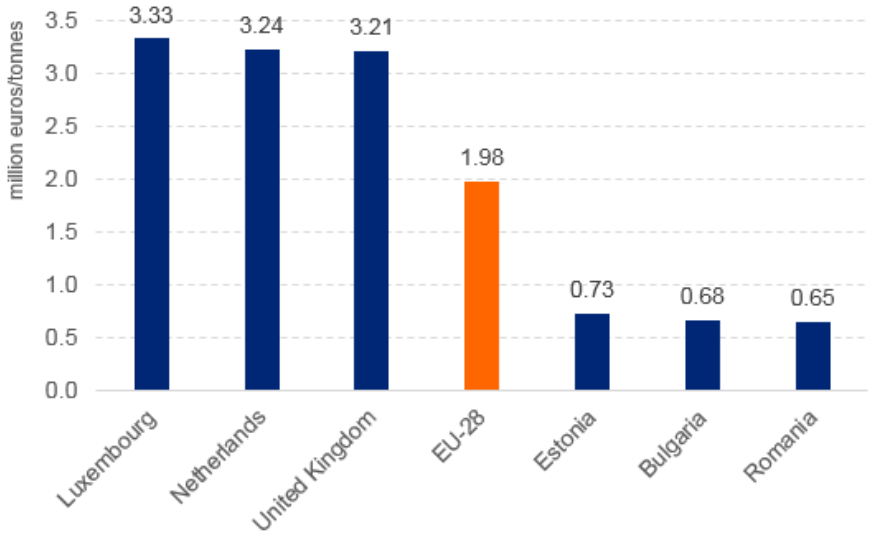
A2 Resource productivity (GDP/DMC)

Eurostat provides an indicator on resource productivity, which is a measure of the total amount of materials directly used by an economy (DMC) in relation to GDP. It provides insights into whether decoupling between the use of natural resources and economic growth is taking place. Resource productivity (GDP/DMC) is used as the EU sustainable development indicator for policy evaluation.[35]

Figure A1-3 shows the results for resource productivity in 2012. Results indicate that Luxembourg, the Netherlands and the UK were the highest performers, whereas Estonia, Bulgaria and Romania were the weakest performers. Interestingly enough, these results are also very similar to the top and bottom MS performers for the circularity indicator used for the ranking (see chapter 4 in main text).

[35] Eurostat website on resource productivity indicator, http://ec.europa.eu/eurostat/statistics-explained/index.php/Resource_productivity_statistics

Figure A-3 Resource productivity of top three and bottom three countries and EU-28 average in 2012 (Purchasing Power Standard GDP per kilogram DMC)



Source: Eurostat.

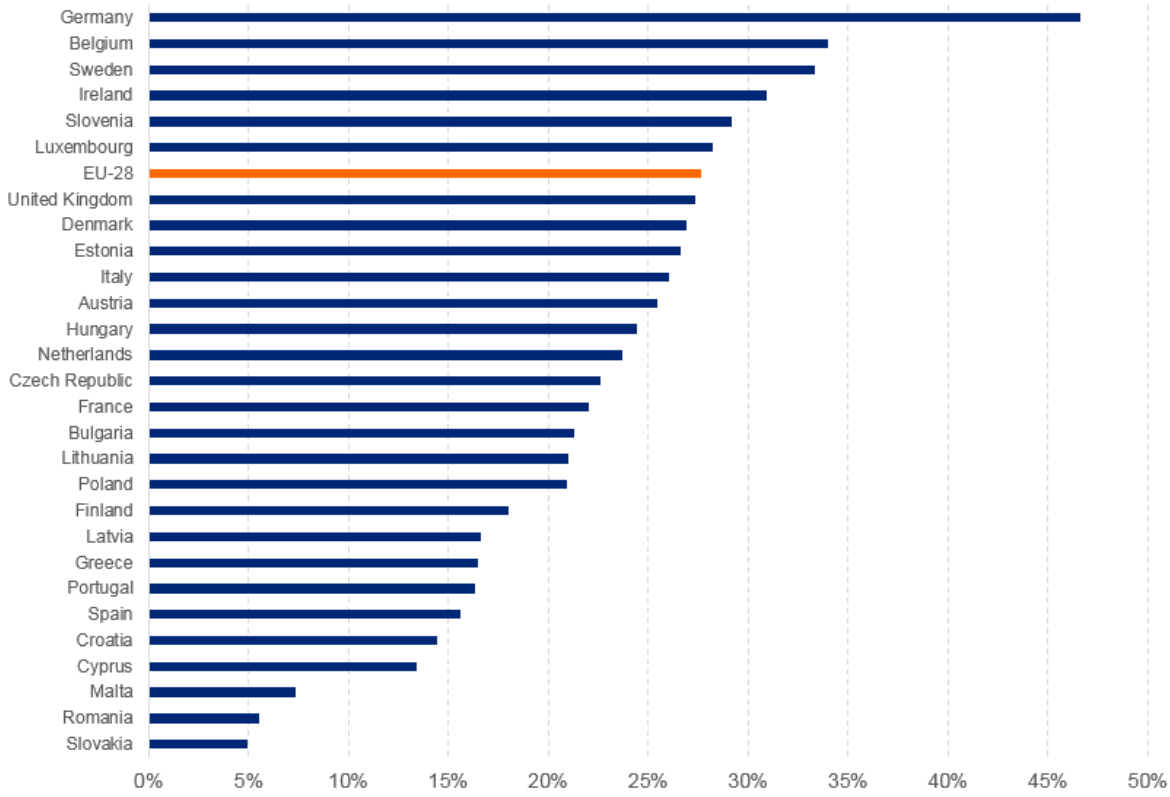
The analysis by Eurostat indicates that there is a correlation between resource use (DMC per capita) and GDP (in purchasing power standard (PPS) per capita) i.e. environmental pressure decreases up to a certain level as the economic activity goes up. However, Eurostat also warns against some limitations of the results related to DMC figures, which does not take into account outsourcing material-intensive production to other parts of the world. This limitation was also highlighted concerning the results of the circularity indicator (see main text of Chapter 4). Further, impacts of the economic crisis on material-intensive industries could also play a key factor on material consumption and thus the DMC value for certain MS.

A3 Municipal recycling rate

The European Commission's Circular Economy Package includes revised legislative proposals on waste to stimulate Europe's transition towards a circular economy. One such proposal includes a common EU target for recycling 65% of municipal waste by 2030.[36] Estimates based on the latest available figures extracted from Eurostat for 2014 (municipal waste recycled/municipal waste generated, see Figure A1-4) indicate that Germany (47%), Belgium (34%) and Sweden (33%) are the closest to meeting the municipal waste recycled target compared to Slovakia, Romania and Malta with an estimated municipal recycling rate at 5%, 6% and 7% respectively. The EU average is 22% in 2014. For the MS with very low municipal recycling rates, much progress would be required to meet the 65 % recycled municipal waste target by 2030.

[36] European Commission website on Circular Economy Package: http://ec.europa.eu/environment/circular-economy/index_en.htm

Figure A-4 Share of municipal waste recycled per MS in 2014 (in %)



Source: Eurostat.

A4 Extended Producer Responsibility (EPR) schemes, deposit schemes, and repair cafes

Finally, some other interesting aspects related to circular economy performance that can be retrieved include information on the existence of EPR schemes, deposit schemes and repair cafes.

EPR is a widely used environmental policy, applicable to many product categories. The principal of EPR is to ensure that producers take over the responsibility for collecting or taking back used goods and for sorting and treating for their eventual recycling. EPR was originally used for packaging waste, and since has broadened to incorporate many other product categories and waste streams such as used oils, used tyres, graphic paper and textile, medicines, etc. A report on EPR from 2014 carried out a benchmark on the performance of EPR schemes across the EU. Comparison of EPR performance was difficult due to inaccessible or incomparable data, however it did provide a good overview of the existing EPR schemes, which is shown in Table A1-1.[37]

[37] BIO (2014), Development of Guidance on Extended Producer Responsibility (EPR) http://ec.europa.eu/environment/waste/pdf/target_review/Guidance%20on%20EPR%20-%20Final%20Report.pdf

Table A-1 Number of EPR schemes per MS and product category

MS	Batteries	WEEE	Packaging	ELV	Tyres	Graphic paper	Oils	Medical waste	Agricultural film
AT	X	X	X	X	X		X	X	
BE	X	X	X	X	X	X	X	X	X
BG	X	X	X	X	X				
CY	X	X	X	X	X	X	X		
CZ	X	X	X	X					
DK	X	X	Δ	X	X	X			
EE	X	X	X	O	X			O	
FI	X	X	X	X	X	X		X	X
FR	X	X	X	X	X	X		X	X
DE	X	X	X	O			X		X
GR	X	X	X	X			X		
HU	X	X	Δ	X	Δ				
IE	X	X	X	X	X				X
IT	X	X	X	X	X				X
LV	X	X	X	X	X	X	X		
LT	X	X	X	X	X	X			
LU	X	X	X	X					
MT	X	X	X	N/A					
NL	X	X	X	X	X	X			
PL	X	X	X	X	X		X		
PT	X	X	X	X	X		X	X	
RO	X	X	X	O					
SE	X	X	X	X	X	X		X	X
SK	X	X	X	X	X	X			
SI	X	X	X	X	X		X	X	
ES	X	X	X	X	X		X	X	X
UK	X	X	X	X					
HR	X	X	X	X	X		X	X	
Total	28	28	27	27	20	11	10	10	8

X	EPR scheme	O	Takeback obligation but no PRO	Δ	Product fee legislation/Govt fund

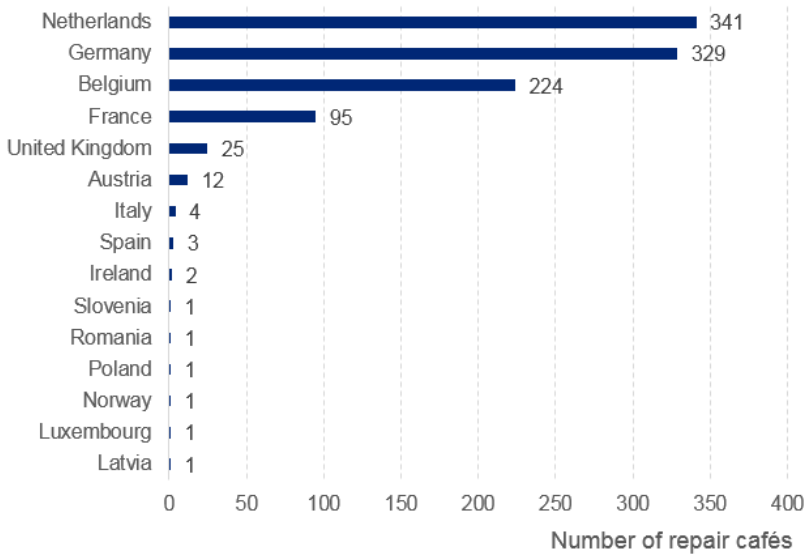
Source: BIO 2014.

Deposit schemes have also been implemented in a number of MS, especially in Denmark, the Netherlands, Germany, Finland, Sweden and Norway.[38] Several MS have passed national legislation on deposit schemes in order to fulfil recycling targets of beverage packaging as required under the EU Packaging Directive (2004/12/EC). Deposit systems allow for high collection rates and high quality of material that can be reused again as packaging. High performing deposit schemes can be particularly highlighted in Germany and Sweden. The introduction of the deposit on one-way beverage packaging in Germany resulted in 98.5% of refillable bottles being returned by consumers. In Sweden, the deposit system for cans and PET plastic bottles for one-way containers reached recovery rates of 86% for cans and 77% for PET.

Finally, the existence of **repair centres** is also a good indicator of MS activities in the repair sector. Data retrieved from the Repair Café Foundation website provides some information on the number of "repair cafes" found in the EU (A1-5). It should be noted that the Repair Café Foundation was first launched in the Netherlands in 2011, which can explain the high number of repair cafés there. Other sources could provide different data. Repair cafés in this context are defined as free meeting places where citizens and can bring in a large variety of objects to be repaired through the provision of tools and materials and expert volunteers with repair skills.

[38] Zerowaste website: www.zerowasteeurope.eu/2010/09/beverage-packaging-and-zero-waste/

Figure A-5 Number of repair cafés in EU-28 MS



Source: Repair Café Foundation, http://repaircafe.org.

ANNEX 2

List of indicators in the EU Eco-Innovation Scoreboard

Name of indicator	Source	Year
1. Eco-innovation inputs		
1.1. Governments environmental and energy R&D appropriations and outlays (% of GDP)	EUROSTAT	2014
1.2. Total R&D personnel and researchers (% of total employment)	EUROSTAT	2014
1.3. Total value of green early stage investments (USD/capita)	Cleantech	2012-2015
2. Eco-innovation activities		
2.1. Firms having implemented innovation activities aiming at a reduction of material input per unit output (% of total firms)	EUROSTAT	2008
2.2. Firms having implemented innovation activities aiming at a reduction of energy input per unit output (% of total firms)	EUROSTAT	2008
2.3. ISO 14001 registered organisations (per mln population)	ISO Survey of Certifications	2014
3. Eco-innovation outputs		
3.1. Eco-innovation related patents (per mln population)	Patstat	2012
3.2. Eco-innovation related academic publications (per mln population)	Scopus	2014
3.3. Eco-innovation related media coverage (per numbers of electronic media)	Meltwater	2015
4. Resource efficiency outcomes		
4.1. Material productivity (GDP/Domestic Material Consumption)	EUROSTAT	2013
4.2. Water productivity (GDP/Water Footprint)	Water Footprint Network	1996-2005
4.3. Energy productivity (GDP/gross inland energy consumption)	EUROSTAT	2013
4.4. GHG emissions intensity (CO2e/GDP)	EEA	2013
5. Socio-economic outcomes		
5.1. Exports of products from eco-industries (% of total exports)	EUROSTAT	2014
5.2. Employment in eco-industries and circular economy (% of total employment across all companies)	Orbis	2014
5.3. Revenue in eco-industries and circular economy (% of total revenue across all companies)	Orbis	2014

List of indicators in the Global Eco-Innovation Scoreboard

Name of indicator	Source	Year	Country Coverage
1. Eco-innovation inputs			
1.1. Governments environmental and energy R&D appropriations and outlays (% of GDP)	OECD	2014	35
1.2. Total value of green early stage investments (USD/capita)*	Cleantech	2012-2015	227
2. Eco-innovation activities			
2.1. Number of ISO 14001 certificates (per 1000 population)	ISO Survey of Certifications	2014	166
2.2. Companies engaged in eco-industry activities (% of total companies)*	Orbis	2014	138
3. Eco-innovation outputs			
3.1. Number of environmental patents (per mln population)	Patstat	2012	227
3.2. Number of publications (per 1000 population)	Scopus	2014	227
3.3. Eco-innovation related media coverage (per mln population)	Meltwater	2015	121
4. Resource efficiency outcomes			
4.1. Material productivity (GDP/Domestic Material Consumption)	UNEP Global Material Flow Database	2010	225
4.2. Water productivity (GDP/Water Footprint)	Water Footprint Network	1996-2005	171
4.3. Energy productivity (GDP/unit of energy use)	International Energy Agency (IEA)	2012	130
4.4. GHG emissions intensity (CO_2e/GDP)	World Resources Institute (WRI)	2012	183
5. Socio-economic outcomes			
5.1. Environmental Goods (EG) share in total trade (% of total exports)	UN COMTRADE	2014	163
5.2. Employment in eco-industries and circular economy (% of total employment across all companies)	Orbis	2014	127
5.3. Revenue in eco-industries and circular economy (% of total revenue across all companies)	Orbis	2014	115

References

Bahn-Walkowiak, B., von Gries, N., Wilts, H., and Schefer, S. 2014. “Comparing Trends and Polices of Key Countries : Report about Drivers for Resource Decoupling and the Role of National Policies.” POLFREE - Policy Options for a Resource efficient Economy; Project funded by the European Commission under Grant 308371. London: University College London.

Bastein, T., Roelofs, E., Rietveld, E., Hoogendoorn, A. 2013. “Opportunities for a Circular Economy in the Netherlands.” Delft: TNO.

Bilsen, V. et al. 2015. Review of the Eco-innovation Action Plan (EcoAP). Prepared for the European Commission, DG Environement. Brussels.

BIO. 2014. Development of Guidance on Extended Producer Responsibility (EPR). Final Report for European Commission, DG Environment. Paris: Bio Intelligence Service.

Botsman, R., Rogers, R. 2010. “What’s Mine Is Yours: The Rise of Collaborative Consumption.” Harper Collins.

Charter, M., Gray, C. 2007. “Remanufacturing and Product Design: Designing for the 7th Generation.” Retrieved from URL http://www.research.ucreative.ac.uk/695/2/Remanufacturing_and_Product_Design.pdf [5 Dec 2016]

Doranova, A., Gigli, M. 2014. “Circular Economy Policy Guidance.” Deliverable 4.3 greenXpo project. Workpackage 4. Brussels.

EEA. 2015. “Waste Prevention in Europe — the Status in 2014.” EEA Report No 6/2015. Copenhagen: European Environment Agency.

———. 2016a. “Circular Economy in Europe — Developing the Knowledge Base.” Copenhagen: European Environment Agency.

———. 2016b. “More from Less — Material Resource Efficiency in Europe : 2015 Overview of Policies, Instruments and Targets in 32 Countries.” EEA Report No 10/2016. Copenhagen: European Environment Agency.

EIO. 2010. “Methodological Report.” Financed by the European Commission, DG Environment. Brussels: Eco-Innovation Observatory.

———. 2012. “Closing the eco-innovation gap: An economic opportunity for business. Annual Report 2011. Financed by the European Commission, DG Environment.” Brussels: Eco-Innovation Observatory.

———. 2013. “Europe in Transition: Paving the Way to a Green Economy through Eco-Innovation. Annual Report 2012. Financed by the European Commission, DG Environment.” Brussels: Eco-Innovation Observatory.

———. 2014. “Eco-Innovation and Competitiveness: Enabling the Transition to a Resource-Efficient Circular Economy. EIO Annual Report 2013.” Financed by the European Commission, DG Environment. Eco-Innovation Observatory. Luxembourg: Publications Office of the European Union. ISBN: 978-92-79-43759-5.

Ellen MacArthur Foundation. 2013. “Towards the Circular Economy: Economic and Business Rationale for an Accelerated Transition.” 1. Retrieved from URL https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Ellen-MacArthur-Foundation-Towards-the-Circular-Economy-vol.1.pdf [5 Dec 2016]

———. 2014. “Towards the Circular Economy: Accelerating the Scale-up across Global Supply Chains.” 3. Retrieved from URL http://www3.weforum.org/docs/WEF_ENV_TowardsCircularEconomy_Report_2014.pdf [5 Dec 2016]

———. 2016. “Intelligent Assets: Unlocking the Circular Economy Potential.” Retrieved from URL http://www.ellenmacarthurfoundation.org/assets/downloads/publications/EllenMacArthurFoundation_Intelligent_Assets_080216.pdf [5 Dec 2016]

Ellen MacArthur Foundation, World Economic Forum, and McKinsey Center for Business and Environment. 2016. “The New Plastics Economy: Rethinking the Future of Plastics.” Retrieved from URL https://www.ellenmacarthurfoundation.org/assets/downloads/EllenMacArthurFoundation_TheNewPlasticsEconomy_29-1-16.pdf [5 Dec 2016]

EPA. 2014. “Towards A Resource Efficient Ireland - A National Strategy to 2020 Incorporating Ireland’s National Waste Prevention Programme.” Wexford: Environmental Protection Agency.

European Commission. 2011a. “Roadmap to a Resource Efficient Europe.” COM(2011) 571 final. Brussels.

———. 2011b. “Innovation for a sustainable Future - The Eco-innovation Action Plan (Eco-AP).” COM(2011) 899 final. Brussels: European Commission.

———. 2014a. “Towards a Circular Economy: A Zero Waste Programme for Europe.” Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions COM(2014) 398 final. Brussels: European Commission.

———. 2014b. “Green Action Plan for SMEs - Enabling SMEs to turn environmental challenges into business opportunities.” COM(2014) 440 final. Brussels: European Commission.

———. 2015a. “Closing the Loop - An EU Action Plan for the Circular Economy.” COM(2015) 614/2. Brussels: European Commission.

———. 2015b. “Innovation Union Scoreboard 2015. DG Internal Market, Industry, Entrepreneurship and SMEs.” Brussels: European Commission.

European Union. 2014. “Scoping Study to Identify Potential Circular Economy Actions, Priority Sectors, Material Flows and Value Chains.” Funded under DG Environment’s Framework contract for economic analysis ENV.F.1/FRA/2010/0044. Luxembourg: Publications Office of the European Union.

Fischer, S., O’Brien, M., Wilts, H., Steger, S., Schepelmann, P., Jordan, N.D., Rademacher, B. 2015. “Waste Prevention in a ‘Leasing Society.’” *International Journal of Waste Resources* 5 (1): 1–9. doi:10.4303/2252-5211.1000137.

Giljum, S., Lieber, M., Doranova, A., 2016. “The Eco-Innovation Scoreboard: 2014 and 2015 versions.” Technical note. Vienna: Vienna University of Economics and Business (WU).

Chipman Koty, A. 2016. “Trash or Treasure? Prospects for China’s Recycling Industry.” Retrieved from URL http://www.china-briefing.com/news/2016/03/10/trash-or-treasure-prospects-for-chinas-recycling-industry.html [5 Dec 2016]

Leismann, K., Schmitt, M., Rohn, H., Baedeker, C. 2013. “Collaborative Consumption: Towards a Resource-Saving Consumption Culture.” *Resources* 2 (3): 184–203. doi:10.3390/resources2030184.

Maschkowski, G. Wanner, M. 2014. “Die Transition-Town-Bewegung - Empowerment für die große Transformation?” Retrieved from URL http://www.planung-neu-denken.de/images/stories/pnd/dokumente/2_2014/maschkowski_wanner.pdf [5 Dec 2016]

Nicolli, F.. 2013. “Waste Technological Dynamics and Policy Effects: Evidence from OECD Patent Data.” *The Dynamics of Environmental and Economic Systems - Innovation, Environmental Policy and Competitiveness*, 179–201. Heidelberg, New York, London: Springer Dordrecht.

Plastics Europe. 2013. “Plastics – the Facts 2013, An Analysis of European Latest Plastics Production, Demand and Waste Data.” Retrieved from URL

http://www.plasticseurope.org/documents/document/20131014095824-final_plastics_the_facts_2013_published_october2013.pdf [5 Dec 2016]

Scottish Goverment. 2016. “Making Things Last - A Circular Economy Strategy for Scotland.” Edinburgh, UK: Scottish Government.

The European Parliament and the Council of the European Union. 2008. “Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on Waste and Repealing Certain Directives.” *Official Journal of the European Union*, L 312/3 – L 312/30.

Velis, C.A. 2014. “Global Recycling Markets - Plastic Waste: A Story for One Player – China. Report Prepared by FUELogy and Formatted by D-Waste on Behalf of International Solid Waste Association - Globalisation and Waste Manage- Ment Task Force.” Vienna: ISWA.

WBGU. 2016. “Der Umzug Der Menschheit: Die Transformative Kraft Der Städte.” Hauptgutachten. Berlin: Wissenschaftlicher Beirat der Bundesregierung Globale Umweltveränderungen.

Wilts, H. 2016. “Deutschland Auf Dem Weg in Die Kreislaufwirtschaft?” WISO Diskurs 06/2016. Bonn: Friedrich Ebert Stiftung. Retrieved from URL http://library.fes.de/pdf-files/wiso/12576.pdf [5 Dec 2016]

Wilts, H., von Gries, N. Bahn-Walkowiak, B. 2016. “From Waste Management to Resource Efficiency—The Need for Policy Mixes.” *Sustainability* 8 (7): 622. doi:10.3390/su8070622.

About the Eco-Innovation Observatory (EIO)

The Eco-Innovation Observatory (EIO) is the initiative financed by the European Commission's Directorate-General for the Environment. The Observatory is developing an integrated information source and a series of analyses on eco-innovation trends and markets, targeting business, innovation service providers, policy makers as well as researchers and analysts.

Visit EIO and DG ENV EcoAP website and register to get access to more information and to access all EIO reports, briefs and databases.

www.eco-innovation.eu

ec.europa.eu/environment/ecoap

European Commission